The City College of New York

Chemical Hygiene Plan
Revised May 7, 2025

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Table of Contents

Table of Contents

CHANGE HISTORY		
REVISION DATE	VERSION	CHANGE SUMMARY
▪ March 2016	▪ 2	▪ Some pictures were added. Reviewed and changed sections such ▪ as Emergency Response
▪ October 2016	▪ 3	▪
▪ February 2017	▪ 4	▪ Review language
▪ January 12, 2018	▪ 5	▪ Working Alone Policy
▪ June 11, 2018	▪ 6	▪ Eye wash stations
▪ August 16, 2018	▪ 7	▪ Working Alone
▪ August 13, 2019	▪ 8	▪ General review
▪ December 10, 2019	▪ 9	▪ General Review
▪ March 2020	▪ 10	▪ Lab Hazard Analysis, Use of Perchloric Acid
▪ September 2022	▪ 11	▪ General review
▪ March 28, 2023	▪ 12	▪ General review
▪ March 28, 2023	▪ 13	▪ Introduction
▪ April 11, 2023	▪ 13	▪ Lab Inspection Personnel=Chemical Hygiene Officer, EHS Personnel
▪ April 11, 2023	▪ 13	▪ LabcliQ=Lab Inspection Computer Program
▪ April 11, 2023	▪ 13	▪ LATCH=Lab Hazard Assessment Tool
▪ April 19, 2023	▪ 14	▪ Introduced Safety Stratus as CCNYs current Chemical Inventory Lab Software to keep track of chemicals on campus.
▪ April 19, 2023	▪ 15	▪ OSHA Right-to-Know Law
▪ April 27, 2023	▪ 16	▪ Created page numbers & EHOS Revision Date at bottom of CHP
▪ May 7, 2025	▪ 17	▪ Appendix C-Methylene Chloride/Dichloromethane Workplace Chemical Protection Program
▪	▪	▪

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1.0 Introduction

The goal of developing and implementing this Chemical Hygiene Plan (CHP) is to ensure that the City College of New York (CCNY) is committed to provide a healthy and safe working environment for the college community involving the handling & use of hazardous chemicals in CCNY laboratories that are made available to all faculty, staff, students, post-docs, visiting scholars, and all other personnel working with potentially dangerous chemicals. Moreover, the CHP is a policy that is conducted safely and consistent with Federal, State and City regulations, while fostering a safe work and study environment among laboratory personnel who store, use and dispose of unsafe chemicals, gases and equipment in the laboratory setting.

1.1 Regulatory Framework

On May 1, 1990, the OSHA "Occupational Exposures to Hazardous Chemicals in Laboratories Standard went into effect. Promulgated by the U.S. Department of Labor, 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (the **"Laboratory Standard"**). The laboratory standard requires employers to develop and implement a Chemical Hygiene Plan, designate a Chemical Hygiene Officer, setup lab safety committees, provide training to all laboratory employees and provide for medical consultations and exams.

Workplaces covered by the Standard are those where:

(a) small quantities of hazardous chemicals are used on a non-production basis;
(b) multiple chemical procedures or chemicals are used.

At the City College of New York these working areas include: laboratories, chemicalstorage rooms, instrument equipment, and cold rooms.

This Chemical Hygiene Plan is available to all laboratory employees and students engaged in lab work and / or their designated representatives. It is also available upon request to the pertinent regulatory and / or enforcement agency, e.g. FDNY, State PESH, and Federal EPA. The Laboratory ChemicalHygiene Plan shall be reviewed and updated annually. Responsibility for coordinating its review and update is assigned to the Laboratory Chemical Hygiene Officer with the cooperation of the Laboratory Safety Committee.

2.0 ADMINISTRATIVE RESPONSIBILITES

The City College of New York is responsible for the safety of its employees and students and for ensuring that everyone is in compliance with all pertinent federal, state and city regulations. The material presented in the CHP is not intended to be all-inclusive. Laboratories or work areas engaged in work with potentially hazardous chemicals that have unusual properties, or are otherwise not sufficiently covered in the written CHP, must have additional procedures, documentation, and training addressing the hazards and how to mitigate their risks, as appropriate. For information on specific chemical safety topics not covered in the CHP, please contact the EHOS at: 212-650-5080.

2.1 Who is covered by the CHP?

Principle Investigators [Researches], College Lab Technicians (CLT), Graduate, Postgraduate, and Undergraduate Students who spend a significant amount of their time working within a laboratory setting are subject to the regulations and policies stated within this Chemical Hygiene Plan. Custodial, maintenance, repair, or other personnel who, as part of their duties, regularly spend a significant amount of their working time within a laboratory environment, must also abide by the provisions of the CHP. Those working with chemicals are responsible for staying informed about the chemicals in their work areas, safe work practices and proper use of personal protective equipment (PPE). Safety is everyone's responsibility!

2.2.1 Chemical Hygiene Plan responsibilities at the City College of New York

The President of City College of New York along with the Senior Vice-President, Deans, the Vice-President of Facilities Planning and Management, and other officers and administrators will provide continued support in the effort to enhance health and safety in the laboratory.

2.2.2 School and Division Deans

The Deans for the School of Engineering, the Deans for Sophie Davis School of Biomedical Education and the Division of Science, have overall responsibility for the maintenance of appropriate conditions and protocols pertaining to the health and safety ofthe employees and students within their departments. Consequently they are required to know and understand the objectives of this plan.

A school dean may delegate to the appropriate Chairperson or her/his designee the execution of this or parts of this plan and has the authority to:

1- Require that department chairs assign a representative to the Lab Safety Committee and

2- ***Close a laboratory unit****, take or recommend other appropriate disciplinary actions* for the lack of regulatory and / or program compliance.

2.2.3 Department Chairs

The department chairs are required to:

- know and understand the objectives of the laboratory safety and health program
- support the laboratory hygiene officer in taking the necessary steps to implement and execute this program within his/her department
- assign at least one senior staff member to be part of the city college of New York laboratory safety committee
- ensure attendance to all required training programs of all employees, students, and long term visitors who may be exposed to potentially hazardous materials or unsafe working conditions in his/her department

2.2.4 CCNY Laboratory Safety Committee (LSC)

The City College of New York Laboratory Safety Committee shall consist of representatives of the following:

- office of environmental health and occupational safety
- departments of chemistry, biology, PhD program in biochemistry, physics and any other department in which laboratory work is performed
- CUNY medical school
- school of engineering: biomedical engineering, civil engineering, chemical engineering, electrical engineering and mechanical engineering
- the Art Department and the School of Architecture
- student representatives designated by student government bodies are welcome to join and participate in the Laboratory Safety Committee

The Laboratory Safety Committee shall be responsible for the following:

- it shall meet at least twice a year; minutes of every meeting shall be taken and maintained as an official record
- periodically monitor, revise and update the Laboratory Chemical Hygiene Plan and ensure that it meets pertinent occupational and environmental laws and codes
- recommend policy on matters concerning those aspects of laboratory practice that pertain to health and safety; serve as technical adviser to those officers responsible for health and safety
- address safety and health issues that may arise and recommend policy and appropriate solutions
- advise Environmental and Occupational Health and Safety on matters of policy

2.2.5 Office of Environmental Health and Occupational Safety (EHOS)

The Office of Environmental Health and Occupational Safety in conjunction with the appropriate dean and chair(s) will ensure implementation of and compliance with this plan, and the safe operation of every laboratory within the college. The Office of Environmental Health and Occupational Safety will provide guidance as necessary on all matters pertaining to:

chemical hygiene and chemical fire safety

- personal protective equipment [PPE]
- proper disposal of all hazardous and non-hazardous waste
- proper disposal of biohazard waste
- occupational and environmental regulation(s)

2.2.6 Chemical Hygiene Officer (CHO)/Environmental Health & Safety (EHOS) Personnel

CCNY has assigned a facility Laboratory Hygiene Officer who will be responsible for the development and implementation of the provisions of this plan. Some aspects of the program may be delegated to other EHOS staff as indicated in other parts of this plan. However,the overall responsibility for the execution of the plan rests with the Laboratory ChemicalHygiene Officer. The LCHO and the EHOS Personnel, i.e. EHOS Specialists, will oversee laboratory health & safety via periodic laboratory inspections using the LabcliQ computer lab inspection program (Safety Stratus Inc.).

The Laboratory Chemical Hygiene Officer is responsible for coordinating all laboratory health and safety issues and implementing the mandates of this program. The LCHO reports to the Director of Environmental Health and Occupational Safety. The Laboratory Chemical Hygiene Officer will assess hazards and set priorities and goals for their correction. He/she has the authority to restrict, stop or shut down procedures and operations he/she deems may pose a severe hazard, imminent danger to the health or life of employees, students, visitors and/or the environment, and situations that are in serious violation of safety practices outlined in this plan.

In the case where a specified hazard places the college in violation of a regulatory mandate but is not considered an imminent danger, the Laboratory Chemical Hygiene Officer will follow the steps outlined under the section entitled **Compliance Procedures** in section **9.5**.

Other responsibilities of the Laboratory Chemical Hygiene Officer **(LCHO/LHO)** are:

- at a minimum inspect annually every laboratory, storage area, equipment and instrument room or any other area where hazardous or toxic chemicals and/or gases may be used and / or stored
- ensure observance of all occupational and environmental health standards/regulations set forth by federal, state and city agencies
- serve as liaison for the City College of New York Laboratory Safety Committee, coordinate its work, and ensure discussion of its policy recommendations and agreements arising from the committee's work
- provide training and technical assistance on all matters pertaining to safety, safe chemical handling, storage and disposal
- provide air monitoring when required by a health assessment or by occupational and environmental health standards
- ensure that chemical inventories and safety data sheet databases are maintained
- investigate any other reported potential human or environmental hazard due to laboratory operation and promptly report the results to the director of environmental health and occupational safety and the appropriate party in the department.
- When an official LCHO is not available, other EHOS Personnel (Specialist) can act as an interim LCHO until a new one is selected

2.2.6 The LabcliQ Laboratory Inspection Program

The LABCLIQ computer program enables laboratory compliance and regulatory issues to be properly maintained throughout the year at CCNY campus via periodic inspections of laboratory areas in the following facilities: Steinman Hall, Marshak Hall, and the Center for the Discovery and Innovation. These inspections do occur routinely and randomly and involve the following EHS categories: Administration, Biohazards & Biosafety, Chemical Storage, Electrical Safety, Fire Safety, Gas Cylinders, General Safety (Showers & Eyewash Stations), Hazardous Materials & Wastes, Housekeeping, Material Storage, Mechanical Hazards, Personal Protective Equipment (PPE), Physical Hazards I: Lasers, Physical Hazards II: Radiation, Supplemental Lab Training, and Ventilation & Engineering Controls.

2.2.8 Laboratory Hazard Assessment Tool=LATCH

The LATCH tool in LabcliQ is used to create a Lab Hazard Assessment (LHA) indicating the level of risk of exposure to a particular hazard present in the laboratory and the assigned Personal Protective Equipment (PPE) to wear. The LHA is normally valid for 1 year after completion and is designed to lower the risk of hazardous exposure in the labs. At completion of 1 year, a new LHA must be created in LATCH and is stored in LabcliQ by the Principle Investigator to assess new or existing exposure risks for his/her lab for the coming year, thus maintaining compliance in the campus research laboratories. The LHA is available for review and must be EHOS approved before storage in LabcliQ.

2.2.9 Principal Investigators and Supervisory Personnel

Principal investigators, faculty and supervisory personnel are ultimately responsible for chemical hygiene in their respective research or teaching lab. All lab supervisory personnel are expected to actively participate in the implementation of this program.

Principal Investigators and/or faculty members and supervisory personnel in charge of a laboratory shall be responsible for reading, understanding and implementing the Laboratory Safety Plan in any area under his/her purview and for seeking clarification and advice on any section of this program that they do not understand. The Principal Investigator(s) and Supervisory Personnel shall be informed by the LCHO/LHO immediately when an unsafe condition is observed in any area under his/her supervision.

Additionally the Principal Investigator shall be responsible for the following:

- that a Hazard Assessment is filled out and updated whenever there are changes to for her or his lab
- that work, experiments and research done in his/her lab be carried out in a manner that is safe and consistent with all the provisions of this laboratory safety program
- that standard operating procedures for hazardous chemicals, experiments, operations and laboratory equipment are developed and followed by all personnel and students
- that the guidelines for hazardous waste handling, storage and disposal be followed by personnel under his/her supervision
- for ensuring that lab personnel attend appropriate safety training sessions
- that every lab employee and student be provided with a copy of this program and that the requirements of this safety program are read and understood
- correcting all safety and health deficiencies or violations detected in any area under his/her supervision
- immediately report any accident or unsafe condition(s) to the office of EHOS, 212-650-5080

2.2.10 Laboratory Employees, Research Fellows and Students

- Every laboratory employee, research fellow and student, is responsible for observing all policies and guidelines in the Chemical Hygiene Plan and any other policy and guideline designed to ensure our institutional safety as well as cooperating in the implementation of this manual. He/she shall:
- attend all required safety and health training sessions
- read and understand the objectives of the CHP and seek advice on those areas that are not clear
- follow all standard operating procedures, the procedures and guidelines outlined in
- this manual and work in a manner that is safe and that does not pose a health risk for him/her, other employees, students, visitors or the environment
- immediately report unsafe conditions to his/her supervisor or the office of EHOS

3.0 STANDARD OPERATING PROCEDURE (SOP) OR SAFETY PROTOCOLS

The SOPs are general guidelines and rules for working in a laboratory and should be followed by all CCNY employees to whom the CHP applies. There are also specific SOPs that address particular experiments, procedures, operations and chemicals. See Appendix A, page I for more information and examples of chemical specific SOP. You will also find a copy of a blank SOP. For assistance in developing an SOP call EHOS at 5080.

3.1 Food Consumption in laboratories

Eating, drinking or the storage of food, drinks or utensils is strictly forbidden in research and teaching laboratories or any other area(s) within the lab that is not separated by construction and adequate ventilation. Food and drinks used for animal or for animal experiments shall be labeled "Not for human consumption".

3.2 Personal Hygiene

- wash immediately whenever a chemical comes in contact with your skin
- avoid inhalation of chemicals; do not taste or "sniff" to test chemicals
- use a pipette aid or suction bulb, never use mouth suction to pipette anything
- wash well with soap and water before leaving the laboratory, even if gloves have been worn; do not wash with solvents
- do not drinks, eat, or apply cosmetics in the laboratory
- refrigerators used for experimental animal food storage shall be clearly labeled "animal food only- no chemicals"
- do not place your food and beverages in refrigerators used for chemical storage; the latter should be clearly labeled "not for food storage"
- never store or bring chemicals, glassware, or equipment used for experiments into an non laboratory area such as an office
- chemicals, glassware and lab equipment used for experiments should not be used for other purposes such as handling food or food preparation
- wash lab coats or jackets separately from personal laundry
- do not wear or bring lab coats or jackets into areas where food is consumed (e.g. office or eating areas)
- City College is "**Smoke Free**"; smoking is prohibited in CCNY buildings or areas around CCNY buildings

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3.3 Rules for working with chemicals

- wear appropriate eye protection at all times while working in any area designated as a laboratory
- always know the hazards, physical and chemical properties of the materials used, such as corrosivity, flammability, reactivity, and toxicity (see Safety Data Sheets section 3.7)
- always use engineering controls such as fume hoods, bio-hoods and personal protective equipment (see section 4.0)
- make certain that there are no sources of ignition while working with flammable materials which can cause a fire or explosion, in the event of a vapor release or a liquid spill
- use proper personal hygiene practices (see section 3.2)
- use a chip-resistant shield for protection whenever an explosion or implosion might occur
- working alone at night is not recommended; if you must work alone someone on the floor should be aware you are working in your laboratory after hours
- be sure as to how and where to store the chemical when it is no longer in use (see section 3.8)
- household refrigerators are not constructed intrinsically safe for storage of flammable materials therefore they shall not be used for the storage of flammable materials
- chemicals stored in flammable storage or explosion proof refrigerators shall be sealed and labeled with the name of the material, the date placed in the refrigerator; old chemicals should be disposed of following our disposal policies
- always use a chemical bottle carrier and / or a cart with a lipped shelf when transporting chemicals within the facility
- know the location and proper use of emergency equipment such as showers and eye wash stations
- be aware of appropriate procedures for emergencies, including evacuation routes and spill cleanup (section 7 “Emergency Procedure Plan”)

A chemical spill on the body can be a serious incident. Wear proper clothing such as lab coat, gloves and goggles. Observe good hygiene practices (good housekeeping) to avoid painful situations.

