Laboratory Safety Training
Regulatory Structure

OSHA
Occupational Safety and Health Administration

Federal Agency
US Department of Labor

Aims to ensure worker safety and health in the U.S. by working with employers to create better working environments

Private Employees

PESH
Public Employee Safety and Health Bureau

State Agency
New York State Department of Labor

Oversees workplace protection of public employees at the New York State and New York City levels

Public Employees
Regulatory Agencies

- FDNY – Fire Safety
- NYC DOHMH
- NYC DEP
- NYS DEC
- PESH, NYS DOL, OSHA
- EPA
Chemical Hygiene Plan Objectives

• Provides the Chemical user with basic safety information regarding the use of chemicals

• Required under the Occupational Safety and Health Administration (OSHA) Regulations 29CFR 1910.1450

• Protects employees and students from potential health hazards associated with handling, use, storage, and disposal of hazardous chemicals in York College’s Laboratories
CHO is responsible for Chemical Hygiene Plan implementation at the institutional level and revision (as necessary) of the Chemical Hygiene Plan (CHP)
Department Chairpersons, Deans, Directors

- Responsible for implementation of the Chemical Hygiene Plan at the departmental level

- Coordinate for lab staff/employees working under their direction to attend CHP trainings
Principle Investigators, Faculty, Lab Supervisors

- Responsible for implementation of the CHP at the laboratory level
- Provide lab-specific training and set up a training profile for all lab personnel under their supervision
- Promptly report all work-related injuries, near misses, and unsafe work conditions to Public Safety/CHO
- Maintain an up-to-date chemical inventory using the Chemical Inventory Database—NEW SYSTEM “Chemtracker”
Responsibilities: Employee/Student

- Comply with applicable environmental health and safety policies, standards, rules, regulations and procedures. These include safety-related signs, posters, warnings and written/oral directions when performing tasks.

- Do not perform any function or operation which is considered hazardous, or is known to be hazardous without proper instructions and authorization.

- Only use equipment and materials approved or provided by the supervisor or instructor and for which instruction has been provided by this or other experience.

- Become thoroughly knowledgeable about potential hazards associated with the work area; knowing where information on these hazards is maintained and how to use this information when needed.

- Wear or use prescribed protective equipment.

- Report all unsafe conditions, practices, or equipment to the supervisor, instructor or safety officer whenever deficiencies are observed.

- Inform the supervisor or instructor immediately of all work-related injuries or accidents and obtain prompt medical attention when necessary.

- Provide information necessary for the supervisor or safety officer to adequately and thoroughly complete the *Incident Report* and any other associated accident/illness reports.
“All laboratory employees, visitors and volunteers must be alerted to hazards that exist in the area they enter. The location of information and emergency equipment must be clearly marked to facilitate ready access in case of emergency.”
Signage: What is required in your lab space?

- “Laboratory: Potentially Hazardous Substances”
- No Smoking
- Emergency equipment and Exit identification
- Emergency telephone numbers
  - Emergency personnel, EHS office, etc.
  - Must be posted next to the phone in each lab, chemical store room/stock room, and storage area
GHS Video
Every bottle ordered and received should come with an affixed label containing:

- Name of product and constituents
- Hazards
- Manufacturer’s Name
Labeling

- OSHA’s HAZCOM standard MANDATES proper labeling (so does the EPA)

- Stock chemicals labels must contain:
  - The common name of the chemical
  - Name, address, emergency phone number of the manufacturing company
  - A hazard warning indicating the most serious health or safety hazards the chemical poses (e.g., corrosive, carcinogen, water-reactive, flammable)
  - New Hazard Communication Standard uses pictograms and signal words (Danger vs Warning) to communicate hazards
Labels on Shipped Containers

HCS

• containers of hazardous chemicals
  – Identity of hazardous chemical(s)
  – Appropriate hazard warnings
  – Name/address of chemical manufacturer, importer, or other responsible party.
  – (3 month updating - stayed)

GHS NPRM

• containers of classified hazardous chemicals
  – Product identifier
  – Signal word
  – Hazard statement(s)
  – Pictogram(s)
  – Precautionary statement(s)
  – Name, address, telephone number of responsible party
  – 3 month updating
  – In some cases,
    • Unclassified hazards
    • \times \text{ percent of the mixture consists of ingredient(s) of unknown toxicity}
    • Supplemental information
### C.4 REQUIREMENTS FOR SIGNAL WORDS, HAZARD STATEMENTS, PICTOGRAMS, AND PRECAUTIONARY STATEMENTS

#### C.4.1 ACUTE TOXICITY – ORAL
(Classified in Accordance with Appendix A.1)

<table>
<thead>
<tr>
<th>Hazard category</th>
<th>Signal word</th>
<th>Hazard statement</th>
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<tbody>
<tr>
<td>1</td>
<td>Danger</td>
<td>Fatal if swallowed</td>
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<td>2</td>
<td>Danger</td>
<td>Fatal if swallowed</td>
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#### Precautionary statements

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<tr>
<th>Prevention</th>
<th>Response</th>
<th>Storage</th>
<th>Disposal</th>
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<tr>
<td>Wash ... thoroughly after handling. ... Chemical manufacturer, importer, or distributor to specify parts of the body to be washed after handling. Do not eat, drink or smoke when using this product.</td>
<td>If swallowed: Immediately call a poison center/doctor/... ... Chemical manufacturer, importer, or distributor to specify the appropriate source of emergency medical advice. Specific treatment (see ... on this label) ... Reference to supplemental first aid instruction. <em>if immediate administration of antidote is required.</em> Rinse mouth.</td>
<td>Store locked up.</td>
<td>Dispose of contents/container to... ... in accordance with local/regional/national/international regulations (to be specified).</td>
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Pictogram: Skull and crossbones
## Pictograms

