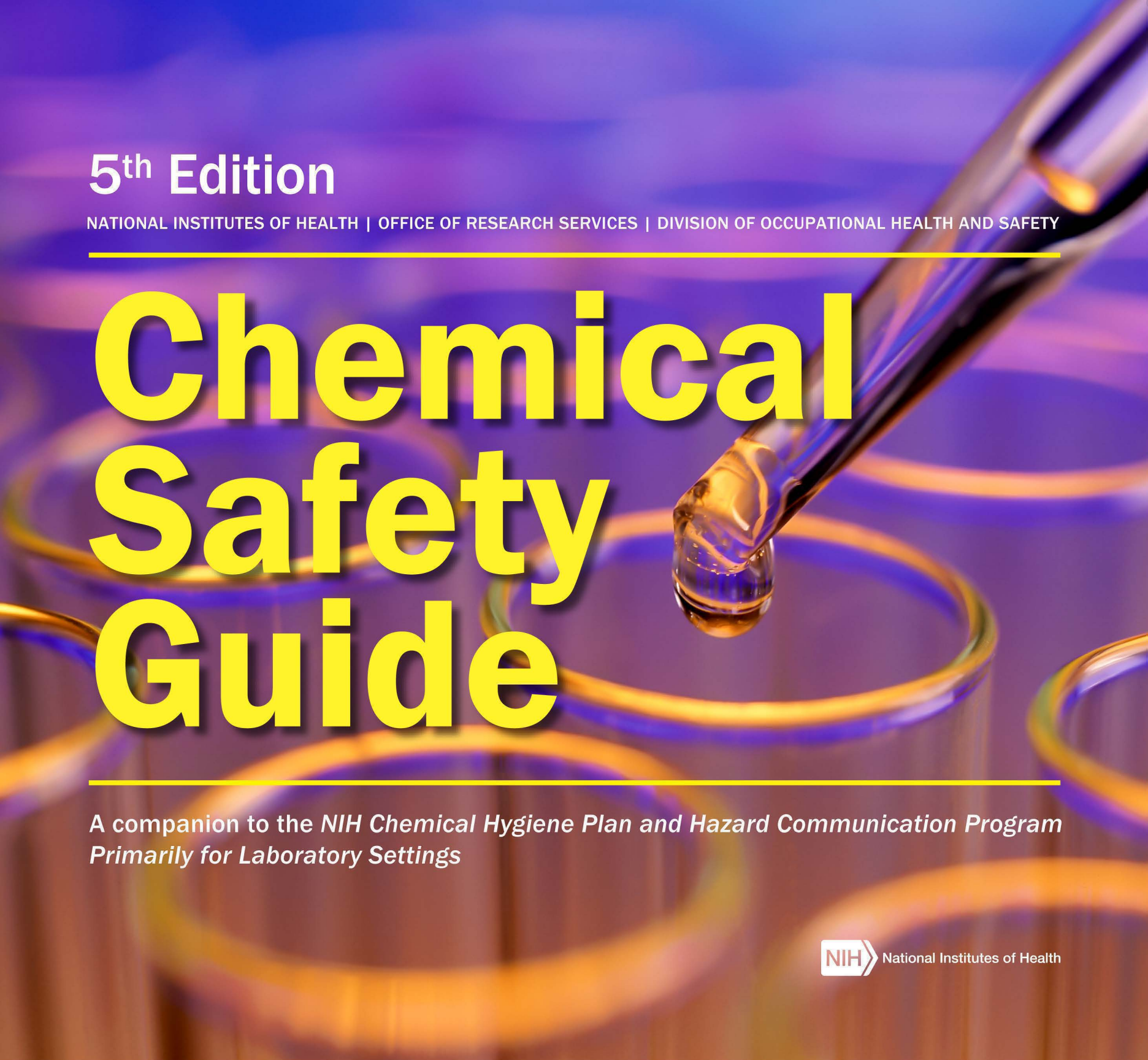


5th Edition

NATIONAL INSTITUTES OF HEALTH | OFFICE OF RESEARCH SERVICES | DIVISION OF OCCUPATIONAL HEALTH AND SAFETY

Chemical Safety Guide

A companion to the *NIH Chemical Hygiene Plan and Hazard Communication Program Primarily for Laboratory Settings*

NIH National Institutes of Health

1 Hazard Identification

Globally Harmonized System

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) provides an international standardized approach to the classification and labeling of chemicals. The Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (HCS) aligns with the GHS to ensure consistency of information. The HCS requirements include:

Hazard Classification: Provides specific criteria for classification of health, physical and environmental hazards, as well as classification of mixtures.