Nitric acid burn on leg; example of not wearing proper clothing to laboratory.

3.4 Good Laboratory Hygiene Practices (Good Housekeeping)

- Good housekeeping is essential for the prevention of fires and accidents; good housekeeping also makes it easier to respond to an emergency or a fire by allowing unobstructed movement in and out of the affected area.
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- The following are good housekeeping practices:
- access to emergency equipment, showers, eyewashes, and exits should never be blocked by anything, not even a cart temporarily stationed
- keep drawers and cabinets closed while working
- keep all work areas, especially laboratory benches, free of clutter
- all chemicals should be placed in their assigned storage areas at the end of each workday; keep aisles, hallways, and stairs clear chemicals, furniture and any other item that can obstruct passage
- wastes should be placed in their original containers and labeled with a CCNY hazardous waste yellow sticker at the end of each workday, the contents of all unwanted materials are to be considered wastes and handled according to our waste management policies

- promptly clean up all spills; properly dispose of the spilled chemical and cleanup materials all working surfaces and floors should be cleaned up regularly; avoid slipping hazards by keeping the floor clear of ice, stoppers, glass beads or rods, other small items, and spilled liquids

3.5 Procurement

Purchasing bulk amounts of a chemical(s) may appear to be less expensive. However the cost of disposal of unused chemical stock may be 5 to 6 times the original catalogue price for unused chemicals adding to long-term costs. Additionally an increase in materialsin the lab can create storage problems, unsafe conditions and potentially violate New YorkCity Fire Codes. Containers that are leaking, lack an adequate label or not accompanied bythe appropriate material data sheet shall not be accepted by anyone in the college.

3.6 Global Harmonized System Labeling

Every incoming container must have labels identifying its contents and its hazards using the Global Harmonized System (GHS). Chemicals that are repackaged or transferred into another container must be re-labeled immediately using the GHS system (see Table 7 under Appendix A). Stickers and ink used for labeling should be waterproof. The name of the chemical must be spelled out as well as other information such as hazards (***pictograms***) and precautions,the date it was re-packaged, strength and purity of the material. Chemicals in storage and/or placed on the benchtop should also be properly labeled with the GHS labeling system.

3.7 Safety Data Sheets

Safety Data Sheets (formerly MSDSs) are present in every laboratory, which shall maintain a hard copy of their SDSs on file, usually a binder, for the chemicals used or stored on the premises. This file shall remain accessible to every employee who works with those chemicals. The Office of Environmental Health and Occupational Safety will also maintain a comprehensive digital file of Safety Data Sheets in their office.

Missing SDS can be obtained by writing to the company in question requesting copies of the SDS or can be searched Online at the company's Webpage, e.g. Fisher Scientific.. Remember that a SDS for a particular material has to be from the company that manufactured the product. You cannot use a SDS for a particular chemical from a different company. Lastly, a standard letter that can be used for requesting an SDS from suppliers has been included (see letter in blue font below).

Sample Safety Data Sheet (SDS) request letter

To: **Name of company**
From: **Name of Principal Investigator or person making the request**

Re: **Safety Data Sheet**

Date:

In an effort to comply with Federal, State and Local employee Right to Know Laws, and the recently passed Globally Harmonized System (GHS) is requesting that your company forward copies of your Safety Data Sheet (SDS). Please forward updated SDS for the following product(s) sent to or purchased by our college:

1-

2-

Copies should be sent to the addresses listed at the end of this letter.

Thank you for your cooperation in the matter.

Signature of requestor

3.8 Storage

Chemical storage areas shall be limited to central stockrooms, storerooms on some floors, lab work areas, storage cabinets, some types of refrigerators and freezers designated for storage, fume hoods and fume hood cabinets. . Be aware that some fume hood cabinets are actually ovens meant for drying glassware. Never use these ovens to store chemicals of any type.

Adequate security to prevent unauthorized access must be ensured. Storage areas mustbe kept neat and orderly. Make sure that shelf units are stable and not in danger of tilting. Storage for large containers of reagents should be provided on lower shelves, preferably ina tray adequate to contain spills or leakage. Storage on laboratory and hallway floors is prohibited. Strong corrosive, toxic, irritating and flammable materials are not to be storedon top shelves of cabinets, or counter top shelves or independent shelves above 5 feet or near electric outlets.

Spaces under sinks cannot be used as chemical storage areas.

Store flammables in a flammable solvent storage area, in flammable storage cabinets or under the fume hood in quantities not to exceed regulatory mandate or design capacity

of the cabinet and/or the laboratory or storage area. Keep only minimum quantities of flammable liquids. Large quantities of flammables materials should be store in approved safety containers or in fire-resistant solvent cabinets and away from ignition sources. Bulk amounts such as 5 and 55 gallon drums of flammable liquids should be stored in a separate storage facility with an automatic fire extinguishing system such as a sprinkler. Metal containers must be grounded at all times

Domestic, household-type refrigerators cannot be used for storage of flammable materials. Vapor concentration from an open container can reach levels where they can be ignited by a spark from the wiring. If you need to store flammables in cold temperatures use an explosion-proof or flammable storage refrigerator which is constructed specificallyto store flammable materials safely. Note that the NYC Fire Codes prohibits the use of regular refrigerators for storage chemicals considered flammables and enforces this rule in a strict manner.

Inherently waste like materials

Ideally the chemical supply in labs should be limited to the amount needed for one month or the amount needed to complete an experiment or procedure. However this is not always possible so be mindful that some chemicals deteriorate during storage. Keep all stored chemicals, especially flammable liquids, away from heat and direct sunlight.

Note that expiration dates by the manufacturer should be used as a guide for determiningmaterials usefulness. Visual inspection of stored chemicals is an important factor. Old chemicals or inherently waste like materials should be disposed independent of expiration date. Chemicals that have been stored for 5 years should be checked periodically. The following are indications a chemical may need to be disposed of:

- slightly cloudy liquids
- chemicals that are changing color (e.g., darkening)
- spotting on solids
- caking of anhydrous materials
- existence of solids in liquids or liquids in solids
- pressure buildup in bottles
- evidence of reaction with water
- damage to the container, label or cap

The expiration date on most peroxide forming chemicals should not be extended past the manufacturer's deadline unless tested for peroxides.

3.9 Incompatible Chemicals

Accidental contact of incompatible substances can result in a serious explosion or the formation of substances highly toxic or flammable or both. Some compounds can pose either a reactive or a toxic hazard, depending on the material and / or conditions (See Table13, page XVII).

General guidelines can be applied to reduce the risks involved with these substances. Concentrated oxidizing agents are incompatible with concentrated reducing agents. In addition, either agent can pose a reactive hazard with chemicals that are not strongly oxidizing or reducing. Therefore, it is important to consult the guidelines mentioned above.

3.10 Prior Approval

- Employees must get prior approval from the principal investigator or immediate supervisor before she /he proceeds with a laboratory task whenever:
- A new laboratory procedure or test is to be carried out.
- The material(s) to be used are highly toxic, flammable or can have detrimental l health effects upon exposure.
- There is a potential of a strong chemical reaction, a fire or toxic fumes.

3.11 Safety Procedures for working with highly toxic chemicals

- read the standard operating procedure for the material(s); if one has not been developed the principal investigator and / or supervisor should be informed and oneshould be developed
- read the appropriate safety data sheet (SDS)
- use a fume hood, especially if the substance is of high volatility or there is a possibility of it becoming airborne
- minimize your exposure by using the smallest amount possible of the substance allowed for by the experiment or procedure
- wear protective equipment such as goggles, gloves and a lab coat

- never work alone when using a highly toxic substance
- keep these materials in storage areas with restricted access or in a locked cabinet
- store breakable containers in lower cabinets and use secondary containment
- know the appropriate spill and emergency response procedures for the material

Examples of highly toxic materials:

- **HYDROGEN CYANIDE**
- **HYDROFLUORIC ACID**

- **FORMALDEHYDE**

3.12 Safety Procedures when handling flammable chemicals

Chemicals with a flash point below 100ºF (37.9ºC) fall under the category of flammables under the New York City Fire Department Fire Codes which governs the handling of flammable materials in NYC college laboratories.

- flammable materials should be stored in a flammable-solvent cabinet storage in quantities not exceeding the NYC Fire Codes
- keep flammable materials away from inorganic acids and combustible materials such as boxes and paper
- flammables should be used only in vented hoods and away from sources of ignition such as hot plates or surfaces, sparks from welding or cutting,
- Do not store flammable chemicals in a regular refrigerator.

3.13 Procedures for handling reactive chemicals

A reactive chemical is one that will react spontaneously or with other materials to release large amounts of energy. Under certain conditions the reaction can be violent enough to produce a detonation. Make certain that you:

- Read the safety data sheet and the Standard Operating Procedure prior to handling a reactive material.
- use personal protective equipment such as gloves, goggles and appropriate administrative controls such as scaling down the experiment
- Do not mix any quantity with other chemicals without approval from your PI or immediate supervisor.
- Peroxide forming chemicals deserve special consideration at all times and particularly during storage; peroxide formation is accelerated by the presence of oxygen and UV light. It is required that detailed records of storage history of compounds that form peroxides on standing be maintained and periodically reviewed (see section on Peroxides).

3.14 Procedures for working corrosive contact hazard chemicals

A corrosive chemical is one that can chemically react upon contact with another material or the skin and cause visible damage. Some examples of corrosives are acid and bases. Make certain that you:

- handle corrosive chemicals with all proper safety precautions, including use of both safety goggles and face shield (see 4.1.1)
- use gloves tested for absence of pin holes and known to be resistant to permeation or penetration, and a laboratory apron or laboratory coat

3.15 Procedures for work involving contact-hazard

A contact-hazard chemical is any material that is known or found to cause an allergic reaction upon contact with the skin. This type of materials is also known as allergens or sensitizer. When you work with known or suspected allergens make sure you are:

- wearing gloves and long sleeve garment to avoid skin contact
- wearing goggles

3.16 Working with carcinogens, reproductive and highly toxic substances

Follow the procedures described in this section when performing laboratory work withgreater than 10 mg of any carcinogen, reproductive toxin, a substance that has a high degreeof acute toxicity, or a chemical whose toxic properties are unknown.

Designated areas shall be clearly identified with a sign that reads the name of the material, its hazards and the protective equipment to use. Only personnel trained to work with chemicals falling in the categories listed above will work with those chemicals in designated areas. All such persons will:

- use the smallest amount of chemical that is consistent with the requirements of the work to be done
- use the high-efficiency particulate air (HEPA) filters or high-efficiency scrubber systems to protect vacuum lines and pumps
- store chemicals or remove them from storage
- decontaminate area when work is completed
- prepare wastes from work for disposal in accordance with specific disposal procedures consistent with the Resource Conservation and Recovery Act (RCRA) and as designated by CCNY EHOS
- store all inimical chemicals in enclosed spaces with a slight negative pressure compared to the rest of the building
- because the decontamination of jewelry may be difficult or impossible, do not wear jewelry
- wear long-sleeved disposable clothing and the appropriate permeation-resistant gloves when working in designated areas

3.17 Working alone in laboratories and shops

At CCNY, it is prohibited for Undergraduate Students to work alone in laboratories without the presence of a C-14 Certificate of Fitness holder (Certificate of Fitness for the Supervision of Chemical Laboratories) Moreover, it is strongly recommended that laboratory personnel avoid working alone when conducting research, especially when experiments or procedures involve hazardous substances and / or equipment. The FDNY requires that any ongoing laboratory operation be under the personal supervision of a C-14 Holder. Consequently, anyone working alone, specifically Undergraduates will be reported to both EHOS and the proper Principle Investigator.

Laboratories need to establish specific guidelines and SOPs stating when working alone is not allowed and develop notification procedures when working alone occurs. All work to be performed by someone working alone, and the monitoring system that is established,must be approved in advance by the P.I. or laboratory supervisor.

3.18 Undergraduate Students working alone

It is prohibited for anyone to allow undergraduate students to work alone, without the supervision of a Certificate of Fitness when the procedure, experiment or equipment may pose a fire, toxic, reactivity or corrosivity hazard. All undergraduate students conducting experiments with hazardous materials and / or equipment shall be trained by the PI or a senior staff member.

3.19 Working with radioactive materials

Work involving radioactive material in New York City is subject to the regulations of the N.Y.C. Bureau for Radiation Control, published under Article 175 of the City Health Code, “Radiological Hazards”.

The City College through action of the administrative Vice-President established a Radiation Safety Committee (R.S.C.) which assumes the detailed responsibilities of the institution as laid down in Article 175. This program is administered by the campus Radiation Safety Officer (R.S.O.), Richard Belgrave, Director of EHOS, extension number is 5085. The Radiation Safety Office is located in MR- 1328, and the extension number is 8085.

Most non-human use is covered by a single broad license issued by the NYC Department of Health in agreement with the Nuclear Regulatory Commission, and administered by the R.S.O. on behalf of the R.S.C.

The acquisition, use, handling, and/or disposal of all radioactive chemicals are under R.S.O.'s control. Employees wanting to use radioactive chemicals need to get a permit from the R. S.O. (see below)

3.19.1 Permits

Permit requirements for the possession and use of radioactive materials: No radioactive material may be acquired, used, or stored unless a permit has been issued on behalf of the College's R.S.C. Permits are issued when the R.S.O. is satisfied that the applicant has sufficient training and experience and that the facilities available are suited to the work proposed. Permits are renewable annually.

3.19.2 Applications for permits

Applications for permits are made through the Radiation Safety Office (MR-1328). The R.S.O. arranges for and reviews the training, experience and laboratory facilities of the applicant before the permit can be approved. All users must pass a written examination on the radiation safety regulations at City College.

3.19.3 Details of permits

Permits Specify:

1) The quantities and types of materials acquired, used, and stored.
2) The laboratories in which use and storage may take place.
3) Which personnel may handle the material and the type of personal monitoring they shall undergo.

Details regarding the above provisions may be found in the CCNY Radiation and Safety Handbook (copies available in MR-1327). The Radiation and Safety Handbook provides information on quantities of materials allowed under permits, requirements for laboratories in which radioactive materials may be stored or used, requirements for laboratory personnel using radioactive materials, disposal of radioactive material, radioactive contamination surveys, record keeping, accidents and emergencies involving radioactive materials, etc.

3.20 Procedures for work with reduced or high pressure

3.20.1 Reduced Pressure Operations

Vacuum desiccators should be protected by covering with cloth-backed friction or ducttape or enclosed in a box or approved shielding device for protection in case of an implosion. Only chemicals being dehydrated should be stored in desiccators.

- Before opening a desiccator that is under reduced pressure, make sure that atmospheric pressure has been restored. A "frozen" desiccator lid can be loosened by using a thin objectas a wedge that is then tapped with a wooden block to raise the lid.
- All vacuum lines should be trapped and shielded whenever the apparatus is under reduced pressure.
- Water aspirators for reduced pressure are used mainly for filtration purposes, and only equipment that is approved for this purpose should be used. Never apply reduced pressureto a flat-bottomed flask unless it is a heavy-walled filter designed for the purpose. Place atrap and a check valve between the aspirator and the apparatus so that water cannot be sucked back into the system if the water pressure should fall unexpectedly while filtering.These recommendations also apply to rotary evaporation equipment where water aspiratorsare being used for reduced pressure.
- If vacuum pumps are used, a cold trap should be placed between the apparatus and the vacuum pump so that volatiles from a reaction or distillation do not get into the pump oil or out into the atmosphere or the laboratory.
- Exhaust from pumps should be vented to a hood. Pumps with belt drives should also have belt guards to prevent hands or loose clothing from being caught in the belt pulley. Remember that aspirators produce pressure gradients across the wall of the apparatus nearly as great as high vacuum pumps.