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<td>Oxidizers</td>
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<td>Corrosives</td>
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<td>Acute Toxicity (severe)</td>
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<td>Gases under pressure</td>
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<td>Aquatic Toxicity</td>
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<td>Explosives</td>
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<td>Self Reactives</td>
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<td>Organic Peroxides</td>
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<td>Flammables</td>
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<td>Pyrophorics</td>
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<td>Self-Heating</td>
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<td>Emits Flammable Gas</td>
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<td>Carcinogen</td>
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<td>Mutagenicity</td>
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<td>Reproductive Toxicity</td>
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<td>Respiratory Sensitizer</td>
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<td>Target Organ Toxicity</td>
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<td>Aspiration Toxicity</td>
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<td>Skin Sensitizer</td>
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<td>Narcoitic Effects</td>
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<td>Respiratory Tract</td>
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<td>Hazardous to Ozone</td>
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<td>Layer</td>
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User Labeling

- EVERY bottle must be labeled to identify its contents
- You may use a piece of tape, a sharpie, or print out a label – as long as it is clearly legible and includes the commonly recognized name of the contents (not the chemical formula) and its hazard(s)
In House Labels

Alternatives are permitted for in house labeling BUT the information must be consistent with the new format and label elements.

<table>
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<tr>
<th>Original label</th>
<th>Product identifier and words, pictures, symbols or combination to provide general information on the hazards</th>
<th>Hazard classification system must be consistent with updated GHS</th>
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</thead>
</table>
Labeling

Required Information on Chemical Labels

- Maintain Labels on Incoming Containers
- Label Secondary Containers Immediately
  - Label Content
  - Full Name of Hazardous Chemical
  - Hazard Warning
  - Name of Responsible Party
  - Date of Preparation
Whenever possible, the full chemical name must be written on a label. If this is not possible, then abbreviations are acceptable.

- If you use any abbreviations, you must hang up a “key” to the abbreviations in a visible location (preferably close to the chemicals and/or by the door).

- The “key” must contain the abbreviation, the name of the chemical and the hazard. In addition, the P.I. must have a copy of the “key” in his/her office.

*A full list of chemical abbreviations must be posted in the laboratory in a readily visible location.*
Newly synthesized chemicals

- Chemicals synthesized in the labs must adhere to similar labeling requirements as stock chemicals
  - Chemical compound name
  - Known hazards
  - Identify that the hazards have not been fully investigated if they are unknown
  - Substances of unknown hazard status MUST be considered hazardous until proven otherwise
  - A preliminary Safety Data Sheet (SDS) must be developed, with additional information added to it as further testing is conducted
Old Chemical Bottles

Do not keep old bottles of chemicals that you will not use

If a label is deteriorating or falling off, make a new one or the chemical will be considered as an UNKNOWN
NFPA Hazard Diamond

**Specific Hazards**
- Oxidizer: Ox
- Acid: Acid
- Alkali: ALK
- Corrosive: COR
- Use NO WATER: ✱
- Radioactive: ☠

**Specific Reactivity**
- 4: May Detonate
- 3: Shock and heat may detonate
- 2: Violent chemical change
- 1: Unstable if heated
- 0: Stable

**Hazard Levels**
- (Blue): Health Hazard
  - 4: Deadly
  - 3: Extreme danger
  - 2: Hazardous
  - 1: Slightly hazardous
  - 0: Normal material

- (Red): Fire Hazard
  - Flash Points
    - 4: Below 73°F
    - 3: Below 100°F
    - 2: Above 100°F not exceeding 200°F
    - 1: Above 100°F
    - 0: Will not burn

- (Yellow): Reactivity
  - 4: May Detonate
  - 3: Shock and heat may detonate
  - 2: Violent chemical change
  - 1: Unstable if heated
  - 0: Stable
# OSHA NPRM GHS – Health Hazards (Building Blocks)

## Hazard Class
- Acute Toxicity, Oral
- Acute Toxicity, Dermal
- Acute Toxicity, Inhalation
- Aspiration hazard
- Skin Corrosion/Irritation
- Eye Corrosion/Irritation
- Respiratory Sensitisation
- Skin Sensitisation
- Germ Cell Mutagenicity
- Carcinogenicity
- Reproductive Toxicity - Fertility
- Reproductive Toxicity - Development
- SpecTargetOrganTox – Single Dose
- SpecTargetOrganTox – Repeat Dose

## Hazard Category

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<th>3</th>
<th>4</th>
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- **Corrosion (1)**
- **Irritation**
- **Lactation**

### Hazard Representation
- **High Hazard**
- **Low Hazard**

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## OSHA NPRM GHS – Physical Hazards (Building Blocks)

### Hazard Class

- Explosives
- Flammable Gases
- Flammable Aerosols
- Oxidising Gases
- Pressurised Gases
  - Compressed Gases
  - Liquefied Gases
  - Refrigerated Liquefied Gases
  - Dissolved Gases
- Flammable Liquids
- Flammable Solids
- Self-reactive Substances
- Pyrophoric Liquids
- Pyrophoric Solids
- Self-heating Substances
- Water Reactive ➔ Flammable Gases
- Oxidising Liquids
- Oxidising Solids
- Organic Peroxides
- Corrosive to Metals

### Hazard Category

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<td>Organic Peroxides</td>
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<td>Corrosive to Metals</td>
<td>Div 1.1</td>
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<td>Div 1.6</td>
</tr>
</tbody>
</table>

### Chart

- High Hazard ➔ Low Hazard
Currently, the HMIS/NFPA and GHS hazard criteria are different.