Labels: Chemical manufacturers and importers are required to provide a label that includes a harmonized signal word, pictogram and hazard statement for each hazard class and category, along with precautionary statements.

Safety Data Sheets (SDS): Previously called, Material Safety Data Sheets (MSDS), have a specified 16-section format.

Signal Word: There are two signal words in the GHS system - Danger and Warning. These signal words are used to communicate the relative level of hazard on both the label and the SDS, with "Danger" indicating the more severe hazard. The appropriate signal word is determined by the hazard classification.

Information and Training: While the GHS does not address training, the HCS requires that all personnel working with chemicals be properly trained to recognize and understand chemical labels and safety data sheets.

GHS Pictograms:

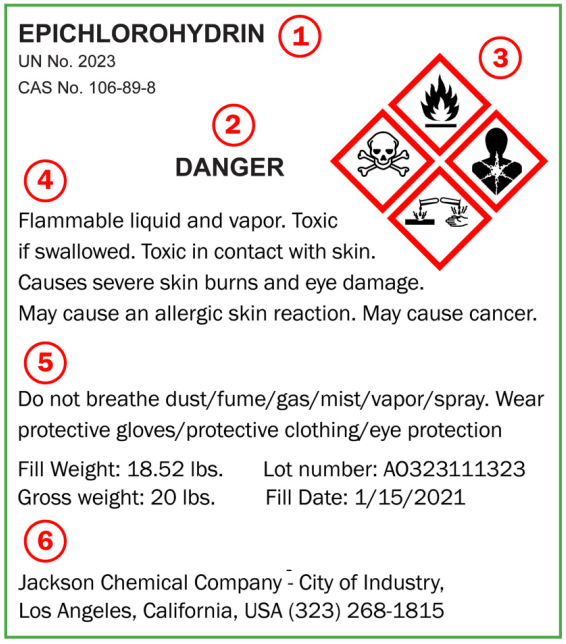
HEALTH HAZARD	FLAME	EXCLAMATION MARK
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
GAS CYLINDER	**CORROSION**	**EXPLODING BOMB**
• Gas Under Pressure	• Skin Corrosive/Burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
FLAME OVER CIRCLE	**ENVIRONMENTAL (NON-MANDATORY)**	**SKULL AND CROSSBONES**
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

If you see old pictograms on chemicals, please contact DEP for disposal at (301) 496-4710

Labeling

In compliance with GHS, chemical manufacturers and importers are required to provide a label that includes six elements:

1. Product identifier
2. Signal word
3. Pictogram
4. Hazard statement
5. Precautionary statment
6. Product supplier



Once in the lab, the user may not obscure or remove any of the label elements from the container. If the chemical is transferred into a different container, the name of the chemical and any associated hazards must also be placed on that container; The label must be legible, in English, and prominently displayed on the container.

This includes:

- All chemicals transferred from original container
- Any prepared solution
- Secondary containers within which a chemical is stored.
- Chemical waste (the word "waste" must also appear on the label)

NOTE **Containers of newly synthesized chemicals have unknown hazards. Label these containers with hazard information as best determined. It is important to include the location (lab notebook, computer file) for finding specific information, such as:**

- Chemical name, exactly as it appears on the outside of the container
- Molecular formula
- Molecular weight (if known)

Peroxide Formers

- Must be double-dated with a received date and open date.

Secondary Container/ Solution Labeling

Secondary container labeling is required in the following instances:

- When the secondary container will be used for longer than one work shift
- When the person who transferred the chemical leaves the work area
- When the person who transferred the chemical takes it to an alternate location where they are no longer in direct possession of the chemical

This labeling requirement includes flasks, beakers, spray bottles and test tubes containing chemicals. If the chemical will not leave the supervision of the person who transferred it during one workday, complete secondary container labeling is not required.

Full secondary container labeling includes the following requirements:

- Name of the chemical (legible in English)
- Hazard warnings
- Date of transfer to secondary container
- Preparer's name
- Expiration date (if applicable)

Please see Chemical Hygiene Plan for more information, Section V, page 9, https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf

Safety Data Sheets

Safety Data Sheets (SDS) have replaced Material Safety Data Sheets (MSDS) under the Globally Harmonized System. They present details of the chemical hazards in a standardized format to improve clarity and comprehension.