3.21 Compressed Gases

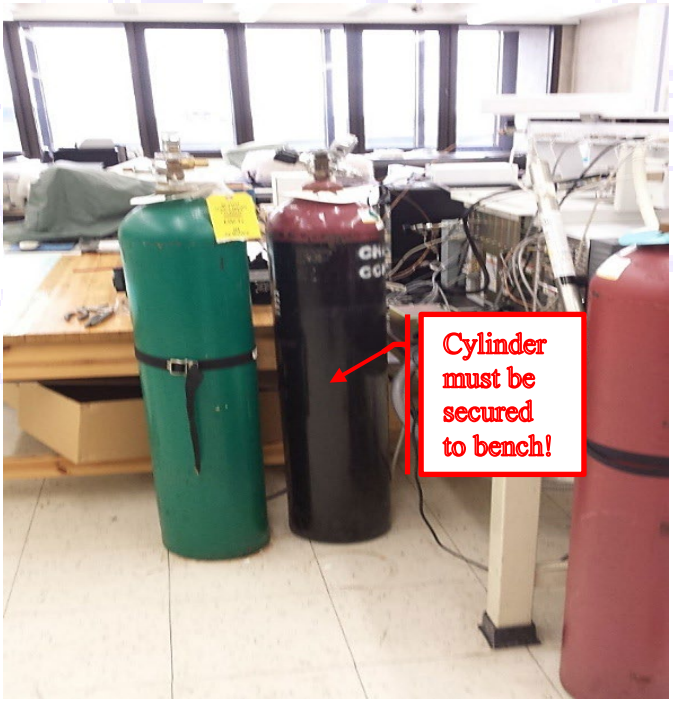
Gases used in laboratories are supplied in cylinders at high pressure. Handle compressed gas cylinders as high- energy sources and as a potential explosion hazard:

- restrain cylinders of all sizes, empty or full using by straps, chains, or a suitable stand, to prevent them from falling
- when storing or moving cylinders, have the protective caps securely in place to protect the valve stems
- when moving large cylinders, strap them to properly to wheeled carts designed for this purpose to ensure stability
- do not expose cylinders to temperatures higher than 50oc; some rupture devices on cylinders will release at about 65^{o}c. some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures
- never use cylinders that are not labeled and cannot be positively identified
- never lubricate, modify, force, or tamper with cylinder valves
- use toxic, flammable, or reactive gases in fume hoods; cylinders should be stored in appropriately ventilated cabinets or in an open storage
- never direct high-pressure gases at a person
- do not use compressed gas or compressed air to blow away dust or dirt; the resultant flying particles can be hazardous
- be aware that rapid release of a compressed gas will cause an unsecured gas hose to whip dangerously and also may build up a static charge that could ignite a

combustible gas

- do not extinguish a flame involving a highly combustible gas until the source of gas has been shut off; otherwise, it can re-ignite causing an explosion
- close the main cylinder valves tightly when not in use
- promptly remove the regulators from empty cylinders and replace the protective caps at once; place an "Empty" notice
- never bleed cylinders completely empty; leave a slight pressure to keep contaminants out
- Use the appropriate regulator on each gas cylinder. the threads on the regulators are designed to avoid improper use; adaptors or homemade modifications are dangerous
- do not put oil or grease on the high pressure side of oxygen, chlorine, or other oxidizing agent cylinder; a fire or explosion can result
- always wear safety glasses when handling and using compressed gases
- always store acetylene cylinders upright; they are partially filled with acetone
- do not use a cylinder which has been stored or handled in a non-upright position until it has remained in an upright position for at least 30 minutes
- ensure that the outlet line of an acetylene cylinder is protected with a flash arrester
- never exceed the pressure limit indicated by the warning red line of an acetylene pressure gauge
- use the correct kind of tubing to transport the gaseous acetylene; some tubing materials such as copper form explosive acetylides

Gas cylinders are under a lot of pressure; always keep them secured to a counter, a wall bracket or a floor stand.



Pressurized cylinders cannot be left unsecured

3.22 Working with Lasers

Because the type and intensity of radiation that can be generated by a laser varies widely with instrument design, only generalizations can be made. However the following general rules apply:

- always wear goggles that offer protection against the specific wavelength of the laser In use if more than one wavelength is being used, additional goggles specific for each wavelength are required; no available goggles protect against all laser wavelengths; every Laser lab should have a list of all lasers in operations, and a sign with the location of the appropriate goggles to be worn
- warning signs should be at the entrance to every room in which a laser operated; only personnel essential to the experiment should be in the room during operation of a laser
- never look directly at the beam or its source a laser beam may be invisible
- never view the beam pattern directly; use an image converter or other safe, indirect means; do not align by looking along the beam
- to decrease reflecting hazard do not allow any objects that cause reflections to be present in or along the beam pathway, even buttons on clothing and polished screw heads can be dangerous;
- to guard against stray beams, each lab bench should have sufficient beam blocking devices; always limit the distance that the output beam may travel by using an opaque barrier
- when possible, keep a high general illumination level in areas where lasers are in operation; low light levels cause dilatation of the pupils, thereby increasing the hazard
- for lasers, if the odor of ozone produced by UV is detected, increased ventilation must be provided

3.22.1 Laser Operating Instructions

3.22.2 Safely turning on lasers

Before using any laser, read the instruction manual carefully. The first time you use a new piece of equipment, request instruction and demonstration of safe use from someone who has used it before. Be familiar with all the interlock safety devices in the laser. Familiarize yourself with all high voltage components, water inlets and outlets, and circuit breakers.

- Do not place your head in front of the laser output, keep experimental setups at low heights, this will help prevent accidental beam-eye encounters
- Never work alone. At night or weekends, make sure to notify the security guards or someone in a nearby laboratory that you are working under potentially hazardous

conditions and ask them to check on you from time to time.

- Prior to alignment of your optical setup, make sure all unnecessary reflective surfaces are removed from your optical bench, never utilize a laser beam across a path where someone might normally walk, once alignment is complete, ensure that all optical components are secured to the bench, and make sure the covers of the lasers are closed; check all interlocks to ensure proper functioning.
- Lasers operating in the infrared or ultraviolet are especially hazardous, since the beams are not visible, when using such lasers, special care must be taken to ensure that no stray light can possibly be emitted after final alignment, use blackened tubes to cover the beams where they might otherwise be exposed between components, remember your safety goggles.
- When turning off lasers follow the shut-down procedure carefully, make sure all high voltage power sources have been turned off, when the laser is cooled, make sure the cooling water is off; never leave an operating-laser unattended.

3.23 Procedures Regarding Other Physical Hazards

3.23.1 Ultraviolet Lamps

Two categories of hazards are involved in the use of UV lamps: those inherent in the radiation itself and those associated with the operation of the lamps.

All radiation of wavelength shorter than 250 nm should be considered dangerous. Protective safety glasses with UV-absorbing lenses should be worn when the eyes may be accidentally exposed to light in this wavelength region (Note: ordinary glass absorbs strongly below ~330 nm). It is advisable to operate such UV irradiation systems in a completely closed radiation box. Skin areas exposed to illumination from UV lamps can receive painful burns not unlike severe sunburn, and so precautions should be taken to protect the skin.

Handling of mercury arc lamps will deposit oils from the skin on the outer glass surface. If the residues are not thoroughly removed, they will burn into the glass causing localized buildup of heat during the operation of the lamp. The lamp may then overheat and even crack.

At the end of the useful life of a lamp, buildup of UV-absorbing films on the interior of the walls of mercury arc lamps may cause their temperature to rise above the safe operating point. Therefore, running-time meters should be attached to such lamps so that the times for discarding the lamps are known. Also, whenever possible, UV sources should be adequately cooled and operated within an enclosure designed to prevent damage by glass fragments and leakage of mercury vapor in case of an explosion.

Ultraviolet light produces ozone (O_3). If the sweet odor of ozone is detected adequate ventilation must be provided.

3.23.2 Microwave

Microwaves are absorbed by the body and produce heating effects. This is especially serious for the testicles and the lens of the eye. Testicles produce viable sperm only if they are below body temperature. The lens of the eye is unable to lose heat, as it lacks a blood supply. Hence, the most obvious consequences of exposure to microwaves are cataracts of the eye and male sterility or possibly, at lower doses, birth defects in offspring. In addition, at still lower doses, there are reports of damage to those organs that depend on electrical excitability, particularly the heart and nervous system. In particular, cardiac pacemakers fail under microwave radiation. Metal screening (mesh or plates) provides effective shielding against microwaves. If microwave ovens are in use, their closing mechanism must be in good repair if microwaves are not to leak.

The present United States standard for microwave radiation is 10 mW/cm^2 powers for any 0.1 hr. period, 1 $mW\text{-}hr/cm^2$ energy, also averaged over 0.1 hr. period. This applies to whole body or partial body radiation.

3.23.3 Noise

Hearing conservation should be practiced through proper design of equipment, modifications of existing sources of noise, and the use of ear protection.

OSHA requires the employer to establish a hearing conservation program whenever employee noise exposures equal or exceed an 8-hour time-weighted average (TWA) sound level of **85 decibels**. The permissible noise exposures are listed in OSHA's Occupational Noise Exposure Standard: 29 CFR 1910.95. Exposure to impact noise should not exceed 140 dB peak sound pressure level.

Ear protection includes earmuffs and earplugs. Generally, earmuffs have a greater attenuation factor than earplugs; namely, almost equal in sound reduction, earplugs are considered better for low frequency noise as compared to earmuffs which are superior for high frequency noise.

3.23.4 Temperature Control

Many reactions are initiated by heating. Since the rates of most reactions increase as the temperature increases, highly exothermic reactions can become dangerously violent unless provisions are made for adequate cooling. If too much of a reagent has been added initially, late induction of the reaction can cause it to become too vigorous for effective condensation of vapors unless a cooling bath is quickly applied to the reaction vessel. Viscous liquids transfer heat poorly and require special precautions. Reactions usually require some temperature control, and the apparatus should be assembled in such a way that either heating or cooling can be applied or withdrawn readily.

Test tubes should be held with a test tube holder and heated gently along the side, not at the bottom, to minimize superheating, which may cause the content to be ejected. Avoid pointing a test tube toward yourself or a nearby person. If possible, test tubes should be heated by placing them in a suitable hot water or hot oil bath. Temperature should be monitored carefully during scale up procedures. Scaling up a reaction presents special hazards, as the surface to volume ratio decreases.

3.23.5 Oil and Sand Baths

When hot oil or sand is used for heating purposes, extreme care must be taken to avoid overturning the bath, hazardous splattering caused by water falling into hot oil or hot sand, smoking caused by decomposition of the oil or of organic materials in the oil, and fire caused by overheated oil bursting into flames. Ensure proper labeling of the oil which includes the name of the oil and its safe working temperatures. Operating baths should never be left unattended and high-temperature shutoff. Precautions should be taken to contain any spills of hot oil caused by breakage or overturning of the baths.

- Important considerations when these types of baths are used include the following:
- size and location of the bath
- operating temperature and temperature control devices
- type of oil used; e.g., silicone oil, Dow Corning 550 (Silicone Oil), is suggested for most heating needs
- available ventilation
- method of cooling the hot oil
- storage of oil for reuse
- location away from possible sources of spilled water or chemicals

3.23.6 Cooling Baths and Cold Traps

When ice water is not cool enough for use as a bath, salt and ice may be used. Even for lower temperatures, dry ice may be used with an organic liquid. An ideal cooling liquid for use with dry ice should have the following characteristics:

- Does not generate toxic vapors
- Has low viscosity
- It is non-flammability
- Has low volatility

Ether, acetone, and butanone are too volatile and flammable for use as a cooling liquid. The final choice of a liquid will also depend on the temperature requirements. Although no substance meets all these criteria, the following are suggested (numbers in parentheses signify above criteria which are not met):

Ethylene glycol or propylene glycol in a 3:2 ratio with water and thinned with Isopropyl alcohol (criterion 2)

Isopropyl alcohol (criterion 3) Some glycol ethers (criterion 2)

Add the dry ice to the liquid, or the liquid to the dry ice, in small increments. Wait for the foaming to stop before proceeding with the addition. The rate of addition can be increased gradually as the liquid cools.

Cryogenic coolants should always be used with caution; cryogenic liquids must be handled in properly vented containers. Be aware that very low temperature coolants (<90K) may condense oxygen and can cause an explosion with combustible materials. For example, Liquid N_2 is the primary cooling liquid in this range; therefore, use gloves and face shields and immerse the object to be cooled slowly to avoid too vigorous boiling and a glass- overflow of the coolant. Use a glass Dewar for cryogenic coolants.

Glass Dewar flasks should be of borosilicate glass and protected by covering with cloth- backed friction or duct tape or a metal casing to contain flying pieces in the event of an implosion. Avoid pouring cold liquid onto the edge of a glass Dewar flask because the flask may break and implode. Metal or plastic Dewar type flasks are preferable and eliminate this problem. Never use a household Thermos bottle in place of a Dewar flask.

Do not lower your head into a dry ice chest. Because no oxygen is present, suffocation can result. Do not handle the dry ice with bare hands; if the skin is even slightly moist, severe burns can result. Use dry leather or suitable cryo-gloves. When chipping dry ice, wear goggles.

3.23.7 Static electricity and spark hazards

Some protection from static electricity and sparks in hazardous areas and in handling flammable solvents and other chemicals is obtained by proper grounding of containers and equipment and by blanketing with inert gas when needed. Static electricity is magnified by low absolute humidity such as is likely in cold weather. Some common potential sources of sparks and electrostatic discharges are:

- Ungrounded metal tanks and containers
- Clothing or containers made of plastic, synthetic materials, or wool
- Making and breaking of an electric circuit while the circuit is energized (switching, pulling plugs)
- Temperature control systems in hot plates
- Metal-based clamps, nipples, or wire used with non-conducting hoses
- High-pressure gas cylinders upon discharge
- Brush motors and hot air dryers
- ***Note that static electricity is also a hazard for all computer equipment.**

3.23.8 Centrifuges

If a tabletop centrifuge is used, make certain that it is securely anchored in a location where its vibration will not cause bottles or equipment to fall. The following rules apply to the safe operation of centrifuges:

- Always close the centrifuge lid during operation.
- Do not leave the centrifuge until full operating speed is attained and the machine appears to be running safely without vibration.
- Stop the centrifuge immediately and check the load balances if vibration occurs. Check swing-out buckets for clearance and support.
- Regularly clean rotors and buckets with non-corrosive cleaning solution.

3.23.9 Electrical Equipment

All electrical outlets must have a grounding connection requiring a three-pronged plug. This is required under OSHA regulations. If equipment does not have a three-pronged plug, replace the plug and cord to ground the equipment properly. All electrical outlets should be protected by ground-fault interrupters, but note that ground-fault interrupters do not work in two-wire installations.

Eliminate wiring that is frayed, worn or stretched across the floor where someone could trip over it. Eliminate obstructed switch gear and panel boards, unlabeled panel boards, electrical outlets with open (or missing) cover plates, and excessive use of extension cords. The condition of wiring, plugs, cords, and related equipment should be

frequently inspected. To prevent a tripping hazard, please use duct tape to secure to ground.

All personnel should know the location of circuit breakers and how to cut off all electrical service in case of fire or accident. All circuit breakers should be labeled properly and electrical panels should never be blocked.

3.24 Waste disposal

A waste is any solid, liquid, or gaseous material that is no longer used and / or wanted that will be recycled, disposed of, or stored in anticipation of treatment or disposal.

Within the federal regulations, hazardous wastes are those chemical wastes that are included on one of several regulatory lists (listed wastes) or fit the defined characteristics as ignitable, corrosive, reactive, or possessing a toxicity characteristic. In general, it is prudent to consider all waste chemicals to be hazardous wastes unless there are good reasons for considering a material to be non-hazardous. Typical laboratory wastes that are regulated as hazardous include acids and bases, heavy metals and inorganic materials, ignitable wastes, reactive, oxidants, and solvents.