**HMIS/NFPA Hazard Ratings**

0 = Minimal Hazard  
1 = Slight Hazard  
2 = Moderate Hazard  
3 = Serious Hazard  
4 = Severe Hazard

**GHS Hazard Categories**

Cat. 1 ~ ‘Severe Hazard’  
Cat. 2 ~ ‘Serious Hazard’  
Cat. 3 ~ ‘Moderate Hazard’  
Cat. 4 ~ ‘Slight Hazard’  
Cat. 5 ~ ‘Minimal Hazard’
The OSHA lab standard (29CFR 1910.1450) requires that SDS’s be collected and maintained for ALL chemicals used and stored.

Each department must maintain an SDS file for the chemicals used within the department.

All employees must be trained on how to access the SDS file.

The Office of Environmental Health & Safety maintains a master file of SDSs.
Experimenting with Danger
Chemical Safety

- Keep worker’s exposure below the Permissible Exposure Limit (PEL)
  - PEL’s are regulatory limits set by OSHA on the amount or concentration of a substance in the air.
- Plan in advance for potential hazards
- Designate a person to manage chemical safety
- Train and inform workers
- Label ALL chemical containers
- Have access to SDS for all chemicals used
• **TOXICITY** -- the ability of a chemical substance to cause harm

• **HAZARD** -- likelihood a material will cause harm under the conditions of use
  - With *proper* handling, even highly toxic chemicals can be used safely
  - Less toxic chemicals can be extremely hazardous if handled *improperly.*
Exposure to Toxic Chemicals

- Exposure to toxic agents can have severe consequences, including death
- These injuries can occur in any area where toxic chemicals are handled
- Most chemical injuries could have been avoided
  - If these people had had the **proper equipment**, if they had been using the **proper techniques** and if they had **adequate knowledge**, such exposures probably would not have occurred.
Have a Plan that includes:

- **Standard operating procedures (SOP)**
- Exposure control measures
- Fume hood & personal protective equipment
- Information & Training
- Chemicals that require prior planning & approval
- Working with Particularly hazardous substances
- Emergencies
Understand the Hazards!

- Know and prepare for hazards in advance
- Review Safety Data Sheets (SDS)
  - Physical and Health Hazards
  - Exposure signs and symptoms
  - Protective measures
  - Emergency procedures
- Read all labels
- Know your protocol / procedures
- Remember, some chemicals may have delayed toxic effects on the body
Physical Hazards

- **Flammable** - catches fire easily and burns rapidly
- **Combustible** - will burn under most conditions
- **Explosive** - will explode / detonate releasing hot gases
- **Oxidizer** - yields oxygen to enhance combustion, may cause ignition of combustibles with no external source
- **Organic peroxide** - uniquely hazardous, potentially explosive
- **Unstable** - tends to decompose during normal handling and storage
- **Water reactive** - reacts with water to release flammable gas, causes fire or presents a health hazard
Health Hazard

- **Carcinogen** - cause cancer or suspected to cause cancer
- **Toxic Agent** - poisonous / cause acute or chronic effects
- **Reproductive toxin (teratogen)** - could have harmful effect on male or female reproductive system or on developing fetus
- **Irritant** - can cause inflammation of skin or eyes
- **Corrosive** - cause irreversible damage to living tissue
- **Sensitizer** - cause exposed person to develop allergies to the substance
- **Target organ-specific agents** - hazardous to specific organs in body (e.g., lungs, liver, blood, kidneys, nervous system)
Signs & Symptoms

How will you know if you have been exposed?

- **Dose** - Amount of chemical absorbed depends upon chemical strength / concentration, exposure duration, frequency of exposure
  - In general, the greater the dose, the more severe the health effects
- **Acute effects** - occurs rapidly following brief exposure (e.g., acid burn)
- **Chronic effect** - develops/recurs slowly, over long period following repeated, long-term, low-level exposure (e.g., benzidine linked to bladder cancer)
- **Individual variability** - not all people exhibit the same signs and symptoms (especially to chronic effects)
Route of Entry

- **Inhalation / breathing** - most common route, gases / vapors can pass to blood, solid particles inhaled into lungs
- **Absorption through the skin** - many solids, liquids, vapors and gases can be absorbed through the skin
- **Ingestion / swallowing** - while not intentional, failure to wash hands, eating in contaminated lab, etc.
- **Injection** - accidents handling glass, sharps, etc.
- **Eye Contact** - either physical damage or absorption

*The route of entry dictates selection of protective equipment*
Inhalation

- **Primary Route of Entry**
- **Airborne contaminants** such as gases, vapors and particulate matter that enter directly into lungs.
- **Chemical fume hood** is the primary control available.
- **Respiratory protection** or specialized exhaust may be necessary where a fume hood cannot be used.
Absorption