The SDS is to include the following sixteen sections in this order:

1. Identification
2. Hazard identification
3. Composition/information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

Hazard Assessment

A chemical hazard assessment identifies the hazards of the chemicals and processes used in the laboratory. The assessment evaluates the potential for risk and the severity of the risk associated with the hazards. The assessment determines measures to eliminate, minimize, or control the hazards and potential risks.

What needs to be done?

To perform a chemical hazard assessment, laboratory workers should examine their plan for an experiment and identify any chemicals with which they are not familiar. The SDS for each unfamiliar chemical should be reviewed. SDS should be maintained by the laboratory in a central location, accessible either as a hard copy or electronically.

Who does the Assessment?

The principal investigator or supervisor with primary responsibility for specific hazard training, performs the chemical hazard assessment. He or she may consult with colleagues or safety specialists from the Division of Occupational Health and Safety (DOHS).

NOTE **The Chemical Hygiene Plan contains templates for performing chemical hazard assessments and generating SOPs. Please see Appendix N of the NIH Chemical Hygiene Plan for more information.**

What does this entail?

A chemical hazard assessment entails gathering information about the properties and proposed use of a chemical or reagent. This information should include:

1. SDS for the chemical or reagent
2. Description of work/activities/use
3. Storage requirements
4. Disposal and environmental requirements
5. Health surveillance
6. First aid/emergency procedures
7. Proposed controls, to include
   - Elimination
   - Substitution
   - Engineering controls
   - Administrative controls
   - Personal protective equipment
8. A specific written chemical standard operating procedure (SOP) is required for Particularly Hazardous Substances (PHS). Reference appendix N of the Chemical Hygiene Plan for a template SOP for this purpose.

Specific Chemical Hazard Template and Lab-Specific Chemical SOP Template

The Specific Chemical Hazard SOP is used to outline the hazards of a chemical and to describe general procedures for working with it The Lab-Specific Chemical SOP is used to outline the chemical hazards of a specific procedure/experiment and to elaborate on the specific protocol to be used during the procedure/experiment. Both SOPs can be used for PHS and non-PHS chemicals.

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STANDARD OPERATING PROCEDURES (SOPs)

Title: Specific Chemical Hazard Template			
Document No.	Document Page(s):	Author's Branch:	Effective Date:
Revision:	Revision Date:	Reviewed/Approved by:	Date:
Overseeing Official's Signature:		Date:	Procedure Location:

Instructions for filling out your SOP

This template is intended to be filled out with information on chemical hazards within the laboratory. The purpose is to generate a chemical-specific standard operating procedure which is to be followed by each individual handling or potentially exposed to the given chemical. To fill out this template:

- Section 1: Use information from the chemical safety data sheet (SDS)
- Section 2: Describe the lab-specific procedure(s) the chemical is used in
- Section 3: Attach the SDS for the chemical to this SOP
- Section 4: Enter information on the ventilation controls used and/or any alternatives to standard ventilation controls
- Section 5: List the PPE that will be worn when working with the chemical. Ensure that any PPE listed is compatible with the chemical.
- Section 6: Fill out information on the preparation, usage, storage, and transport of the chemical. Add details for lab-specific procedures.
- Section 7: Fill in specific details for spill procedures. Include information such as the location of spill kits, the specific materials that must be used, PPE that must be worn, or specific procedures that must be followed during spill cleanup.
- Section 8: No action necessary.
- Section 9: Fill in information on waste disposal – customize to the specific procedure and chemical.
- Section 10: No action necessary.
- Section 11: Fill in information on decontamination and designated work location for the chemical.
- Section 12: Document training for all personnel who will handle this chemical. All personnel must sign to indicate they are aware of the hazards and of all general and lab-specific procedures which must be followed when using this chemical.

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1 PURPOSE Of STANDARD OPERATING PROCEDURE

☐ **Specific Laboratory procedure or experiment** [Examples: synthesis of chemical luminescent esters, folate functionalization of polymeric micelles, etc.]

☐ **Generic laboratory procedure that covers several chemicals** [Examples:distillation, chromatography, etc.]

☐ **Generic use of specific chemical or class of chemicals with similar hazards** [Examples: organic azides, mineral acids, etc.]