You can minimize the volume and cost of the wastes by following a few basic "housekeeping" principles:

- Do not mix nonhazardous wastes and hazardous wastes. such a mixture will have to be regulated as a hazardous waste, thus increasing the cost and responsibility associated with the waste
- segregate hazardous wastes by type of waste; this practice may be required to prevent the mixing of incompatible wastes, but it also makes sense to preserve the waste properties, and thus make recycling or treatment easier and less expensive. for example, do not mix halogenated with non-halogenated solvents
- avoid spills or leaks used spill cleanup materials for hazardous wastes are regulated as hazardous wastes

More information on disposal and hazardous waste determination can be found in the EHOS policy manual "Hazardous Waste Management Plan"

3.24.1 Chemical Waste

Waste materials must be handled in specific ways according to their nature and properties. Some general guidelines are:

- Dispose of waste materials promptly. When disposing of chemicals keep each different classes of chemical in a separate clearly labeled disposal container (see tables 14 and 15 for chemical compatibility).
- Never put chemicals into a sink or down the drain unless they are deactivated or neutralized and they are allowed by local regulation in the sanitary sewer system;

nothing except water or dilute aqueous solutions of non-toxics (e.g. sodium chloride, sugar, soap) from a chemistry laboratory should be disposed of in the sink.

- Put ordinary waste paper in a wastepaper basket separate from the chemical wastes. if a piece of paper is contaminated, such as paper towels used to clean up a spill, put the contaminated paper in the special container that is marked for this use. It must be treated as a chemical waste.
- Because of their reactivity and their unpredictable nature, chemicals that form peroxides should be handled with care. For disposal of quantities larger than 25g of peroxide consult with the Department of EHOS (extension 5080) for assistance.
- Any by-product resulting from research experimentation or unwanted chemicals shall be considered chemical waste and fall under the policies described herein.

3.24.2 Radioactive Waste

Radioactive waste results when a laboratory uses radioisotopes, usually as tracers. A radioactive material is one that contains at least 0.005 micro curie (μCi) per gram of material, or per milliliter if a liquid. Below this limit, a laboratory may discard materials without regard to their radioactive component; above this limit disposal becomes a strictly regulated issue and is under the control of the Radiation Safety Officer (See 3.2.6).

3.24.3 Biological Waste

As in the case of chemical and radioactive wastes, laboratories must handle bio-hazardous wastes independently. However, unlike other wastes, bio-hazardous wastes must be decontaminated before disposal, and this is the laboratory's responsibility. The point at which bio-hazardous agents are to be decontaminated depends on the bio-safety level—BSL,BSL2, or BSL3 (highly infectious to humans). However, the type of decontamination depends partly on the actual agent and partly on personal preference.

Any decontamination method should include the following general procedures:

- bio-hazardous materials should be sterilized before regular washing or disposal
- a strong oxidizing material should never be autoclaved with paper, cloth, or other organic materials, because an explosion may occurred
- floors and laboratory surfaces should be disinfected regularly
- floors should not be swept without the use of decontamination procedures assessed for compatibility with materials that come in contact with disinfectant (e.g., gloves, bench tops, plastics, and floor files)

Specific decontamination methods are described:

1. **Wet heat.**

Steam sterilization in an autoclave at a pressure of approximately 15 psi and a temperature of 121ºC (250ºF) for at least 15 minutes. Autoclaves should be calibrated for temperature and pressure, and monitored with a biological indicator, such as *Bacillus stearothermophilus* spores. It is important that the steam and the heat be made to contact with the biological agent. Therefore, bottles containing a liquid material should have loosened caps, or cotton plug caps, to allow for steam and heat exchange within the bottle.

2. **Dry heat.**

This form of sterilization generally requires temperatures of 160-170ºC (320-338ºF) for 2-4 hours. Again, it is important that the items be arranged in the autoclave in ways that allow heat transfer.

3. **Liquid disinfectants.**

a. **Alcohol**. Alcohol is not always an appropriate disinfectant. Ethanol or iso-propanol (70-85%) can effectively denature proteins, but not lipids.

b. **Chlorine**. A 1:10 dilution of bleach is a very effective disinfectant against many microorganisms. This disinfectant may be effective against several life-threatening viruses, including the AIDS virus. It is important to remember, however, that this compound will lose its effectiveness over time and that even at a 1:10 dilution it is corrosive to metals and even stainless steel.

c. **Iodine**. Wescodyne is an iodine-based disinfectant often encountered in laboratories Dilutions of 3 oz. in 5 gal of water are recommended for general laboratory cleanup, and a 1:10 dilution in 50% ethanol is recommended for hand washing.

d. **Phenolic compounds.** These disinfectants are not generally effective against bacteria, but they are usually used as disinfectants against rickets, fungi, and some vegetative bacteria. Phenol alone is not a good disinfectant because of its physical properties.

3.28 Sharps

Sharps mean any article that may cause punctures or cuts, including intravenous tubing or syringes with needles attached.

Under Federal, New York State and New York City law, sharps are defined as potentially infectious regulated medical waste if they have been used in research laboratories. Sharps include hypodermic needles, syringes (with or without the attached needle), Pasteur pipettes, broken glassware and scalpel blades, blood vials, test tubes, needles with attached tubing, culture dishes (regardless of presence of infectious

agents), and such unused sharps that have been discarded.

To dispose of sharps they must be segregated from other regulated medical wastes, properly packaged in a leak proof, rigid, puncture-resistant container, placed in a bio-waste box and disposed as infectious waste. Red bags and bio-waste boxes can be obtained from the Safety Office (X 5080).

Broken mercury thermometers may contain mercury in the fragments and these belong in their own special "broken thermometer" container. If drops of mercury have spilled, see section on mercury clean-up.

4.0 CONTROL MEASURES and SAFETY EQUIPMENT

4.1 Fume hoods and ventilation

Whenever over exposure by inhalation is likely to exceed the threshold limits described in the SDS, use a hood; if this is not possible, proper respiratory protection may be required (see section 4.10) in which case the EHOS office has to be consulted. **Be aware that many chemicals can be present at hazardous concentrations without noticeable odor!**

Laboratory employees should understand and comply with the following fume hood rules:

- a fume hood can be is a safety backup for condensers, traps, or other devices that collect vapors and fumes, it is not used to "dispose" of chemicals by evaporation unless the vapors are trapped and recovered for proper waste disposal
- equipment should be placed on the floor of the hood at least 15 cm (six inches) away from the front edge; the apparatus inside the hood. The effectiveness of hoods is limited by the possibility of turbulent flow at the hood face. cross flows of air can produce ***turbulence***, and these in turn produce such currents
- fume hood with sash or sliding doors should be kept in the closed position at all times except when necessary to adjust the apparatus that is inside the hood
- fume hoods with on/off switches should be kept "on" whenever a chemical is inside the hood, whether or not any work is being done in the hood
- **personnel should discontinue all work in the event of a power or other hood failure!**
- before each use, be sure that the hood is clean and is working properly; although not a substitute for a velometer measurement, a continuous monitoring device such as a narrow strip of tissue paper can be used to ensure that the hood is operating
- use of fume hoods as storage areas for chemicals, apparatus, or other materials should be kept at a minimum
- a hood sash or sliding door is not equivalent to a well-designed standing safety

shield

4.2 Perchloric acid and Peroxide forming chemicals

Regular fume hoods such as those installed in the Steinman, Marshak and the Center for Discovery and Innovation are not equipped to handle peroxide forming materials such as perchloric acid. These chemicals will definitely cause corrosion in the duct work, as well as visible rust on the interior walls of the cabinet. A fume hood capable of handling peroxide forming materials must have a wash- down mechanism that can remove any peroxide formation that may have accumulated within the duct.

4.3 Personal Protective Equipment (P.P.E.)

According to the Laboratory Standard, all necessary protective clothing, e.g. Nitrile Gloves, Eye Glasses/Shields, Dust Masks. etc. (except Lab Coats [optional]) and equipment must be provided by the employer.

4.4 Eye Protection

All individuals working within the laboratory including visitors must wear eye protection when a chemical procedure is being performed.

Eye protection worn when working with chemicals should meet the requirements of the American National Standards Institute (ANSI) Z87.1. Wear goggles such as type G, H, or I at all times.

Wearing contact lenses in the laboratory is generally forbidden because contact lenses can hold foreign materials against the cornea in case of a splash. Furthermore, they may be difficult to remove in the case such a need arises. Soft contact lenses present a particular hazard because they can absorb and retain chemical vapors.

Normal prescription eyeglasses, though meeting the Food and Drug Administration's (FDA) standards for shatter resistance; do not provide appropriate laboratory eye protection because they lack splash protection. If the use of eye wear is required for therapeutic reasons, fitted goggles must also be worn.

When using more than 10 mL of a corrosive liquid, or where there is a potential for explosions, implosions or splashing, use an approved standing shield or wear a face shield, large enough to protect the chin, neck, and ears, as well as the face. Goggles should be worn when working with compressed gases.

Special goggles should be worn for specialized uses:

- ultraviolet goggles
- laser safety goggles
- glassblowing goggles
- cobalt glass spectacles for looking into furnaces, or into oxyhydrogen or oxyacetylene flames

4.5 Gloves

When working with corrosive liquids, allergenic, sensitizing, or toxic chemicals, wear gloves made of a material known to be or tested and found to be resistant to permeation by the chemical and tested for the absence of pin holes by air inflation (do not inflate by mouth but rather use compressed air).

Always read the manufacturer's instructions and warnings on chemical container labels and SDS prior to working with a chemical. The type of gloves that can be used can be found under the PPE section of the SDS. If a glove type is not found on the SDS, lab personnel should call the manufacturer. A chart on recommended glove types can be found in Table 16 on page XXXV Chemical Resistance. However always double check with the manufacturer's specifications.

An additional way of ensuring you are protecting your hands from chemical exposure is to double glove by wearing one pair of gloves over another. Be aware of any signs of deterioration, changes in color, texture or tears of the outer glove. Remove the gloves including the inner pair promptly at any signs that there has been any contamination or that there is some form of degradation. Replace both pair of gloves to continue working.

In order to prevent unintentional spread of chemicals, gloves should be removed before leaving the work area and before handling such things as telephones, doorknobs, writing instruments, and laboratory notebooks. Disposable gloves should not be cleaned and reused.

Remove disposable gloves by grabbing the cuff of the opposite hand pulling outward and inverting the glove onto the glove of the other hand. Pull down on the cuff of the gloved hand and remove the other glove. Always wash your hands with soap after removing gloves.

4.6 Protective Clothing

Clothing worn in the laboratory should offer protection from splashes and spills, be easily removable in case of an accident, and be at least fire resistant. Nonflammable, nonporous high-necked, calf- or ankle-length rubberized laboratory aprons offer the

most protection and should be worn when working with corrosive liquids. Lab jackets or coats should have snap fasteners rather than buttons so that they can be readily removed and some lab chemicals being pyrophoric, e.g. *Organolithium*, the lab coats should be nonflammable, as well.

Important considerations to note:

- wear low-heeled shoes with fully covering "uppers"; do not wear shoes with open toes or with uppers constructed of woven material
- wear long-sleeved/long-legged clothing; do not wear short-sleeved shirts, shorts, or short skirts
- long hair and loose clothing should be constrained
- jewelry such as rings, bracelets, and watches with metal watchbands should not be worn in order to prevent chemical seepage under the jewelry, contact with electrical sources, catching on equipment

4.7 Flammable-Liquid Storage

Fire-hazard chemicals in quantities of 20 L should be kept in metal safety cans designed for such storage. These cans should be used following the recommendations of the manufacturer, including the following safety practices:

- never disable the spring-loaded closure
- keep the flame-arrestor screen in place; replace if punctured or damaged.
- cabinets designed for the storage of flammable materials should be properly used and maintained
- read and follow the manufacturer's information and also follow these safety practices:
- store only compatible materials inside a cabinet
- do not store paper or cardboard or other combustible packaging material in a flammable-liquid storage cabinet

The manufacturer establishes quantity limits for various sizes of flammable-liquid storage cabinets; do not overload a cabinet.

4.8 Safety Showers

The New York City fire Department requires that emergency showers be located no more than 10 seconds in time or greater than 25 feet in distance from the lab. The shower area must be readily accessible, be kept clear of obstructions, and be clearly identified. Chain pulls to activate the shower are difficult to grasp in an emergency, and should be provided with a large ring. The valve should open readily and remain open until intentionally closed.

Water flow must be sufficient to drench the individual rapidly and to accommodate more than one person. **ANSI Z 358.1-1981** requires a minimum flow of 113.6 liters per

minute (30 gallons per minute) of water. Temperate, potable water should be used in safety showers. Although an associated floor drain is desirable, its absence should not prohibit installation of a safety shower. The shower should be tested on a regular basis and a record kept of such tests.

4.9 Eyewash Stations

Eyewash fountains should provide a copious and gentle flow of temperate aerated potable water for a period of at least 15 minutes (15 minutes of cold water is intolerable). Plumbed installations are best and strongly recommended. When possible, employees should be encouraged to practice the procedure. Use of the hands should not be required to maintain the water flow.

ANSI Z 358.1-1981 requires that eyewash units be located no more than 10 seconds in time nor greater than 100 feet in distance from the hazard. Their location should be clearly labeled.

A hand-held eye wash spray with a 5-ft hose is more adaptable than fixed fountains for unusual situations, including head and body splashes. Portable eyewash units provide an inadequate supply of water, require strict attention to maintenance, and may provide an environment for the growth of microorganisms. Their use should be discouraged except as an interim wash until the injured party can reach a plumbed fixture.

4.10 Sinks

The water supply for laboratory sinks must be separate from that used for toilets, drinking water, emergency showers, and eye washes. This is necessary to prevent possible contamination of the potable water supply. Back siphonage or back pressure can suck sink water into the potable water system through hoses or other apparatus. NYC Building codes require a check valve system that must be tested periodically. It is recommended to have separate laboratory sink drainage from the sanitary drainage in order to facilitate independent treatment of each type of waste where this is appropriate.

4.11 Respirators

When use of a respirator is considered necessary because other controls are not available or feasible, CCNY shall provide respiratory protection and:

- train its employees on the use of the respirator annually
- train on how to inspect and evaluate his or her respirator prior to every use
- review and provide biannual surveillance of working conditions
- provide written standard operating procedures for the use of respirators
- provide medical surveillance

Respirators should not be used as the first line of protection against contaminants. They should only be used during an emergency. Where appropriately deemed,

respirators will be placed in permanent cabinets outside the lab area.

The requirements of 29 CFR 1910.134 should be followed, including in particular:

a. Written standard operating procedures governing the selection and use of respirators.
b. All employees who are likely to need to use respirators must be trained in their proper use, inspection, and maintenance. (For details see "NIOSH Guide to Industrial Respiratory Protection", DHHS Publication No. 87-0116, NIOSH Cincinnati, 1987.)

4.12 Vapor Detection

Do not use odor as a means of determining that inhalation exposure limits are or are not being exceeded or for identifying a particular material. If there is a reason to suspect that a toxic chemical inhalation limit might be exceeded, whether or not a suspicious odor is detected, notify your PI. Your PI must inform the office of EHOS.

A laboratory worker may need to wear a respirator suitable for protecting against the suspect chemical until measurements are taken by the office of EHOS, of the concentration of the suspect vapor in the air. Use of a respirator must follow the guidelines established by the Occupational Safety and Health Standard.

If air monitoring shows that exposure limits are not exceeded and if there is no reason to anticipate an increase in the concentration of the chemical, and with the approval of EHOS, the respirator can be removed and the work may continue. Remember a fume hood is the primary protection method. See "Air Monitoring", (5.2)

4.13 Fire Extinguishers

Fire extinguishers in the laboratory have been selected with the understanding that a fire can have a variety of "fuel" sources. Hence we have deployed the multipurpose type of extinguisher or "A-B-C" which can be used for most classes of fires except for fires involving of alkali, alkaline and metals.

Fire extinguishers are placed by the entrance door of the lab or storage room. It is no longer acceptable to locate fire extinguishers somewhere in the middle of a lab or storage room where the potential for not being immediately found during an emergency is greater. At the City College of New York all fire extinguishers are 20 pound, which are much easier to handle by the average lab occupant.