- Can occur very quickly through cuts or abrasions on the skin.
- Absorption may occur through intact skin (example: phenol)
- Mucous membranes and eye tissue are particularly vulnerable
- Barrier protection (such as gloves) and personal hygiene are the primary control measures.
Ingestion

- Includes direct tasting of chemicals.
- More often occurs when contaminated items are placed in the mouth.
- Purpose for banning food, drink, tobacco, and cosmetics in the lab.
- Personal hygiene, labeling and housekeeping are very important to ingestion hazard control.
Injection

- Includes all puncture wounds.
- Examples: needle sticks, glass shards or capillary tubes puncturing skin
- Difficult to protect against
- Use carefully planned procedures and personal diligence, including needles.
Videos

A Day in the Lab
and
Outfit for Safety
Handling Chemicals

Laboratory Hazard Evaluation

- Laboratory personnel must be familiar with the potential hazards prior to beginning work and take appropriate action (select proper PPE, check local exhaust ventilation etc.)
Personal Protective Equipment (PPE) should be selected based on:

- Types of chemicals being handled
- The degree of protection required
- Areas of the body that may become contaminated
Eye Protection (continued)

- DO NOT WEAR CONTACT LENSES! Even under goggles or safety glasses
- Gasses and vapors can concentrate under lenses and cause permanent eye damage
- In an emergency situation, it is exceedingly difficult to remove contact lenses to irrigate the eye, leading to potentially permanent damage
- Soft lenses can absorb solvent vapors
- Instructors are not to allow students to remain in the laboratory without proper eye protection
Eye Protection

• All lab users, including visitors, must wear chemical safety goggles where splashing is possible.

• At a minimum, each person in the laboratory must be issued his/her own pair of safety glasses.
Use of Face Shield Plus Goggles

Face shields are necessary for high risk activities where there is a need to protect the face in addition to the eye. Because they are not made for heavy impact, face shields are designed to be worn with goggles. Face shields are not a replacement for safety glasses or goggles.
Protiective Clothing

- Clothing that covers exposed arms and legs
- Close toed shoes of non-woven material with non-slip soles
- Lab coats with closed fasteners
- Non-flammable, non-porous aprons when using corrosives
- Remove before leaving the lab
Gloves

- Compatible with the chemical being used.
- Remove gloves and wash hands before leaving.
- Do not use latex gloves for chemical protection.
- Inspect before use.
- Clean or discard immediately after use.
Glove Selection

- **No** glove material will remain impervious to a specific chemical forever.

- **No** one glove material is resistant to all chemicals.

- Some chemicals will travel through or permeate the glove in a few seconds, while other chemicals may take days or weeks.

- Information specifying the best type of chemical protective material is what should be on the SDS.

Karen Wetterhahn's Story - Accidental Poisoning at Dartmouth
Personal Hygiene

- No Food, Drink, or Beverages.
- No Smoking.
- Do Not Apply Cosmetics.
- Do Not Consume Lab Ice or Deionized Water.
  - Wash Hands and Arms Before Leaving Lab.
  - Never Pipette by Mouth.
  - Do Not Smell or Taste Chemical
  - Constrain Long Hair and Loose Clothing.
Housekeeping

- Keep Chemical Use Areas Free From Contamination
- Close and Cap All Containers Not in Use
- Clean Drips and Spillage Off of Container Exterior
- Maintain the Minimum on the Work Surface

- Maintain Clear Working Aisles
- Maintain Clear Access to Fire Extinguishers, Safety Showers and Eyewashes
- Label Doors that Are Blocked
- Keep Storage Off of the Floor and Out of the Halls
Flammable Liquids

Properties of Flammable Liquids

• The vapor of a flammable liquid ignites and causes fire or explosion – not the liquid itself.

• The flammability of a liquid depends on its physical properties:
  - Vapor Pressure
  - Flash Point
  - Limits of Flammability
  - Vapor Density
Safe Use of Flammable & Combustible Liquids

- When handling flammable and combustible liquids, you must take adequate precautions to prevent ignition of flammable vapors.
- Some sources of ignition include:
  - Open flames
  - Smoking
  - Static electricity
  - Cutting and welding
  - Hot surfaces
  - Electrical and mechanical sparks
  - Lightning
Corrosive

Aqueous liquids with a PH of $\leq 2$ or PH $\geq 12.5$.

Inorganic acids.
Organic acids.
Bases – amines, hydroxide solutions.

Hazards

- Destruction of living tissue on contact.
- Chemicals continue to burn until removed or inactivated
Corrosives Hazards

Extent of the Injury is dependent on:

- Concentration of the acid/base
- Quantity of acid/base involved
- Body area affected
- Duration of the contact
Corrosives Hazards

Treatment for Skin Exposure

Flush with water a minimum of 15 minutes

- Flushing physically removes without pressure.

- Dilutes chemical, cools wound, reduces swelling.
Oxidizers

- Oxidizers are any solid or liquid that readily yields oxygen or other oxidizing gas or that readily reacts to oxidize combustible materials. Strong oxidizers can present fire and explosion hazards on contact with organic compounds or other oxidizers. Some examples are:
- silver nitrate, ammonium perchlorate, potassium permanganate perchloric acid, sodium peroxide
Storage Considerations for Oxidizers

Oxidizers must be stored away from incompatible materials such as:

- Flammable and combustible materials
- Greases
- Paper trash bins
- Finely divided metals
- Organic liquids
Organic Peroxides

- Peroxide crystal may violently detonate when subjected to thermal or mechanical shock.
- Peroxide-forming chemicals react with oxygen to form peroxy compounds, even at low concentrations.
- Factors that affect the rate of peroxide formation include exposure to air, light, heat, moisture and contamination from metals.
- The risk associated with peroxide formation increases if the peroxide crystallizes or becomes concentrated by evaporation or distillation.
- Can form along threads of old solvent drums and around glass openings of old laboratory bottles (ethers).
When possible, purchase only peroxide-forming chemicals which contain a peroxide formation inhibitor (e.g., tetrahydrofuran or diethyl ether inhibited with butylated hydroxy toluene (BHT)) or metal can with inner coating.