2 DESCRIPTION OF PROCESS/EXPERIMENT

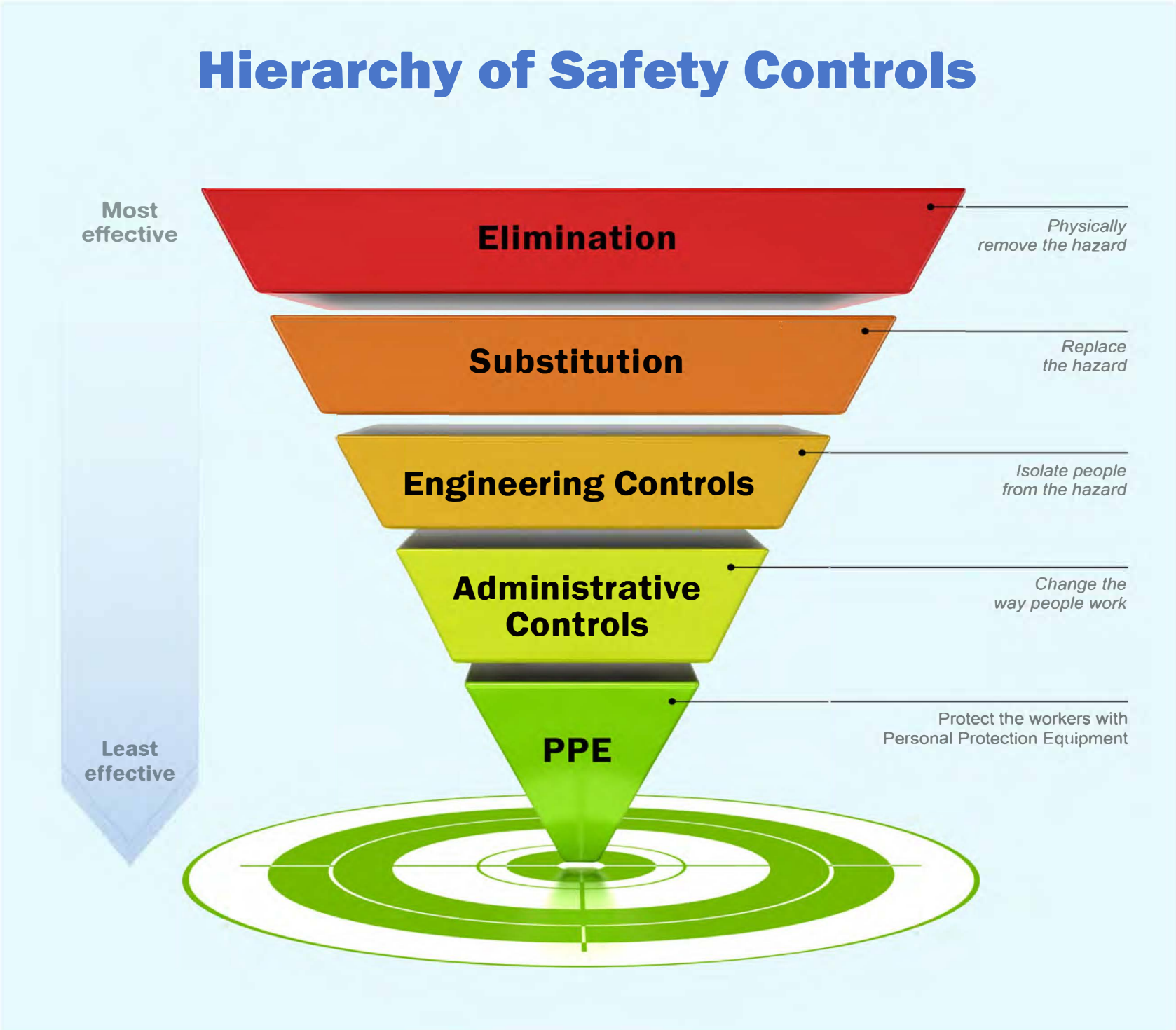
[Provide a brief description of your process or experiment, including its purpose. Do not provide a detailed sequential description as this will be covered by section #6 of this template. Indicate the frequency and duration below.]

Frequency	☐ one time ☐ daily ☐ weekly ☐ monthly ☐ other: _____
Duration per experiment:	_____ minutes; or _____ hours

3 SAFETY LITERATURE REVIEW AND HAZARD SUMMARY

1. Hazardous Substances
[List hazardous substances and their associated health and safety hazards. Examples of potential hazards include toxicity, reactivity, flammability, corrosivity, pressure, etc. Refer to Safety Data Sheets (SDSs) and other resources, as needed.]