*New York City Fire Department Codes require that laboratory and shop fire extinguishers be inspected at the beginning of the month. Once inspected the tag on the fire extinguisher has to be initialed and dated by the individual conducting the inspection.

Attempts to fight a fire should not be made by untrained personnel and / or if the fire is in an advanced stage or it has already taken more than 40 seconds to suppress.

Remember the temperature of a fire can increase dramatically and spread in a matter of seconds.

***See Emergency Procedures for details on proper fire response.**

4.14 Controls

Safety in the lab setting requires vigilance and ensuring that all safety equipment is functioning properly. To ensure this always:

- check that the fume hood(s) in your lab are working properly; the office of EHOS checks every fume hood once a year to ensure as per New York City fire department that it provides a minimum linear velocity of 60 to 150 feet per minute; if a new fume hood the velocity required is 80 to 120 feet minute
- check at least every beginning or end of the month that emergency equipment is in working order (showers, eyewash stations, fire extinguishers, spill kits),
- inspect laboratories to ensure that safety practices are followed (once a year for every lab)
- maintain an updated inventory of the substances in the laboratory

5.0 RECORDS AND RECORD KEEPING

- Air concentration monitoring results
- Exposure assessments
- Medical consultations and examinations
- Records have to be kept for at least 30 years and be accessible to employees or their representatives.
- With regard to CCNY's respiratory protection program, the following should also be documented and retained for at least 30 years thereafter:
- Medical records
- Exposure monitoring records
- Any other information pertaining to employee exposure and complaints The following should also be documented:
- All emergencies as well as all injuries, even if minor
- Controls, inspections and the results subsequently forwarded to the PI, the safety committees, and department chair for action and filing
- Public employees safety and health logs 900, 900.1 and 900.2
- Attendance at regulatory mandated training sessions and all safety training sessions and seminars
- A chemical inventory must be kept and revised annually
- Safety Data Sheets (SDS) should be kept at a known location and should be readily available to all employees for consulting or copying.

In addition to required records, it is our practice to keep records developed internally that document employee exposure complaints and suspected exposures, regardless of the outcome of an exposure assessment. Other incidents also might be

documented for future reference.

Examples include:

- safety suggestions from employees
- near-miss reports, employees who participate in or witness events that could have caused harm, but fortunately did not, should prepare reports of the incidents; these reports are used to develop changes in procedures that will prevent a future more serious occurrence
- repair and maintenance records for control systems such as fume hoods and safety cabinets
- complaints from employees

5.1 Chemical Inventory System for the Labs

It is a regulatory mandate that every lab in possession of a chemical stock keep a current chemical inventory. A chemical inventory is also an efficient way to keep track of the chemicals in a lab or storage room and ensure that unnecessary purchases are not incurred.

Every laboratory unit with chemical and / or products containing chemicals shall conduct an initial inventory of its stock and shall update this inventory whenever there is a change in the type of chemicals stored, amounts, type of container(s) used or any other factor that may affect its shelf life. It is the responsibility of the individual faculty member(s) in charge of the laboratory to ensure that the inventories are compiled and updated at least once a year.

All chemicals and chemical products bought, stored and used at CCNY are to be kept in a **chemical inventory system** commonly known as ***Safety Stratus***. All principal investigators will be registered and will designate from their staff members individuals who will have access to the inventory. Additionally, Safety Stratus [formerly Chem-tracker] shall be updated annually. Please contact the Department of Health and Occupational Safety for questions regarding the usage of our Chemical Inventory System.

5.2 Air Monitoring

The office of Environmental Health and Occupational Safety will make continuous efforts to identify those areas where airborne contaminants may pose a health and safety problem to employees. Exposure assessments and air monitoring shall be conducted immediately whenever:

- using chemicals that require initial monitoring
- a hazardous condition or a situation is identified
- where a relevant standard requires air sampling to be conducted
- a highly toxic substance is used

- where testing or redesigning of fume hoods is necessary

Air monitoring and the appropriate corrective measures are part of the many steps undertaken to protect our employees. Air monitoring shall not be terminated unless it has been determined that the potential for exposure no longer exists, or use of a substance or a process is totally eliminated in a particular area.

When initial air monitoring reveal levels deemed unhealthy or in violation of the Occupational Health and Safety Administration (OSHA) or standard, appropriate measures shall be taken to prevent further exposure by employees, students and visitors to our institution. Our department shall take the steps to comply with any provision of the law and/or follow the recommendations of good industrial hygiene practices so as to prevent overexposure from occurring in the first place.

6.0 EMPLOYEE INFORMATION and TRAINING

6.1 Chemical Safety Information

CCNY will provide all its employees subject to the CHP with training sessions concerning the hazards of chemicals in its laboratories. These sessions are mandatory for all employees subject to the Lab Standard who have not yet attended a chemical safety training session at CCNY. Employees should be provided with sufficient information to understand the potential hazards that can affect them personally. All employees are accountable to their peers and, therefore, should fully utilize all available information. Chemical health and safety training session(s) will include:

- The contents and requirements of the laboratory standard, including general principles of Good Laboratory Practice.
- The content of the Chemical Hygiene Plan (CHP, the present document).
- The employer's responsibility for a safe workplace.
- Employee's responsibilities for laboratory practices.
- Methods for detecting the presence or release of a hazardous chemical or recognizing the presence of such a hazard
- The potential health and safety hazards associated with the chemicals used in CCNY laboratories, and signs and symptoms of exposure.
- The measures employees can use to protect themselves from these hazards including the use of personal protective equipment, the use of fume hoods and emergency response procedures.

In addition to the above, the office of EHOS will provide training on RCRA (Resource Conservation and Recovery Act, 1976 ["Cradle-to-Grave"]) Hazardous Waste Management (EPA) and on the requirements for the New York City Fire

Department certificate of fitness holder also known as C-14.

Chemical laboratory health and safety training sessions will be held biannually at the beginning of the spring and fall semester and at such other times as are deemed appropriate. A notice sent to each chair of a relevant department will announce time and location of these sessions in advance.

Employees who will come in contact with particularly hazardous substances such as carcinogens, reproductive toxins, substances with a high degree of acute toxicity or radioactive materials, or who will use equipment with specific hazards(e.g. lasers), must receive additional specific safety training prior to beginning work

6.2 Reference Literature

A list of the reference material or chemical safety information sources is provided and can be found at the end of Appendix C in the Chemical Hygiene Plan.

The CHP will be discussed with every CCNY laboratory employee during the training sessions and a hard copy will be present in every lab on campus. A copy will be available for consultation or for copying in each Science and Engineering Department office during regular business hours.

6.3 Safety Data Sheets

An OSHA regulatory requirement is that every CCNY laboratory and storage room have a binder available with the SDS of the chemicals and chemical products on the premises. A standard letter that can be sent to companies requesting copies of an SDS (or MSDS) is enclosed in this CHP. They are also available in the office of Environmental Health and Occupational Safety (CG- 04).

As required by the Right-to Know (RTK) Law or Hazard Communication Standard, an OSHA regulation found in 29 CFR 1910.1200, Safety Data Sheets (SDS) are references to be used principally for the training of workers concerning the hazards and precautionary measures applicable to those particular chemicals that workers will handle in the workplace. Prior to working with any chemical, particularly hazardous substances, always consult the manufacturers SDS.

6.4 Signs

<u>The following signs will be posted conspicuously in every laboratory:</u>

- Required NYC Fire Department laboratory door signs
- Special warning signs at designated areas, where work with particularly hazardous substances is performed, or where equipment with specific hazards is being used
- Sign identifying the location of safety equipment (Safety Showers and Eyewash Stations)

- Fire extinguishers, First aid kits, etc.
- An Emergency Procedure Plan with contacts and their telephone numbers listed in case of an emergency should be posted near the telephone. A copy is found in Appendix L. of labeling.

6.5 Labels

Labels shall conform to the **Globally Harmonized System** (GHS) a worldwide system led by the United Nations to ensure an understanding of the hazards of chemicals across languages and culture. Under the GHS labels will contain pictograms, the name of the chemical, its CAS number and when applicable an expiration date. Chemical hazards can be classified by four categories: toxicity, ignitability, corrosivity, and reactivity. Container labels will convey this hazard information. It should be stressed that all chemical containers must have labels. If the chemical has been prepared in the laboratory, a permanent label must be made.

The Lab Safety Standard, OSHA Hazard Communication Standard 1910.12, and in the case of waste material the Resource Conservation and Recovery Act (RCRA) 40 CFR Part 262 all require that every chemical bottle, container or box in CCNY be properly labeled. A Chemical product, which is not labeled or is missing the required information cannot be accepted by lab personnel and must be immediately returned to the manufacturer, importer or distributor.

Laboratory personnel are responsible for ensuring that chemicals or chemical products purchased, borrowed or developed in the lab also be properly labeled.

The following information must be placed on the label of every container of a chemical or chemical product:

- The identity of the material clearly spelled out. Abbreviations and chemical symbols will not be considered appropriate for labeling purposes.
- Hazard warnings such as: flammability, reactivity, corrosivity, toxicity.
- Name and address of the manufacturer
- Date of receipt. If the material is one which generates peroxide, it shall have the date it was opened and its expiration date clearly displayed. This is especially important with regard to ethyl ether, tetrahydrofuran, perchloric and picric acids.

Chemicals that are repackaged or transferred to another container should have secure, waterproof labels marked with waterproof ink which state the hazards, precautions, the name of the chemical, date packaged and its strength and purity.

Chemicals developed in the lab shall be assumed to be hazardous unless they are clearly determined by the safety office to be non-hazardous.

***Labeling for chemical products developed in the lab should be as follows:**

- Identity of the material.
- Hazard and/ or potential hazards.
- Neutralization or treatment agent in case of a spill.
- Name, room number and lab telephone number of the individual(s) who created the chemical/solution.
- Preparation and expiration dates.

For the purposes of long-term storage of some chemicals, periodic inspection is mandated. Based on the overall condition of a material a decision can be made to either extend its storage period or to dispose of it as hazardous waste.

The criteria for extending storage of chemicals are:

- Good storage condition.
- Material at hand must be considered chemically and physically stable.
- The possible lifetime of a container must be determined.
- The date of receipt, expiration date as well as shelf life must be clearly written on container labels for the following chemicals:
  - — picric acid
  - — perchlorates
  - — peroxide forming chemicals such as ethers
- Any other material known to be unstable, reactive or to deteriorate with time or environmental factors.

If any of the information described is missing then the chemical must be removed immediately!

6.6 Chemical Laboratory Health and Safety Training

CCNY will provide all its employees subject to the CHP with training sessions concerning the hazards of chemicals in its laboratories. These sessions are mandatory for all employees subject to the CHP who have not yet attended a chemical safety training session in CCNY. Chemical laboratory health and safety training session will include:

- the contents and requirements of the laboratory standard, including general principles of good laboratory practice
- the content of the chemical hygiene plan (the present document)
- the employer's responsibility for providing a safe workplace (e.g., working fume hoods, emergency eyewash stations and showers, and personal protective equipment)
- employee's responsibilities for following proper laboratory practices to help protect their

health and provide for the safety of themselves and fellow employees

- the methods and observations that may be used to detect the presence or release of a hazardous chemical
- the potential health and safety hazards associated with the chemicals used in CCNY laboratories and signs and symptoms of exposure
- the measures employees can use to protect themselves from these hazards, including specific procedures such as appropriate work practices, personal protective equipment to be used, criteria for using fume hoods, and emergency procedures

In addition, employees who will come in contact with particularly hazardous substances (select carcinogens, reproductive toxins, substances with a high degree of acute toxicity: see Appendix C for a list of these chemicals) or radioactive materials (see 3.2.6), who will use equipment with specific hazards (e.g., lasers), biological or physical hazards will receive additional training specific to the hazard prior to beginning work.

Chemical laboratory health and safety training sessions will be held twice a year, at the beginning of the fall and spring semester and when necessary during the summer months. Times and locations for these sessions will be announced in advance by a notice sent to each department chair.

Records of attendance at the safety training sessions as well as those conducted by PI'S shall be kept by the Department Chairperson. A copy of the Emergency Procedures should be posted conspicuously in every laboratory near a telephone and near the exit. A copy of the Emergency Procedures can be found in Appendix A of this manual.

***Doors to laboratories and shops shall remain free from obstructions at all times.**

7.0 EMERGENCY PROCEDURE PLAN

7.1 Fire Notes and precautions

Small fires can be extinguished without evacuation. However a fire can get out of control in a matter of seconds so it is preferable that students and employees do not attempt to fight a fire. Fire extinguishers should be used only by trained and authorized personnel. An immediate readiness to evacuate is essential in the event the fire cannot be extinguished.

- Do not panic and do not run if evacuation is necessary
- Never enter a room that is filled with smoke or fire
- ***Do not open the door nor enter a room if the top half of the door is warm to the touch.**

7.2 If you discover a Fire:

Two types.

7.2.1 A Small fire:

- Alert people in laboratory to evacuate the room.
- Close the door(s) behind you this will retard the spread fire and smoke
- Locate and pull the nearest fire alarm pull station
- If you are trained and authorized to fight fire remember the following:
  - — If room is filled with smoke or fumes. do not attempt to fight the fire
  - — do so from a position where the fire is in front of you and you can move back towards the door and escape
  - — If unable to extinguish the fire within **40** seconds use **major fire** procedures
  - — immediately after the fire, all extinguishers that were used should be recharged or replaced by with full ones

7.2.2 Major Fire:

- alert people in the area to evacuate the room, closing but not locking, the door behind you
- locate and pull the nearest fire alarm pull station
- proceed to the nearest stairwell and calmly walk down the stairs; **do not use the elevators**
- after arriving at a safe space, call security (212-650-**7777**) and fire department (**9-911**); provide as much information as possible: the building, the floor and room number, and

material that is burning

- indicate if there are people injured or trapped

7.3 If a fire alarm rings:

- evacuate the building immediately, do not panic and run, do not use the elevators
- the last person out of the room should close, but not lock, the door

7.4 Radiation Spill

Caution: Spreading of radiation beyond the spill area can easily occur by the movement of personnel involved in the spill or cleanup effort. Prevent spread by confining movement of personnel until they have been monitored and found free of contamination.

- Notify your advisor as soon as possible in case of area or personnel contamination or excessive exposure to radiation.
- In case of airborne contamination, evacuate the area, lock and post the door. Call
- **6911** and the Radiation Safety Officer at extension **5080**.
- **In case of personnel contamination, remove victim from exposure. Remove contaminated clothing, wash skin contamination with soap and water only.**

7.5 Chemical Spill

We recognize the potential dangers that are hazardous material spill in its original form or as a waste can pose to the health of humans and to our environment. Proper management and monitoring of all materials is the soundest approach to the prevention of hazardous spills.

However, should an accident occur, our institution should have the capabilities of responding to the situation in a manner that is safe, prompt, efficient and will also minimize harm to life, health and property. The following policies are designed to accomplish this objective:

- The Department of EHOS will provide the appropriate training to lab and school personnel and students to ensure there is a clear understanding of the steps to take in an emergency involving a chemical spill.
- All appropriate measures, including evacuation, shall be taken to ensure the safety of employees, students and visitors in the event of an emergency.
- EHOS will monitor emergency readiness levels by inspecting and upgrading proper protective equipment and will ensure the “mobility” of emergency equipment via an “emergency cart” from one area to another.
- Training of personnel in charge for responding to chemical spills and fire response emergency.

- EHOS will ensure the upkeep and supply of spill skits including ash soda for acids, corrosives and solvent neutralizer.
- EHOS will carry out periodic review of its policies and procedures

Caution: The cleanup of a chemical spill should only be done by trained personnel. Spill kits with instructions, absorbents, reactants, and protective equipment should be available to clean up minor spills. A minor chemical spill is one that the laboratory staff s capable of handling safely without assistance of safety and emergency personnel. All other chemical spills are considered major.