Only purchase quantities of peroxide-forming chemicals that you expect to use within expiration and disposal time frames.
NEVER, UNDER Any CIRCUMSTANCES, touch or attempt to open container of a peroxide-forming liquid if there are whitish crystals around the cap and/or in the bottle.

Labeling requirements

– All bottles of peroxide-forming chemicals must have the date received marked on the container. –

When the bottle is first opened, the container must be marked with the date opened.

– Do not distill, evaporate or concentrate a peroxide-forming chemical until you have first tested it for the presence of peroxides.
Peroxide-forming chemicals must be disposed within the timeframes specified in the table below regardless if the container is unopened, unless they have been tested and found free of peroxides.

There are four classes of peroxide-forming chemicals based upon the peroxide formation hazard:

- **Class A** – Severe Peroxide Hazard
- **Class B** – Concentration Hazard
- **Class C** – Shock and Heat Sensitive
- **Class D** – Potential Peroxide-Forming Chemical

<table>
<thead>
<tr>
<th></th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date Opened</strong></td>
<td>3 months</td>
<td>6 months</td>
<td>6 months</td>
<td>Only if peroxide crystals are present.</td>
</tr>
<tr>
<td><strong>Date Received</strong></td>
<td>1 year</td>
<td>1 year</td>
<td>1 year</td>
<td></td>
</tr>
</tbody>
</table>
Reactive Chemicals

Can explode or enter into violent reactions releasing large amounts of light, heat, and gases. Reactive chemicals must be handled with extreme care, even milligram quantities of some chemicals can result in violent explosions.

Reactive chemicals are classified as:

• explosives,
• strong oxidizing agents,
• acid sensitives,
• water reactives,
• air reactives, and
• special organic compounds.
Unstable Reactives

Do not store any quantity of unstable reactives exceeding that which is immediately required
Water Reactive Chemicals

- Metal alkyls, such as lithium and aluminum alkyls

Partial List of Water Reactive Chemicals
- Alkali metals, such as Na, Li, K
- Alkali metal hydrides, such as LiH, CaH2, LiAlH4, NaBH2
- Alkali metal amides, such as NaNH2
- Grignard reagents, RMgX
- Halides of nonmetals, such as BCl3, BF3, PCl3, PCl5, SiCl4, S2Cl2
- Inorganic acid halides, such as POCl3, SOCl2, SO2Cl2
- Anhydrous metal halides, such as AlCl3, TiCl4, ZrCl4, SnCl4
- Phosphorus pentoxide
- Calcium carbide
- Organic acid halides and anhydrides of low molecular weight, such as, acetylchloride acetic acid
- anhydride
Highly Toxic/Particularly Hazardous Substances

- Must be stored in unbreakable chemically resistant secondary containers
- Adequate ventilation must be provided in storage areas especially for toxic substances that have a high vapor pressure (volatile).
- All dispensing of these materials must be conducted in a fume hood
Chemicals Requiring Special Precaution

For chemicals with high degree of acute toxicity, select carcinogens & reproductive toxins:

- Establish designated area
- Proper storage and management
- Use engineering controls (e.g., fume hood)
- Use appropriate PPE
- Waste removal
- Decontamination procedures
- Emergency planning and response
Pyrophoric Chemicals

Ignites spontaneously upon exposure to air (or oxygen)

Partial List of Pyrophoric Chemicals
• Grignard reagents, RMgX
• Metal alkyls and aryls, such as RLi, RNa, R3Al, R2Zn
• Metal carbonyls, such as Ni(CO)4, Fe(CO)5, Co2(CO)8
• Alkali metals such as Na, K
• Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
• Metal hydrides, such as NaH, LiAlH4
• Nonmetal hydrides, such as B2H6 and other boranes, PH3, AsH3
• Nonmetal alkyls, such as R3B, R3P, R3As
• Phosphorus (white)
Pyrophoric Chemicals

- Pyrophoric chemicals can be handled and stored safely as long as exposure to atmospheric oxygen and moisture is avoided.
- Solids must be transferred under an inert atmosphere or otherwise protected.
- Failure to follow proper handling techniques could result in serious injury, death, and/or property damage.
Cryogenic Materials

- Cold (e.g., Ar (-302°F), H₂ (-423°F), N₂ (-320°F), O₂ (-297°F)) vapors can rapidly freeze human tissue
- Produces large volumes of gas that can displace breathable oxygen
- Materials can be embrittled
- Boiling/splashing occurs when charging or filling a warm container
- Wear face shields during transfers, loose fitting, dry leather or cryogenic gloves and long pants w/o cuffs
Personal Chemical Contamination and Medical Emergencies

Chemical Eye Splashes:
- Rinse the eyes at the eyewash station for at least 15 minutes while holding the eyelids open
- Get medical assistance whether or not symptoms persist