2. Other Hazards
[List nonchemical hazards, e.g., biological hazards, electrical hazards, physical hazards, (including sharps), mechanical hazards, nonanes radiation, or ionizing radiation.]


Hierarchy of Safety Controls
Most effective
Least effective
Elimination
Physically remove the hazard
Substitution
Replace the hazard
Engineering Controls
Isolate people from the hazard
Administrative Controls
Change the way people work
PPE
Protect the workers with Personal Protection Equipment

Control of Exposure

The best way to control or minimize exposures is to eliminate the hazard.

If a hazard cannot be eliminated, other hazard control methods must be used. Personal protective equipment (PPE) should never be the only method used to reduce exposure because PPE may "fail" (stop protecting the worker) with little or no warning.

Engineering Control: Chemical Fume Hood

Administrative Control: Standard Operating Procedures, policies and guidance

Personal Protective Equipment: Gloves and goggles

For information about engineering controls please see Section 5 – Ventilation

For information about Personal Protective Equipment (PPE) please see Section 6 – Personal Protective Equipment (PPE)

NOTE **Prevention is the most effective means of hazard control. Prepare your work area before beginning any work!**

Administrative controls:

- Ensure personnel are adequately trained on the chemicals and associated processes.
- Never pipette by mouth.
- Transport laboratory chemicals using bottle carriers, secondary containment, and/or suitable carts.
- Follow the established procedures for the decontamination and movement of scientific and medical equipment found in the NIH Personal Property Management Guide.
- In the event of a hazardous chemical spill, immediately follow the hazardous material spill procedure (see next page).
- Store all food, beverages, cosmetics, and medications outside the lab.
- Keep all doors to the laboratory closed to ensure proper fume hood performance and directional airflow into the lab.
- Ensure unimpeded access to safety showers, eyewash stations and exit pathways.
- Test and flush eyewash stations weekly documenting the date and initials of the individual who performed the test. Call ORF (301) 435-8000 to have equipment that fails tests fixed promptly. Make sure all personnel know where the eye wash is located and how to use.
- Call Office of Research Facilities (ORF) (301) 435-8000 to have the safety showers tested annually. Submit a ticket at https://58000.nih.gov/.
- Enter an online clearance request for the lab with the Division of Occupational Health and Safety (DOHS) when non-laboratory personnel have to enter the laboratory to perform services such as renovations or equipment repair. Routine services such as floor cleaning and trach collection do not require clearance.
- Keep personal protective equipment, emergency phone numbers, and fire extinguishers readily available.

Personal Protective Equipment:

- Protect your clothes and exposed skin by wearing appropriate personal protective equipment. Consult the PPE section for detailed information.
- Do not wear PPE outside the laboratory.
- Upon completion of work remove gloves carefully and thoroughly wash hands and forearms before leaving the laboratory. Dispose of used gloves properly.
- Wear eye protection when a splash potential exists.

NOTE **Contact lenses may be worn, with some exceptions, but these do not function as protective devices. The NIOSH Current Intelligence Bulletin prohibits wear of contact lenses when working with acrylonitrile, methyl-enechloride, 1,2 dibromo-3-chloropropane, ethylene oxide, and methyline dianiline.**

Spill Prevention:

Most spills are preventable. The following are some tips that could help to prevent or minimize the magnitude of a spill:

- Substitute a less hazardous chemical whenever possible.
- Think through each step of your experiment carefully.
- Order/use the smallest quantity of chemicals possible.
- Use bottle carriers to transport all glass bottles containing chemicals.
- Order solvents and acids in poly-coated glass safety bottles. The protective coating on these bottles can provide containment if the bottle breaks.
- Use secondary containment when possible.
- Do not store bottles near the edges of shelves and bench tops.

High-Level Hazard Spills:

ALERT **Contact the Fire Department:**

Bethesda main campus: Dial 911 from an office phone or (301) 496-9911 from a cell phone; Off-campus: Dial 9-911 from an office phone or 911 from a cell phone. For satellite locations, follow satellite-specific guidance which supersedes the main campus guidance at these locations.

RML: Contact the Security Control Center (SCC). Dial 0 from an office phone or (406) 363-9400 from a cell phone.

IRF-Frederick: Call on-site OMS Clinic or follow emergency response plan.

Baltimore: Refer to the Baltimore chemical spill SOP for guidance.