Minor Chemical Spill

- Alert people in immediate area of spill.
- Report to advisor.
- Wear protective equipment, including safety goggles, and long-sleeve lab coat.
- Avoid breathing vapors from spill.
- Confine spill to small area.
- Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, and dispose as chemical waste.
- For other chemicals, use appropriate kit or absorb spill with vermiculite, dry sand, or diatomaceous earth.
- If it is a mercury spill, do not use these absorbents; a mercury spill kit is required. Collect residue, place in container and dispose pf it as chemical waste.
- Clean spill area with water.

7.6 Major Chemical Spill

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory, evacuate.
- If spilled material is flammable, turn off ignition and heat sources.
- Close doors to affected area.
- Call 212-650-6911 and 9-911.

7.7 Biological Spill

Notes and precautions: Biological spills outside biological safety cabinets can pose the danger of aerosol generation and dispersion. These spills can be serious. To reduce the risk of inhalation exposure in such an incident, occupants should leave the laboratory immediately. The laboratory should not be reentered to decontaminate and clean up the spill for at least **30** minutes. During this time the aerosol should be removed from the laboratory by the exhaust air ventilation system.

Appropriate protective equipment is particularly important in decontaminating spills involving microorganisms that require either BSL 2 OR BL3 containment. This equipment includes lab coat with long sleeves, back-fastening gown or jumpsuit, disposable gloves, disposable shoe covers, and safety goggles and mask or full face shield. Use of this equipment will prevent contact with contaminated surfaces and protect eyes and mucous membranes from exposure to spattered materials.

7.8 Spill Involving a Microorganism Requiring BL 1 containment

- Wear disposable gloves
- Soak paper towels in disinfectant and place over spill area
- Place towels in plastic bag for disposal
- Clean spill area with fresh towels soaked in disinfectant.

7.9 Spill Involving a Microorganism Requiring BL 2 containment

- Alert people in immediate area of spill.
- Put on protective equipment.
- Cover spill with paper towels or other absorbent materials.
- Carefully pour a freshly prepared 1 in 10 dilution of household bleach around the edges of the spill and then into the spill. Avoid splashing.
- Allow a **20**-minute contact period.
- Use paper towels to wipe up the spill, working from the edges into the center.
- Clean spill area with fresh towels soaked in disinfectant.
- Place towels in a plastic bag and decontaminate in an autoclave.

7.10 Microorganism Requiring BSL 3 Containment

Microorganisms requiring BSL 3 or BSL 4 are strictly prohibited at the City College of New York.

7.11 Personal Injury

Life threatening injuries are to be reported immediately to 9-911 for ambulance service to the closest emergency service room.

7.12 Clothing on fire

- Drench person with water using the safety shower.
- If no safety shower is immediately available, roll person on the floor to smother the flames.
- Fire blankets must be used with caution because wrapping the body can force flames

toward the face and neck.

- Quickly remove any clothing contaminated with chemicals.
- Use caution when removing pullover shirts or sweaters with a knife or scissors to prevent contamination of the eyes.
- Wrap the injured person to avoid shock and exposure.

7.13 Hazardous material splashed in eye

- Immediately flush the eye (eyeball and inner surface of eyelid) with temperate potable water from an eyewash fountain for at least 15 minutes.
- If no eyewash fountain is available, injured persons should be placed on their backs and water gently poured into their eyes for at least 15 minutes.
- Forcibly hold eye open to ensure effective wash behind eyelids.
- First aid must be followed by prompt treatment by a member of a medical staff or an ophthalmologist especially alerted and acquainted with chemical injuries.

7.14 Chemical spill on the body

- For spills covering a small area of skin, immediately flush with flowing water for no less than 5 minutes. If there is no visible burn, wash with warm water and soap. Check the MSDS/SDS to see if any delayed effects should be expected. It is advisable to seek medical attention for even minor chemical burns.
- If clothing is contaminated, remove it at once using caution when removing shirts or sweaters to prevent contamination of the eyes.

7.15 Minor Cuts and Puncture Wounds

- Vigorously wash injury with soap and water for several minutes.
- If the wound is deep and is severely bleeding, obtain medical attention.

7.16 Radiation or Biological Spill on Body

- Remove contaminated person from exposure.
- Remove contaminated clothing.
- Rinse exposed area thoroughly with soap and water.
- In case of injury following a radiation spill, call 9-911 and treat injuries without regard to radioisotope contamination.
- ***A radiation spill should be reported to both supervisor and the Radiation Safety Officer (Richard Belgrave, CG-04, ext. 5085).***
- *In any case, report the incident to your supervisor!*

8.0 EXPOSURE ASSESSMENT and MEDICAL CONSULATIONS

8.1 Suspected Exposures to Toxic Substances

Lab and / or other CCNY personnel will be offered free medical examination / consultation with no loss of workday time whenever there has been over-exposure to a hazardous chemical.

8.2 Criteria for reasonable suspicion of exposure

It is the policy of CCNY to promptly investigate all employee-reported incidents in which there is a possibility of employee overexposure to a toxic substance.

***Events or circumstances that might reasonably constitute overexposure include:**

- A hazardous chemical was leaked, spilled or otherwise rapidly released in uncontrolled manner.
- A laboratory employee had direct skin or eye contact with a hazardous chemical.
- A laboratory employee manifests symptoms, such a headache, rash, nausea, coughing, tearing, irritation or redness or eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, etc., and
- Some or all of the symptoms disappear when the person is taken away from the exposure area and breathes fresh air.
- The symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
- Two or more persons in the same laboratory work area have similar complaints.

8.3 Exposures

All complaints and their disposition, no matter what the ultimate disposition may be, are to be ***documented***. Included in the documentation should be an explanation for the reason(s) for no further investigation assessment of the event if this is the final decision. If the decision is to investigate, a formal exposure assessment will be conducted.

8.4 Exposure assessment

The purpose of an overexposure assessment is to determine that there was, or was not, an exposure that might have caused harm to one or more employees and, if so., to identify the hazardous chemical or chemicals involved. Other investigations might well result and conclusions from exposure assessment, along with other information, to derive recommendations that will prevent or mitigate any future overexposures.

An overexposure assessment may include the following:

- Interview the complainant and also the victim, if not the same person, and

- *List the essential information about the circumstances of the complaint, including:
  - The chemical under suspicion
  - Other chemicals used by the victim.
  - All chemicals being used by others in the immediate area.
  - Symptoms exhibited or claimed by the victim.
  - How these symptoms compare to symptoms stated in the MSDS for each of the identified chemicals.
  - Were control measures, such as personal protective equipment and hoods, used properly
  - Were any air samplings or monitoring devices in place? If so, are the measurements obtained from these devices consistent with other information.
  - Are any chemical traces, reaction products, or other residual materials found in the area; if so, what can be inferred about possible exposures?

8.5 Notification of Results of Monitoring

CCNY will notify employees of any monitoring results within 15 working days of receipt.

8.6 Medical Consultation and Examination

It is the policy of The City College of New York to promptly investigate all employee- reported incidents in which there is a possibility of employee overexposure to a toxic substance. Employees shall be provided with a medical examination at no cost to the employee with no loss of work time. The details or medical consultations and examinations are determined by the physician.

Events or circumstances which may reasonably constitute overexposure include:

- Hazardous chemicals leaked, spilled or otherwise rapidly released in an uncontrolled manner.
- Laboratory employees with direct eye or skin contact with a hazardous chemical
- Laboratory employees who manifest symptoms, such as headache, rash, nausea, coughing, tearing, irritation, redness of the eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment
- Some or all of the symptoms disappearing when the person is taken away from the exposure area and breathes fresh air with symptoms reappearing when the employee returns to work with the same hazardous chemicals.
- Two or more individual employees in the same laboratory work area having similar symptoms or complaints.

The purpose of a medical examination is warranted when, from the results of an overexposure assessment, it is suspected or known that an employee was overexposed to a hazardous chemical or chemicals; the employee should obtain medical consultation

from or under the direct supervision of a licensed physician who is experienced in treating victims of chemical overexposure. The medical professional should also be knowledgeable about which tests or procedures are appropriate to determine if there has been an overexposure; these diagnostic techniques are called “differential diagnoses”.

Employees shall be notified of the results of any medical consultation or examination with regard to any medical condition that exists or might exist as a result of overexposure to a hazardous chemical.

8.7 Documentation

All memos, notes, and reports related to a complaint of actual or possible exposure to hazardous chemicals are to be maintained as part of the record.

8.8 Notification

Employees shall be notified of the results of any medical consultation or examination with regard to any medical condition that exists or might exist as a result of overexposure to a hazardous chemical.

9.0 Other

9.1 Composition of the Lab Safety Committee

Each department to which this Plan applies shall be a member of the college wide safety committee and insure that the Plan is in fact adhered to. The Committee shall generally have the responsibility of insuring that the rules set forth in other parts of this Plan are adhered to, including among others the controls listed in section 4.10 of this Plan. The Committee shall include tenured faculty from the department, plus at least one tenured technician. It may also include students (graduate and undergraduate), and others whom the department feels should be included.

9.2 Records and Record keeping

The records of the LSC are to be kept in a file in the offices of the EHOS.

9.3 Training of Employees

CCNY will provide all its employees subject to the CHP with training sessions concerning the hazards of chemicals in its laboratories and shops. These sessions are mandatory for all employees subject to the Lab Standard who have not yet attended a chemical safety training session at CCNY.

9.4 Responsibilities of the Lab Safety Committee

The responsibilities of the LSC are described under section 2.5 CCNY Laboratory Safety Committee (LSC) page 5 of this document.

9.5 Compliance Procedure

Poor safety practices and violations of the policies set forth in this plan can be reason for cessation of a laboratory procedure and/or operation. In the case of serious repeated violation(s) of CCNY policies and / or regulatory mandates, the following steps may result in termination of employment. The procedure set forth is intended to provide a mechanism for corrective action.

The Laboratory Hygiene Officer (LHO) on behalf of the Office of Environmental and Occupational Safety and Health and the Laboratory Safety Committee shall abide by the following procedures when an unsafe condition is detected or violation of this program or of any statutory mandate is found:

1. Immediately inform in writing the Principal Investigator or the designated person in his/her absence, of the unsafe condition or violation and the recommended corrective measure. A time frame for remediation will be assigned by the LCHO/LHO.

2. If the condition is not corrected within the assigned time frame the LCHO/LHO shall inform in writing the appropriate department Chair, Dean and the Lab Safety Committee.

3. If there is no response from the Chair and Dean the LCHO/LHO will inform in writing the Vice President for Planning and Management, the ior Vice-President, the Provost, and the President of CCNY.

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Appendix A

STANDARD OPERATING PROCEDURES

The OSHA Laboratory Standard requires that Chemical Hygiene Plans include specific elements and measures to ensure employee protection in the laboratory. One such requirement is Standard Operating Procedures (SOPs) “relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals”. This is especially the case if your lab operations include the routine use of "select carcinogens,' reproductive toxins and substances which have a high degree of acute toxicity”.

Standard Operating Procedures can be stand-alone documents or supplemental information included as part of research notebooks, experiment documentation, or research proposals. The SOP blank template can be downloaded from our EHOS files from the following link:

CCNY SOP Template Download

The key idea with laboratories having standard operating procedures is to ensure a process is in place so that an experiment is well thought out and includes and addresses relevant health and safety issues.

At a minimum, SOPs should include details such as:

- The chemicals involved and their hazards.
- Special hazards and circumstances.
- Use of engineering controls (such as fume hoods).
- Required personal protective equipment.
- Spill response measures.
- Waste disposal procedures.
- Decontamination procedures.
- Description of how to perform the experiment or operation.

While the OSHA Laboratory Standard specifies the requirement for SOPs for work involving hazardous chemicals, laboratories should also develop SOPs for use with any piece of equipment or operation that may pose any physical hazards.

Examples include:

- Safe use and considerations of lasers.
- Use of cryogenic liquids and fill procedures.
- Connecting regulators to gas cylinders and cylinder change outs.
- Use of equipment with high voltage.

Standard Operating Procedures do not need to be lengthy dissertations and it is perfectly acceptable to point laboratory personnel to other sources of information. An Example to include as part of the SOPs can be:

"*To use this piece of equipment, see page 4 in the operator's manual (located in filecabinet #4).*"

EH&S can assist laboratories in developing general and specific SOPs for chemical use inlaboratories. Due to the large variety of research and the number of laboratories at City College, it is the responsibility of each laboratory PI and department to ensure that SOPs are developed and the practices and procedures are adequate to protect their lab workers who use hazardous chemicals.

Standard Operating Procedure

Read the Standard Operating Procedures Fact Sheet before filling out this form. Printout the completed form and keep a readily accessible hard copy in the lab (also keeping an electronic copy is highly recommended).

▪ Date:	▪
▪ SOP Title:	▪
▪ Principal Investigator:	▪
▪ Department:	▪

▪ Room and Building:	▪
▪ Lab Phone Number:	▪

Section 1 – Process or Experiment Description

Provide a brief description of your process or experiment, including its purpose. Do not provide a detailed sequential description as this will be covered by section #15 of this template.

Section 2 – Hazardous Chemicals

List chemicals used. Include chemical name, common name and abbreviation.

Section 3 – Potential Hazards

List chemicals used. Include chemical name, common name and abbreviation.
(Describe the potential hazards associated with the chemicals or the procedure.) Examples include:

1. Chemical hazards such as carcinogenic, irritant, corrosive, acutely toxic
2. Reproductive hazards such as teratogens or mutagens
3. Allergies or chemical sensitivities that may be associated with the chemical
4. Physical hazards such as reactive, unstable, pyrophoric, implosion, exothermic, use of high energy equipment.

Section 4 – Routes of Exposure

As applicable, describe the potential routes of exposure associated with the procedure such as inhalation, injection, absorption, and skin/eye contact.

Section 5 – Approval

Use will be limited to the following personnel (check all that apply):

Approval		
▪ Principal Investigator		
▪ Graduate students		

▪ Technical staff		
▪ Post-doctoral employees		
▪ Undergraduates		
▪ Other (describe)		

Section 6 – Training

Training requirements: The user must demonstrate competency and familiarity regarding the safe handlingand use of this material prior to purchase. Training should include the following:

- Review of current MSDS
- Review of the OSHA Lab Standard
- Review of the Chemical Hygiene Plan
- Review CUNY Laboratory Manual
- Laboratory safety training (EH&S)

Section 7 – Personal Protective Equipment

- All personnel are required to wear the following personal protective equipment whenever
- handling this material (check all that apply):

▪ Safety glasses		▪
▪ Chemical safety goggles		
▪ Face shield		
▪ Gloves (*type*)		
▪ Lab coat		

▪ Rubber coat	
▪ Other ▪ (describe)___	

Section 8 – Designated Area

Designated work area(s) - Required whenever carcinogens, highly acutely toxic materials, or reproductive toxins are used. The intent of a designated work area is to limit and minimize possible sources of exposure to these materials. The entire laboratory, a portion of the laboratory, or a laboratory fume hood or bench may be considered a designated area location. Materials shall be used only in the following designated areas in the laboratory.

- Check all that apply:

▪ Demarcated area in lab		▪
▪ Fume hood		▪
▪ Glove box		▪
▪ Other		▪ (describe)

Section 9 –Storage Requirements

Materials will be stored according to compatibility and label recommendations in a designated area. Describe storage requirements for the hazardous chemicals, especially for highly toxic, highly reactive/unstable materials, highly flammable materials, and corrosives.

Section 10 – Special Handling Procedures

Describe special handling requirements for hazardous chemicals used in your procedure, especially for highly toxic, highly reactive/unstable materials, highly flammable materials, and corrosives.

Section 11 – Engineering Controls

Guidance on Engineering and Ventilation Controls – Consult MSD and review safety literature and peer- reviewed journal articles to determine appropriate engineering and ventilation controls for your process or experiment. Guidance is available from health and safety specialists at City College.