Contamination of Large areas of the body:
- Immediately remove contaminated clothing
- Use the safety shower for at least 15 minutes
- Wash contaminated areas with mild soap and water

Ingestion of Chemicals:
- Seek medical attention by calling Public safety

Development of signs or symptoms of chemical exposure:
- Dizziness, nausea, burning sensation in the eyes, nose, or throat, or other signs of chemical exposure, leave the area immediately to fresh air, notify your supervisor, and contact public safety
Chemical Storage

- Where are chemicals stored?
  - Central storerooms
  - Lab work areas
  - Storage cabinets
  - Cold rooms
  - Refrigerators
  - Freezers
General Requirements for Laboratory Storage

• Every chemical must have an identifiable storage place, and must be returned to that location after use
• A storage scheme must be developed in each chemical storage area to ensure the segregation of incompatibles
• A storage scheme based solely on alphabetizing is prohibited!
• Chemicals should not be stored on the floor
• Excess chemical storage in hoods should be avoided
• Labels must be maintained in legible condition at all times
• Secondary containment bins must be used to store liquid chemicals as a means to contain any spills that may occur
• Chemical bottles should be marked with a ‘received date’ to ensure that older chemicals are used first
General Requirements for Laboratory Storage (continued)

- Dates of opening should be assigned to all chemical containers in the following groups when they are initially opened by the first laboratory employee using them:
  - Picrates
  - Perchlorates
  - Peroxides
  - Peroxide forming materials (aldehydes, ethers, benzylic hydrogen compounds, e.g., cumene isopropyl benzene)
  - Polymerizers that react violently during polymerization or become hazardous after polymerization
  - Other materials known to deteriorate or become unstable or reactive over time
  - Peroxide forming chemicals should be tested routinely (with last test date marked on the bottle) for peroxide formation. **FDNY mandates testing at least every 6 months.**
**Flammable and Other Compressed Gasses (cont’d)**

<table>
<thead>
<tr>
<th>Area of Laboratory</th>
<th>Up to 500 Sq.Ft</th>
<th>Per additional 100 Sq. ft.</th>
<th>Maximum per Laboratory Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Capacity</td>
<td>9.24 cu. Ft.</td>
<td>1.54 cu. Ft</td>
<td>15.4 cu. ft</td>
</tr>
</tbody>
</table>

- Flammable gas cylinders should be stored in a separate area from other types of compressed gases
- Cylinders of incompatible gases must be segregated by distance
- Cylinders must be grouped by type of gas (e.g., toxic, corrosive, etc.)
- Empty cylinders should be separated from non-empty cylinders and labeled “empty”
- All compressed gases must be stored away from direct or localized heat (including radiators, steam pipes, or boilers); in well-ventilated and dry areas and away from areas where heavy items may strike them
Acid Storage

- Inorganic acids (hydrochloric acid, phosphoric acid, sulfuric acid) should be stored separately from Organic acids (acetic acid, trichloroacetic acid, formic acid)
# Chemical Storage Limits

<table>
<thead>
<tr>
<th>LAB TYPE</th>
<th>FIRE RATING</th>
<th>FIRE PROTECTION</th>
<th>FLAMMABLE LIQUIDS &amp; VFOs</th>
<th>FLAMMABLE SOLIDS</th>
<th>OXIDIZING MATERIALS</th>
<th>UNSTABLE REACTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2 HRS</td>
<td>SPRINKLERS</td>
<td>30 GALS</td>
<td>15 LBS</td>
<td>50 LBS</td>
<td>12 LBS</td>
</tr>
<tr>
<td>II</td>
<td>1 HR</td>
<td>SPRINKLERS</td>
<td>25 GALS</td>
<td>10 LBS</td>
<td>40 LBS</td>
<td>6 LBS</td>
</tr>
<tr>
<td>III</td>
<td>2 HRS</td>
<td>NO SPRINKLERS</td>
<td>20 GALS</td>
<td>6 LBS</td>
<td>30 LBS</td>
<td>3 LBS</td>
</tr>
<tr>
<td>IV</td>
<td>1 HR</td>
<td>NO SPRINKLERS</td>
<td>15 GALS</td>
<td>3 LBS</td>
<td>20 LBS</td>
<td>2 LBS</td>
</tr>
</tbody>
</table>
Flammable liquids that require refrigeration must be kept in either a flammable storage or an intrinsically safe refrigerator. They must **never** be stored in a household refrigerator due to the potential for explosions.
Household Refrigerator in Lab.
Transport of Chemicals

The following guidelines should be followed when transporting all chemicals within facilities and from building to building, or room to room:

- Hand-carried chemicals should be placed in an outside container or acid-carrying bucket to protect against breakage.
- Lab employees transporting chemicals should wear splash goggles and an apron.
Transporting Chemicals

- Cap All Containers
- Tightly Sealed, Inside Secondary Containment
- Use Elevator
- Ground Metal Containers When Dispensing Flammable Liquids
Storage of Compressed Gas Cylinders

- Properly secure at all times
  - Straps, belts, or chains
- Keep valve caps on unless the cylinder is being used
- Store in a well ventilated area
  - Keep away from heat or ignition sources
  - Keep away from electrical circuits
- Segregate Oxygen cylinders (empty or full) from fuel-gas cylinders and combustible materials
  - 20 feet minimum distance
- Store flammable gas cylinders away from oxygen, nitrous oxide cylinders.
- Segregate full and empty cylinders
  - Label empty cylinders to prevent confusion
  - Empty cylinders should be returned to Vendor
Certificate of Fitness (C-14)

- Laboratories must operate under the supervision of a certificate of fitness holder.
- The FDNY issues Certificate of Fitness for Supervising Non-Production Chemical Laboratories.
  - Address the specific fire safety concerns associated with:
    - the storage, handling and use of hazardous materials in non-production laboratories.
  - Is required when the storage of flammable or combustible liquids within a laboratory or chemical storage room exceeds 1 gallon or flammable gas storage exceeds 75 SCF.
  - At least one certificate of fitness holder be present while the laboratory is in operation (FC 2706.4).
  - It is CUNY policy that all Faculty, Staff, Post Docs and Graduate Students working in chemical laboratories, be Certificate of Fitness Holders.
  - Must be posted in the laboratory for inspection by Fire Department representatives.
NYC Fire Department Laboratory Inspection

A Violation and Order to comply will be issued for the following findings:

- No Certificate of Fitness (C14) (Study material for C-14)
- More than 15 gallons of flammable liquids in a type IV Laboratory
- Expired chemicals (ether, THF,...)
- Unlabeled chemicals
- Corroded containers
- Blocked safety shower
- Compressed gas cylinder not securely fastened with a strap
- Compressed gas cylinders have not been hydrostatically tested in the past 10 years
NYC Fire Department Laboratory Inspection

- Fire extinguisher not fully charged
- Fire extinguisher not inspected within the last year
- Poor housekeeping (accumulation of combustible rubbish, blocked exits)
- Absence of fixed overhead shower or flexible hand held shower in laboratory where more than 5 gallons of flammable liquids or corrosive acids are stored or used
- Incompatible chemicals stored together
- Non-functioning fume hood (minimum average face velocity of 100 FPM, with no point having face velocity below 75 FPM))
- Flammable liquids stored in refrigerator not approved for storing flammables
Eyewash and Safety Showers

- Must Meet ANSI Requirements
- 15 Minutes of Clear, Running Water
- Operate Eyewash Weekly
- If Used Seek Medical Attention
- Maintain Clear Access
Emergency Safety Shower

- Keep area around safety equipment clutter free
- If chemical is splashed on the skin and clothing, the splashed surface must be drenched with large quantities of water from a **SAFETY SHOWER**
- Flush affected area for at least **15 minutes**
- For spill on clothing / skin:
  - Remove clothes
  - Wash with soap and water
  - Follow info on SDS for decon steps
  - Seek medical advice
Chemical Fume Hood

- Use for all operations where odoriferous, volatile, toxic or harmful release possible
- To limit turbulence and assure hood is properly functioning:
  - Work at least 6 inches into the hood
  - Elevate large apparatus 2 inches
  - Maintain sash height at or posted level
  - Do not use the hood storage or block back slot
Fume Hood Not Operational!!

Post a Sign like this example.

![Warning Sign](image)

Link

[This fume hood is not working](link)
Electrical Safety

Fires are often caused by damaged electrical equipment and the misuse of such equipment.

- check all equipment for damaged and worn insulation on wiring
- connect ground wires to clean metal
- keep wires and other electrical equipment away from water & hot surfaces
- avoid use of extension cords, (designed for temporary use only)
- avoid homemade/makeshift wiring (use approved wiring methods)
- never touch a switch/outlet with wet hands
- do not use electrical equipment in a flammable atmosphere (I.e. electrical plug strip in a fume hood)
Fire Safety

Know your emergency exits

Fire in the Laboratory:

Fight or Flee? **Your safety is the most important consideration.**

- Do not fight the fire if there is any possibility that you might be trapped by the fire or smoke.
- Do not fight the fire if there is considerable heat, smoke or fumes.
- Call the Fire Department before you or someone else starts to fight the fire. You may need backup.
- Tell all others to get out. Leave the laboratory.
- Close the doors.
- Do not use the elevator.
Fire Extinguishers

- **PASS Method:** Pull, Aim, Squeeze, and Sweep
- **All Uses Must Be Reported to Facilities Services**
- **Inspected Monthly**
Fuel Classifications

- **Class A**: Wood, paper, cloth, trash, plastics—solids that are not metals.
- **Class B**: Flammable liquids—gasoline, oil, grease, acetone. Includes flammable gases.
- **Class C**: Electrical—energized electrical equipment. As long as it’s “plugged in.”
- **Class D**: Metals—potassium, sodium, aluminum, magnesium. Requires Metal-X, foam, and other special extinguishing agents.
How to Use a Fire Extinguisher

It’s easy to remember how to use a fire extinguisher if you remember the acronym **PASS**:

- **P**ull
- **A**im
- **S**queeze
- **S**weep
Rules for Fighting Fires

- Fires can be very dangerous and you should always be certain that you will not endanger yourself or others when attempting to put out a fire.
- **For this reason, when a fire is discovered...**
  - Assist any person in immediate danger to safety, if it can be accomplished without risk to yourself.
  - Call 911 or activate the building fire alarm. The fire alarm will notify the fire department and other building occupants and shut off the air handling system to prevent the spread of smoke.
  - If the fire is small (and Only after having done these 2 things), you may attempt to use an extinguisher to put it out.
  - However . . .
Rules for Fighting Fires

... before deciding to fight the fire, keep these things in mind:

1. Know what is burning. If you don’t know what’s burning, you won’t know what kind of extinguisher to use.

2. Even if you have an ABC fire extinguisher, there may be something in the fire that is going to explode or produce toxic fumes.