As applicable, describe the engineering controls used for the procedure) Examples:

1. Use of fume hoods or glove boxes
2. Special ventilation
3. HEPA filtered vacuum lines
4. Non-reactive containers
5. Temperature control
6. Bench paper, pads, plastic-backed paper

Section 12 – Decontamination

***For hazardous material spills or releases which have impacted the environment (via the stormdrain, soil, or air outside the building) or for a spill or release that cannot be cleaned up by local personnel:**

1. Notify City College
   a. Public Safety by calling 7777/-6911
   b. EH&S by calling the numbers listed above,

2. Small Spills Cleanup:
   - In the event of a minor spill or release that can be cleaned up by local personnel using readily available equipment (absorbent, available from EH&S in Small Spill Kit):
   - Notify personnel in the area and restrict access.
   - Review the SDS/MSDS for the spilled material, or use your knowledge of the hazards of the material to determine the appropriate level of protection.
   - Wearing appropriate personal protective equipment, clean up spill. Collect spill cleanup materials in a tightly closed container.
   - Manage spill cleanup debris as hazardous waste.

3. Clean up work area and lab equipment.
   - Describe specific cleanup procedures for work areas and lab equipment that must be performed aftercompletion of your process or experiment. For carcinogens and reproductive toxins, designated areasmust be immediately wiped down following each use.

Section 13 – Exposure: Emergency procedures to be followed (from SDS/MSDS)

- Skin/eye contact--Symptoms: Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician. Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.
- First Aid: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.
- Inhalation--Symptoms: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.
- First Aid: Remove from exposure to fresh air immediately. If not breathing give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Section 14 – Waste Disposal

Collect the hazardous waste in a container that is compatible with the waste. Tightly capped and label the container. Use preprinted hazardous waste labels to label all hazardous waste containers. Hazardous waste containers are kept in secondary containment trays at the satellite accumulation area.

▪ Chemical Waste Generated					
▪ Chemical Name	▪ State	▪ Non- ▪ Hazardous		▪ If hazardous what is/are the hazard/s?	▪ ▪ How is the waste managed?

	▪				
	▪				

Section 15 – Process Steps

- For each step's description, include any step-specific hazard, personal protective equipment, engineering
- controls, and designated work areas in the left hand column.

▪ Process Steps	▪ Safety Measures
▪ 1.	▪
▪ 2.	▪
▪ 3.	▪
▪ 4.	▪
▪ 5.	▪
▪ 6.	▪
▪ 7.	▪
▪ 8.	▪
▪ 9.	▪
▪ 10.	▪

Section 16 - Training Documentation

Name (Printed)	Signature	Date
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
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■	■	■
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■	■	■
■	■	■
■	■	■
■	■	■
■	■	■
■	■	■

Prepared by:_____ Date: _____

Reviewed/Revised by:_____

A copy of the completed SOP must be filed with the Environmental Heath & Occupational Safety Office, ehos@ccny.cuny.edu.

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Appendix B

Table 1: Peroxide Guidelines when storing peroxide forming materials

Containers Holding Peroxide Forming Materials	55 Gallon Drums of Peroxide Forming Materials are not allowed on CCNY premises
▪ 1) Need to be tested for peroxide every six (6) months ▪ a)- Test date should be noted on label ▪ b)- If transferring to another container date bottle is filled must be noted on the label	▪ 1) Labels must include: ▪ a)- Date opened (signed by person opening the container) ▪ b)- Date last tested (signed by the person who did the test)
▪ 2) Someone with a Certificate of Fitness must do the test and sign it. It has to be notarized if required by the Fire Dept.	▪ 2) A logbook might be advisable if ethyl ether is distributed to a different location. The logbook should include dates on which ether was, and names of recipients.
▪ 3) Distributed peroxide materials are the responsibility of whoever has them. They must have been tested for peroxide within the last 6 months.	▪
▪ 4) Those receiving the material must be noted in a logbook.	▪
▪ 5) The person conducting the peroxide testing will be held harmless by the state except in the case of gross negligence	▪

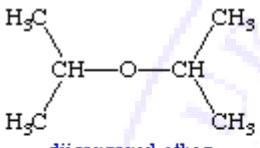
Table 2: Chemicals Prone to Form Peroxide

▪ Organics	▪ Inorganics
▪ Ethers, acetyls	▪ Alkali metals, particularly potassium
▪ Olefins with allylic hydrogens,chloro- and fluoroolefins, terpenes, tetrahydronaphthalene	▪ Alkali metals alkoxides and amides
▪ Dienes, vinyl acetylenes	▪ Organometallics
▪ Aldehydes	▪ Vinyl monomers including vinyl halides, acrylates,methacrylates, vinyl esters
▪ Ureas, amides, lactams	▪

Table 3: Common Peroxide Forming Chemicals

List A Severe Peroxide Hazard on Storage with Exposure to Air(Discard within 3 months)		
Organic	Inorganic	
▪ Divinyl ether	▪ Potassium metal	▪ Po
▪	▪	
▪ Divinyl acetylene	▪ Potassium amide	
▪ lsopropyl ether	▪ Sodium amide (sodamide)	
▪ Vinylidene chloride (1, 1 -dichloro ethylene)	▪	

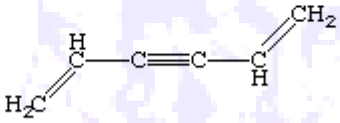
Figure 1: Severe peroxide Hazard on Storage with Exposure to Air (Use within 3 months)



diisopropyl ether
(isopropyl ether)

vinylidene chloride
(1, 1-dichloroethene)
(1, 1-dichloroethylene)

K
potassium metal



divinyl acetylene

KNH_2
potassium amide

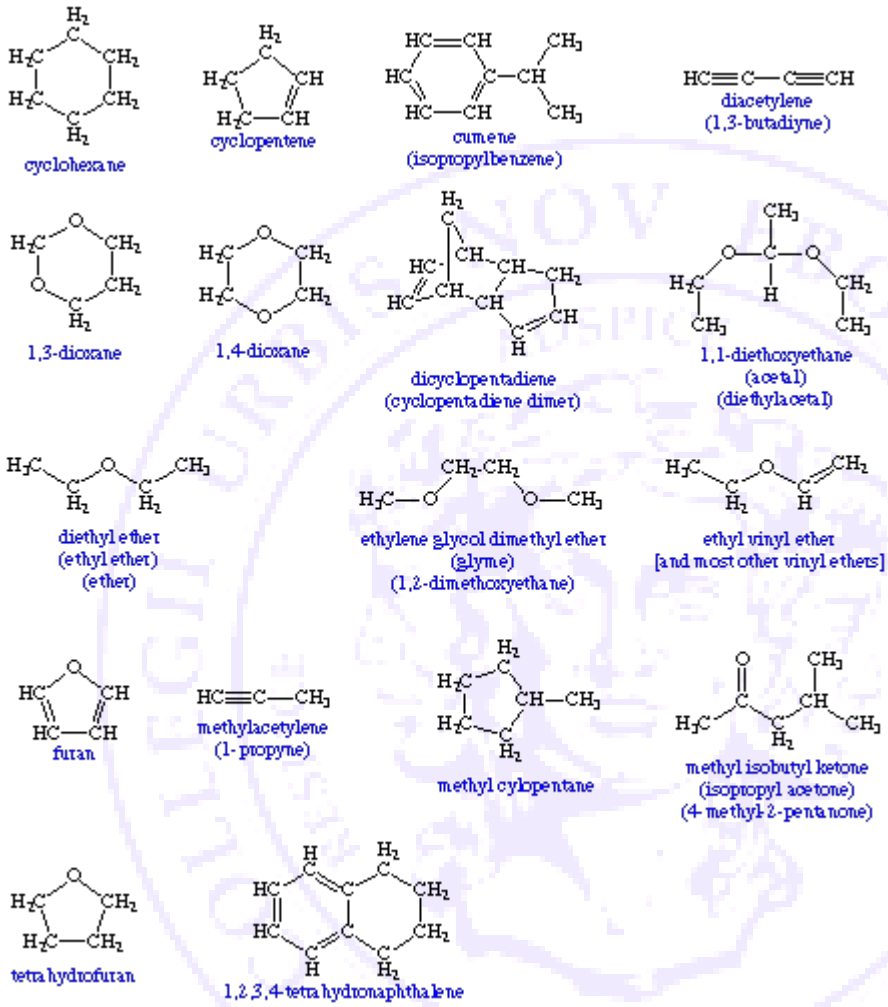
$NaNH_2$
sodium amide

Table 4: Peroxide Hazard on Concentration

Do not distill or evaporate without first testing for the presence of peroxides. Discard or test for peroxides after 6 months	
▪ Acetyl	▪ Dioxane (p-dioxane)
▪ Cumene	▪ Ethylene glycol dime
▪ Cyclohexene	▪ Ethylene glycol ether
▪ Cyclopenetene	▪ Ethylene glycol mono
▪ Decalin (decahydronaphtalene)	▪ Furan.
▪ Diacetylene	▪ Methyl acetylene
▪ Dicyclopentadiene	▪ Methyl cyclopentanc
▪ Diethylene glycol dimethyl ether (diglyme)	▪ Tetrahydrofuran
▪ Methyl-I-butyl Ketone	▪
▪ Diethyl ether	▪
▪ Tetrahydronaphthale	▪
▪ Vinyl ethers	▪

Figure 2: Peroxide Hazard on Concentration by Evaporation or Distillation (Use or test for peroxides within 6 months)

Figure 2: Peroxide Hazard on concentration by evaporation or distillation
(Use or test for peroxides within 6 months)



Including the following:

- Acetaldehyde diethyl acetal (acetal)
- Butadiene
- Cellusolve
- Decalin (decahydronaphthalene)
- Diethylene glycol dimethyl ether (diglyme)

- Ether
- Ethylene glycol ether acetates
- Ethylene glycol mono-ethers (cellusolves)
- Glyme

Table 5: Hazard of Rapid Polymerization Initiated by Internally Formed Peroxides

Normal Liquids- Discard or test for peroxides after 6 months Normal Gases-Discard after 12 months	
▪ Acrylic acid	▪ Tetrafluoroethylene
▪ Acrylonitrile	▪ Vinyl acetate
▪ Butadiene	▪ Vinyl acetylene
▪ Chlorobutadiene (chloroprene)	▪ Vinyl chloride
▪ Chlorotrifluoroethylene	▪ Vinyl pyridine
▪ Methyl Methacrylate	▪ Vinylidene chloride Styrene

Figure 3: Hazard of Rapid Olymerization by Internally-Formed Peroxides

(Use or test for peroxides within 6 months)

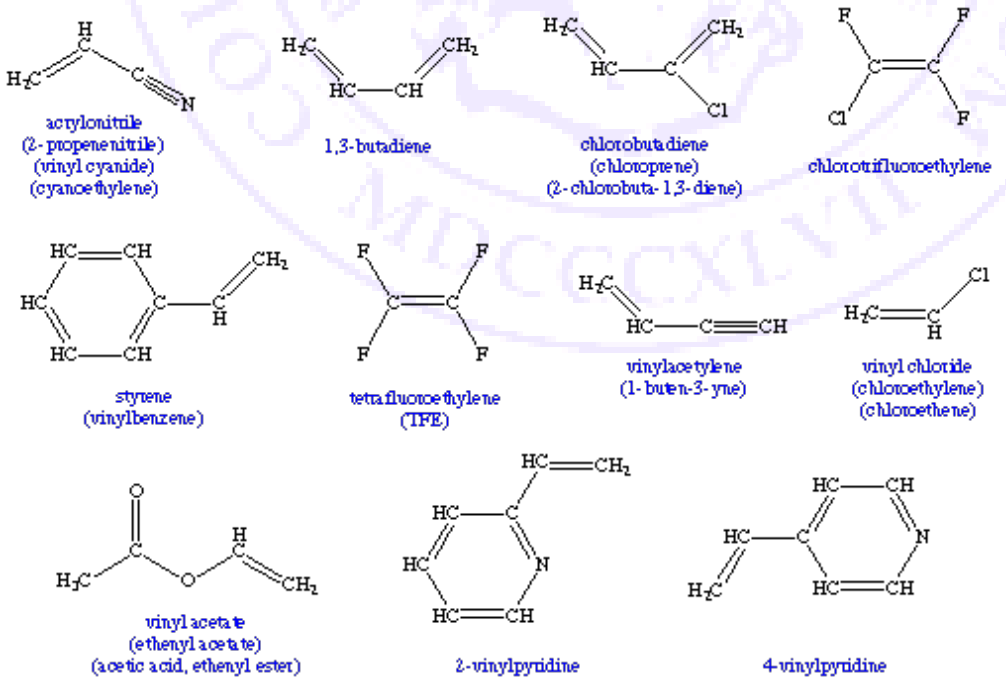


Table 6: Additional List of Materials which Tend to form Peroxides

Table 6:Additional List of Materials which Tend to form Peroxides		
▪ Acrolein	▪ Dccahydronaphthalene	▪ Ethyl methyl ether
▪ Allyl ethyl ether	▪ Dibutyl ether	▪ Methylanisole
▪ Allyl phenyl ether	▪ Diethylene glycol	▪ Methylphenetole
▪ Benzyl ether	▪ Diethylene glycol diethyl ether	▪ Phenetole
▪ Benzoylon-butyl ether	▪ Diethylene glycol mono-O-butyl ether	▪
▪ Bromophenetole	▪ Dimethyl ether	▪
▪ p-Chloroanisole	▪ Dimethyl isopropyl ether	▪

Table 7: National Fire Protection Association (NFPA) System for Classification of Hazards.

▪ Health Hazards	▪ Fire Hazards
▪ 4- Deadly	▪ 4- Extremely flammable
▪ 3- Extreme danger	▪ 3- Ignites at normal temperature
▪ 2- Hazardous	▪ 2- Ignites when moderately heated
▪ 1- Slightly hazardous	▪ 1- Must be preheated to burn
▪ 0- Normal material	▪ 0- Will not burn

Table 8: Specific Hazard and Reactivity

Specific Hazard	Abbreviations	Reactivity
Oxidizer	Ox	4-May detonate
Acid	ACID	3-Shock and heat may detonate
Alkali	ALK	2-Violent chemical change
Corrosive	CORR	1-Unstable if heated
Use NO Water		0-Stable
Radioactive		

Table 10: Classes of flammable and Combustible Liquids

Class	Boiling points C(F)	Flash points C(F)
Flammable IA	<37.8 (100)	<22.8 (73)
Aflammable 113	>37.8 (100)	<22.8 (73)
Flammable IC	22.8(73)	37.8(100)
Combustible 2	37.8(100)	60(140)
Combustible 3A	60(140)	93.3(200)
Combustible 313		>93.3 (200)

Table 11: A Brief List of Common Class 1A Liquids

A Brief List of Common Class 1A Liquids		
Acetaldehyde	Furan	Methyl sulfide
2-chloropropane	Isopprene	N-Pentane
Collodian	Ligroine	Pentene
Ethyl ether	Methyl acetate	Iso-Propylamine
Ethanethiol	Methylamine	Propylene oxide
Ethylamine	2-Methylbutane	Petroleum ether

▪ Ethyl vinyl ether	▪ Methyl formate	▪ Trimethylamine

Table 12: NFPA Fire Hazard Ratings, Flash Points, Boiling Points, Ignition Temperatures, and Flammable Limits of Some Common Laboratory solvents

Chemical	NFPA Flash Rating	Boiling Point ^{0}C	Ignition Temperatures $_0$C	Lower$_0$C	Upper$_0$C	Flammable Limits Percent by Volume
▪	▪	▪	▪	▪	▪	▪
▪ Acetaldehyde	▪ 4	▪ -37.8	▪ 21.1	▪ 175	▪ 4	▪ 60
▪ Acetic acid (glacial)	▪ 2	▪ 39	▪ 118	▪ 463	▪ 4	▪ 19.9
▪ Acetone	▪ 3	▪ -18	▪ 56.7	▪ 465	▪ 2.6	▪ 12.8
▪ Acetonitrile	▪ 3	▪ 6	▪ 82	▪ 524	▪ 3	▪ 16
▪ Benzene	▪ 3	▪ -11.1	▪ 80.1	▪ 560	▪ 1.3	▪ 7.1
▪ Carbon disulfide	▪ 3	▪ -30	▪ 46.1	▪ 90	▪ 1.3	▪ 50
▪ Cyvlohexane	▪ 3	▪ -20	▪ 81.7	▪ 245	▪ 1.3	▪ 8
▪ Diethyl amine	▪ 3	▪ -23	▪ 57	▪ 312	▪ 1.8	▪ 10.1
▪ Diethyl ether	▪ 4	▪ -45	▪ 35	▪ 160	▪ 1.9	▪ 36
▪ Dimethyl sulfoxide	▪ 1	▪ 95	▪ 189	▪ 215	▪ 2.6	▪ 42
▪ Ethyl acetate	▪ 3	▪ -4	▪ 77	▪ 427	▪ 2	▪ 11.5
▪ Ethyl alcohol	▪ 3	▪ 12.8	▪ 78.3	▪ 365	▪ 3.3	▪ 19
▪ Ethyleneimine	▪ 3	▪ -11	▪ 56	▪	▪ 3.6	▪ 46
▪ Heptane	▪ 3	▪ -3.9	▪ 98.3	▪ 204	▪ 1.05	▪ 6.7

▪ Hexane	▪ 3	▪ -21.7	▪ 68.9	▪ 225	▪ 1.1	▪ 7.5
▪ Isopropyl alcohol	▪ 3	▪ 11.7	▪ 82.8	▪ 398	▪ 2	▪ 12
▪ Methyl alcohol	▪ 3	▪ 11.1	▪ 64.9	▪ 385	▪ 6.7	▪ 36
▪ Methyl ethyl ketone	▪ 3	▪ -6.1	▪ 80	▪ 515	▪ 1.8	▪ 10
▪ Pentane	▪ 4	▪ -40	▪ 36.1	▪ 260	▪ 1.5	▪ 7.8
▪ Styrene	▪ 3	▪ 32.2	▪ 146.1	▪ 490	▪ 1.1	▪ 6.1
▪ Tetrahydro furan	▪ 3	▪ -14	▪ 66	▪ 321	▪ 2	▪ 11.8
▪ Toluene	▪ 3	▪ 4.4	▪ 110.6	▪ 4.8	▪ 1.2	▪ 7.1
▪ p-Xylene	▪ 3	▪ 27.2	▪ 138.3	▪ 530	▪ 1.1	▪ 7

*The Flash point (fp) is the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of a liquid. The experimental values for this quantity are defined in terms of specific test procedures and are based on certain physical properties of the liquid.