Chances are you will know what’s burning, or at least have a pretty good idea, but if you don’t, let the fire department handle it.
Rules for Fighting Fires

... before deciding to fight the fire, keep these things in mind:

3. Is the fire spreading rapidly beyond the point where it started? The time to use an extinguisher is at the beginning stages of the fire.

4. If the fire is already spreading quickly, it is best to simply evacuate the building.

As you evacuate a building, close doors and windows behind you as you leave. This will help to slow the spread of smoke and fire.
Rules for Fighting Fires

Do not fight the fire if:

- **You don’t have adequate or appropriate equipment.** If you don’t have the correct type or large enough extinguisher, it is best not to try fighting the fire.

- **You might inhale toxic smoke.** When synthetic materials such as the nylon in carpeting or foam padding in a sofa burn, they can produce hydrogen cyanide, acrolein, and ammonia in addition to carbon monoxide. These gases can be fatal in very small amounts.

- **Your instincts tell you not to.** If you are uncomfortable with the situation for any reason, just let the fire department do their job.
The final rule is to always position yourself with an exit or means of escape at your back before you attempt to use an extinguisher to put out a fire.

In case the extinguisher malfunctions, or something unexpected happens, you need to be able to get out quickly. You don’t want to become trapped.
Chemical Emergencies

**Classification**

- **Simple Spill** -- one which you can safely clean up yourself

- **Major Emergency or High Hazard Spill** -- one which you can not safely clean up yourself
Action to be Taken for Hazardous Spills

Most spills in the laboratory can be readily neutralized and cleaned up by laboratory personnel.

The Office of Environmental Health & Safety should be immediately contacted if assistance is needed, and to arrange for the disposal of resultant chemical waste.

It is required that each laboratory and chemical stock room to have an adequate supply of suitable neutralizing or absorbent material for the hazardous chemicals in that area.
Action to be Taken for Hazardous Spills

If the size of the spill exceeds an amount that can be handled by lab personnel:

- Clear the laboratory of all personnel
- Close any door to adjacent rooms if possible
- Exit immediately, closing the door and restrict others from entering
- **Immediately contact Public Safety**
Action to be Taken for Hazardous Spills

When reporting to Public Safety, provide the following information:

- Name of person calling
- Is anyone hurt?
- Type of Spill and Approximate Quantity
- Location of the spill
  - Building
  - Floor
  - Room number, etc.
- Don’t Hang Up!
Chemical Emergency Response

To Clean Up a Simple Spill

- **Notify** your fellow workers and supervisor
- **Control Access** to the area, prevent contact or spread of spill
- **Call** EHS for advice and to report as soon as possible

EXAMPLE: 500 ml of a dilute acid
Spills

Clean-up small spills if you:

- Have materials to absorb and bag the spilled material
- Are familiar with the properties of the spilled materials
- Have the proper personal protection
- Know spilled acids or bases are dilute

Do not clean-up a spill if you:

- Don’t know the identity of the chemical
- Lack the knowledge to safely handle the spill
- Feel the spill is unsafe to clean up
When a chemical has been spilled on the counter top or floor:

- Use the materials in the Spill Cleanup Kit to contain all chemical spills.
- Collect all cleanup material in a closed container.
- Complete and affix a preprinted hazardous waste label to the container.
- Dispose of all cleanup materials as a hazardous waste.

When a chemical has been splashed on a person:

- Use the Safety Shower or the Eyewash Station or cold water from the sink of for fifteen minutes of continuous flow.
- Always Get medical help as soon as possible.
How to handle broken glassware:

Inspect all glassware before use. Discard any broken, cracked, or chipped glassware.

- Place non-contaminated broken glassware into the broken glass.
- Never overfill the broken glass containers.
- Once the container is full, cover it using the container cardboard lid, seal it with tape, and leave outside the laboratory at the end of the day for Custodial Services.
Sharps disposal

Sharps that are considered special waste include:

- hypodermic needles
- hypodermic syringes with attached needles
- scalpel blades
- razor blades
- disposable razors
- Pasteur pipettes
- Broken glassware is also treated as special waste if it may be capable of transmitting infectious disease.

All of the above listed items shall be deposited into the sharps containers and disposed of as infectious waste. An Safety Office will deliver, pick up, and dispose of sharps containers to any departments or laboratories at no charge. Keep these containers in each work area that generates sharps.
Substitution as a Primary Method of Control

- Always consider substituting with less hazardous and toxic substances
- Only chemicals for which appropriate exposure controls are present may be used

\[
y = 5x - 1 \quad 2y = 3x + 12
\]

\[
\begin{align*}
2y &= 3x + 12 \\
2(5x - 1) &= 3x + 12 \\
10x - 2 &= 3x + 12 \\
-3x &= -3x \\
7x - 2 &= 12 \\
+2 &= +2 \\
7x &= 14 \\
\frac{7x}{7} &= \frac{14}{7} \\
x &= 2 \\
y &= 5x - 1 \\
y &= 5(2) - 1 \\
y &= 9
\]

Solution: (2, 9)
Working Alone

- Individuals should avoid working alone when conducting research and experiments involving hazardous substances and procedures.
- NYC Fire Department requires teaching and research labs requiring a permit shall be under the personal supervision of a certificate of fitness holder (C 14).
Questions?

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