*The Ignition (auto ignition) temperature is the minimum temperature, which will initiate a self-sustained combustion independent of the heat source.

*The Lower explosion (or flammable) limits (LEL) is the minimum concentration, by volume percent in air, below which a flame will not be propagated in the presence of an ignition source.

* The Upper explosion (or flammable) limit (fuel) is the maximum concentration, by volume percent of the vapor from a flammable liquid in air, above which a flame will not be propagated in the presence of an ignition source.

Table 13: General Classes of Chemical Incompatibility

A	Incompatible with	B
▪ Acetic acid		▪ Chromicacid, nitric acid, peroxides,permanganates
▪ Acetic anhydride		▪ Hydroxyl-containing compounds such asethylene glycol, perchloric acid

▪ Acetone mixtures	▪ Concentrated nitric and sulfuric acid mixtures,hydrogen peroxide
▪ Acetylene	▪ Chlorine, bromine, copper, silver, fluorine,mercury
▪ Alkali and alkaline earth	▪ Water
▪ Ammonia (anhydrous)	▪ Mercury, chlorine, calcium hypochlorite, iodine,bromine, hydrogen fluoride
▪ Ammonium nitrate	▪ Acids, metal powders, flammable liquids,chlorates, nitrites, sulfur, finely divided organics, ▪ combustibles
▪ Aniline	▪ Nitric acid, hydrogen peroxide
▪ Azides, inorganic	▪ Acids, Heavy metals and their salts Oxidizingagents
▪ Bromine	▪ Ammonia, acetylene, butadiene, butane, other ▪ Petroleum gases, sodium carbide, turpentine,benzene, finely divided metals
▪ Calcium oxide	▪ Water
▪ Carbides	▪ Acids
▪ Carbon, activated	▪ Calcium hypochlorite, other oxidants
▪ Chlorates	▪ Ammonia, anhydrous and aqueous
▪ Chlorates	▪ Ammonium salts, acids, metal powders, sulfur,finely divided organics, combustibles
▪ Chlorine	▪ Ammonia, acetylene, butadiene,*tane, other petroleum gases, hydrogen, sodium carbide, turpentine, benzene, finely divided metals
▪ Chlorine dioxide	▪ Ammonia, methane, phosphine, hydrogen sulfide

▪ Chromates	▪ Carbon
▪ Chromic acid and chromium trioxide	▪ Acetic acid, naphthalene, camphor, glycerol,turpentine, alcohol, other flammable liquids
▪ Chromium trioxide	▪ Metals
▪ Copper	▪ Acetylene, hydrogen peroxide
▪ Cyanides, inorganic	▪ Acids, Strong bases
▪ Dichromate	▪ Metal Hydrides
▪ Fluorine	▪ Isolate from everything
▪ Halogenating agents	▪ Organic compounds
▪ Halogens	▪ Nitrates
A Incompatible with B	
▪ Hydrazine	▪ Hydrogen peroxide, nitric acid, any other oxidant
▪ Hydrides	▪ Halogenated orphic compounds
▪ Hydrocarbons (benzene, butane, propane, gasoline,turpentine, etc.)	▪ Fluorine, chlorine, bromine, chromicaciqbcroxides
▪ Hydrocyanic acid	▪ Nitric acid, alkalis
▪ Hydrofluoric acid (anhydrous)	▪ Ammonia (aqueous or anhydrous)
▪ Hydrogen fluoride	▪
▪ Hydrogen peroxide	▪ Phosphorous
▪ ▪ ▪ Hydrogen peroxide	▪ Copper, chromium, iron, most metals or theirsalts, any flammable liquid, combustible materials, ▪ aniline, nitro methane
▪ Hydrogen sulfide	▪ Fuming nitric acid, oxidizing gases
▪ Hydroxides	▪ Halogenating agents
▪ Iodine	▪ Acetylene, ammonia (anhydrous or aqueous)

▪ ▪ Magnesium, Calcium, Powdered Aluminum	▪ ▪ Use dry sand

▪ Mercury	▪ Acetylene, nitric acid, ammonia, sodium azide
▪ Metals	▪ Oxidizing agents
▪ Nitrates	▪ Sulfur
▪ Nitrates, inorganic	▪ Acids, Reducing agents
▪ Nitric acid	▪ Silicon
▪ ▪ ▪ ▪ Nitric acid (concentrated)	▪ Acetic acid, acetone, alcohol, aniline, chromic acid, chromates, hydrocyanic acid, hydrogen sulfide, flammable gases, flammable liquids, metals, ▪ permanganates, sulfides, sulfuric acid
▪ Nitrites, inorganic	▪ Acids, Oxidizing agents
▪ Nitroparaffins	▪ permanganates, sulfides, sulfuric acid
▪ Organic acyl halides	▪ Bases, Organic hydroxy and amino compounds
▪ Organic anhydrides	▪ Bases, Organic hydroxyl and amino compounds
▪ Organic halogen compounds	▪ Group IA and IIA metals, Aluminum
▪ Organic nitro compound	▪ Strong bases
▪ Oxalic acid	▪ Silver and mercury and their salts
▪ Oxidizing agents	▪ Reducing agents
▪ ▪ Oxygen	▪ Oils, grease, hydrogen, flammable liquids, solids,gases Perchloric acid
▪ Perchlorates	▪
▪ Permanganates	▪
▪ Peroxides	▪
▪ Peroxides	▪
▪ ▪ Peroxides, organic	▪ Acids (organic or mineral), (also avoid friction,store cold)
▪ Persulfates:	▪
▪ Phosphorus (white)	▪ Air, oxygen, oxidizing agents, strong bases
▪ Phosphorus pentoxide	▪ Alcohols, strong bases, water

▪ Potassium chlorate	▪ Acids (see also chlorates)
▪ Potassium perchlorate	▪ Acids (see also perchloric acid)
▪ ▪ Potassium permanganate	▪ Glycerol, ethylene glycol, benzaldehyde, sulfuricacid
▪ ▪ Silver and silver salts	▪ Acetylene, oxalic acid, tartaric acid, fulminicacid, ammonium compounds
▪ Sodium	▪ See alkali metals (above)
▪ Sodium nitrite	▪ Ammonium nitrate and other ammonium salts
▪ ▪ ▪ ▪ Sodium peroxide	▪ Any oxidizable substance, such as ethanol,methanol, glacial acetic acid, acetic anhydride, ▪ benzaldehyde, carbon disulfide, glycerol, ethyleneglycol, ethyl acetate, methyl acetate, furfurM

▪ ▪ ▪ Sodium, potassium, lithium	▪ Carbon dioxide, carbon tetrachloride, otherchlorinated hydrocarbons prohibit the use of water, ▪ foam and dry chemical extinguishers on fires)
▪ Sulfides, inorganic	▪ Acids
▪ Sulfuric acid	▪ Bases, chlorates, perchlorates, permanganates

Table 14: Related and Compatible Storage Groups
Organic Family
▪ Acids, anhydrides, peracids ▪ Alcohols, glycols, amines, amides, iminpimides ▪ Epoxy compounds, isocyanates ▪ Ethers, ketones, ketens, halogenated, hydrocarbons, ethylene oxide ▪ Hydrocarbons, esters, aldehydes: ▪ Peroxides, hydroperoxidcs, azides ▪ Phenols, cresols ▪ Sulfides, polysulfides, sulfoxidesnitrites
Inorganic Family
▪ Amides, nitrates (except ammonium nitrates), nitrites, azides ▪ Arsenates, cyanides, cyanates ▪ Borates, chroma, manganates, permanganates ▪ Chlorates, perchlorates, perchloric acid, chlorites, hypochlorite's, peroxides, hydrogenperoxide ▪ Halides, sulfates, sulfites, thiosulfates, phosphates, halogens ▪ Hydroxides, oxides, silicates, carbonates, carbon ▪ Metals, hydrides ▪ Nitric acid, other inorganic acids ▪ Sulfides, selenides, phosphides, carbides, nitrides ▪ Sulfur, phosphorus, arsenic, phosphorus pentoxide

Table 15: Chemical Compatibility Storage Groups		
Number	Chemical group	Do not store with group numbers
▪ 1	▪ Inorganic acids	▪ 2-8, 10, 11, 13, 14, 16-19, 21, 22, 23
▪ 2	▪ Organic acids	▪ 1, 3, 4, 7, 14, 16, 17-19, 22
▪ 3	▪ Caustics	▪ 1, 2, 6, 7, 8, 13-18, 20, 22, 23
▪ 4	▪ Araines and alkanolamines	▪ 1, 2,5, 7, 8, 13-18, 23
▪ 5	▪ Halogenated compounds	▪ 1, 3, 4, 11, 14, 17
▪ 6	▪ Alcohols, glycols, glycol ethers	▪ 1, 7, 14, 16, 20, 23
▪ 7	▪ Aldehydes	▪ 1-4, 6, 8, 15-17, 19, 20, 23
▪ 8	▪ Ketones	▪ 1, 3, 4, 7, 19, 20
▪ 9	▪ Saturated hydrocarbons	▪ 20
▪ 10	▪ Aromatic hydrocarbons	▪ 1,20
▪ 11	▪ Olefins	▪ 1,5,20
▪ 12	▪ Petroleum oils	▪ 20
▪ 13	▪ Esters	▪ 1, 3, 4, 19, 20
▪ 14	▪ Monomers, polymerizable esters	▪ 1-6, 15, 16, 19-21, 23
▪ 15	▪ Phenols	▪ 3, 4, 7, 14, 16, 19, 20
▪ 16	▪ Alkylene oxides	▪ 14, 6, 7, 14, 15, 17-19, 23
▪ 17	▪ Cyanohydrins	▪ 1-5, 7, 16, 19, 23
▪ 18	▪ Nitrates	▪ 14,16,23
▪ 19	▪ Ammonia	▪ 1-2, 7, 8, 13-17, 20, 23
▪ 20	▪ Halogens	▪ 3, 6-15, 19, 21, 22
▪ 21	▪ Ethers	▪ 1,14,20
▪ 22	▪ Elemental phosphorus	▪ 1-3,20
▪ 23	▪ Acid anhydrides	▪ 1, 3, 4, 6, 7, 14, 16-19

Table 16: Chemical Resistance Selection Chart for Protective Gloves

The following table from the U.S. Department of Energy (Occupational Safety and Health Technical Reference Manual) rates various gloves as being protective against specific chemicals and will help you select the most appropriate gloves to protect your employees. The ratings are abbreviated as follows: VG: Very Good; G: Good; F: Fair; P: Poor (not recommended). Chemicals marked with an asterisk (*) are for limited service.

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
Acetaldehyde*	VG	G	VG	G
Acetic acid	VG	VG	VG	VG
Acetone*	G	VG	VG	P
Ammonium hydroxide	VG	VG	VG	VG
Amy acetate*	F	P	F	P
Aniline	G	F	F	P
Benzaldehyde*	F	F	G	G
Benzene*	P	P	P	F
Butyl acetate	G	F	F	P
Butyl alcohol	VG	VG	VG	VG
Carbon disulfide	F	F	F	F
Carbon tetrachloride*	F	P	P	G
Castor oil	F	P	F	VG
Chlorobenzene*	F	P	F	P
Chloroform*	G	P	P	F
Chloronaphthalene	F	P	F	F
Chromic acid (50%)	F	P	F	F
Citric acid (10%)	VG	VG	VG	VG
Cyclohexanol	G	F	G	VG
Dibutyl phthalate*	G	P	G	G
Diesel fuel	G	P	P	VG
Diisobutyl ketone	P	F	G	P
Dimethylformamide	F	F	G	G
Dioctyl phthalate	G	P	F	VG
Dioxane	VG	G	G	G

Table 4 (continued) Chemical Resistance Selection Chart for Protective Gloves

Epoxy resins, dry	VG	VG	VG	VG
Ethyl acetate*	G	F	G	F

Table 16 Continued Chemical Resistance Selection Chart for Protective

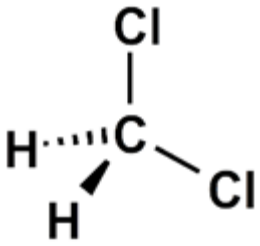
Ethyl alcohol	VG	VG	VG	VG
Ethyl ether*	VG	G	VG	G
Ethylene dichloride*	F	P	F	P
Ethylene glycol	VG	VG	VG	VG
Formaldehyde	VG	VG	VG	VG
Formic acid	VG	VG	VG	VG
Freon 11	G	P	F	G
Freon 12	G	P	F	G
Freon 21	G	P	F	G
Freon 22	G	P	F	G
Furfural*	G	G	G	G
Gasoline, leaded	G	P	F	VG
Gasoline, unleaded	G	P	F	VG
Glycerin	VG	VG	VG	VG
Hexane	F	P	P	G
Hydrazine (65%)	F	G	G	G
Hydrochloric acid	VG	G	G	G
Hydrofluoric acid (48%)	VG	G	G	G
Hydrogen peroxide (30%)	G	G	G	G
Hydroquinone	G	G	G	F
Isooctane	F	P	P	VG
Kerosene	VG	F	F	VG
Ketones	G	VG	VG	P
Lacquer thinners	G	F	F	P
Lactic acid (85%)	VG	VG	VG	VG
Lauric acid (36%)	VG	F	VG	VG
Lineolic acid	VG	P	F	G
Linseed oil	VG	P	F	VG
Maleic acid	VG	VG	VG	VG
Methyl alcohol	VG	VG	VG	VG
Methylamine	F	F	G	G
Methyl bromide	G	F	G	F
Methyl chloride*	P	P	P	P

Table 17 Continued: Chemical Resistance Selection Chart for Protective Gloves

Trichloroethylene*	F	F	P	G
Triethanolamine (85%)	VG	G	G	VG
Tung oil	VG	P	F	VG
Turpentine	G	F	F	VG
Xylene*	P	P	P	F

Note: When selecting chemical-resistant gloves be sure to consult the manufacturer'srecommendations, especially if the gloved hand(s) will be immersed in the chemical.

Methylene Chloride/Dichloromethane



Refer to the Methylene Chloride Workplace Chemical Protection Program for more information.

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Appendix D

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