A high-level hazard spill is defined as one that requires an emergency response. If ANY of the following criteria are met, an emergency response must be initiated:

1. The employee is uncomfortable.
2. Assistance from outside the immediate release area is required.
3. The incident is likely to result in an uncontrolled release of hazardous substances (to drains, to the air, etc.).
4. Response to a release poses a potential safety or health hazard to the responder.
5. The spill involves Particularly Hazardous Substances (PHS). PHS include select carcinogens, reproductive toxins and chemicals that have a high degree of acute toxicity. Please refer to Section X of CHP.

If you witness or are involved in a high-level hazardous spill situation:

1. Leave the area, closing doors behind you.
2. Prevent others from entering the area.
3. Initiate first aid at the work site:
   - Eyes: Flush with eyewash for 15 minutes. For water reactive chemicals, consult the SDS for proper emergency response prior to using the chemical.
   - Skin: Remove contaminated clothing. Use closest emergency shower for 15 minutes.
4. Notify your supervisor as soon as possible.
5. **Bethesda main campus:** Report (Monday-Friday, 7:30 AM to 5:00 PM) to the Occupational Medical Service (OMS), Building 10, Room 6C306 or call (301) 496-4411 as soon as possible. If life-threatening, call the Fire Department of your local NIH campus immediately.

   RML: Report (Monday-Friday, 8:00 AM to 4:30 PM) to RML OMS, Building 5, Room 204 or call (406) 375-9600 as soon as possible. If life-threatening, call 0 from an office phone or 911.

   IRF-Frederick: Report (Monday-Friday, 7:30 AM to 5:00 PM) to IRF OMS, Room 1B116 or call (301) 631-7233 as soon as possible. If life-threatening, call 911.

   Baltimore: Report (Monday-Thursday, 8:30 AM to 4:30 PM; Friday, 7:30 AM to 3:30 PM) to Baltimore OMS: BRC, Room 1B210 or call (443)740-2309 as soon as possible. If Baltimore OMS is unavailable during normal working hours, contact Bethesda OMS at (301) 496-4411.

   For all campuses, if OMS is closed, call the Clinical Center Operator at (301) 496-1211 and ask them to page an OMS physician immediately. For alternate satellite locations,report to your on-site OMS Clinic (if applicable) or follow your satellite emergency response plan.
6. Do not re-enter the room until the Fire Department or appropriate authorities determine that the area is safe.

NOTE **High-level hazard spills: Note that spills of >100 mls of any material and spills of Particularly Hazardous Substances of ANY volume should be cleaned up by emergency personnel. Refer to site specific directions under the High-Level Hazard Spills "Alert" on this page for more specific directions.**

The following substances are very hazardous and clean up must be performed by experienced personnel only:

Aromatic amines, nitro compounds, organic halides, bromine carbon, disulfide ethers, cyanides, hydrazines, and nitriles.

NOTE **Breakthrough time for some nitrile gloves may be quite short; use thick nitrile gloves or multi-hazard gloves such as Silver Shield®. Always check the manufacturer's guide for compatibility.**

NOTE **ALWAYS report to OMS in the event of chemical exposure, no matter how minor.**

Low-Level Hazard Spills:

As a general guideline, chemical spills that are <100 mls and within a lab or contained area (such as a bench top or inside the chemical fume hood) AND don't involve PHS, are considered to be low-level spills. HOWEVER, DO NOT attempt to clean up a spill unless you have the training and resources to clean the spill with no risk to yourself or others. Attempt ONLY if it is non-volatile liquid with which you are familiar, and you have appropriate supplies on hand, including:

- Personal protective equipment: safety goggles, chemical resistant gloves, lab coats, face shields.
- Spill kit or absorbent, compatible material to contain the spill.
- Disposal container (or bag) to collect absorbent material. Dispose as chemical waste.

RML: Contact the Security Control Center (SCC). Dial 0 from an office phone or (406) 363-9400 from from a cell phone.

Baltimore: Refer to the Baltimore Chemical Spill SOP

Other satellite locations: Follow satellite-specific guidance, if applicable.

For more information consult the NIH Chemical Hygiene Plan at https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf

Chemical Storage

Proper chemical storage can be a challenge in the limited space of laboratories. The hazards associated with chemical storage can be reduced through prudent purchasing, handling and disposal practices.

Considerations for proper storage:

Ensure all hazardous chemicals are properly labeled.

Record the date of receipt on each bottle to assist with inventory management.

Record the date of opening on each peroxide former and dispose prior to the expiration date. See the Chemical Hygiene Plan, Appendix D, for more information.

Upon preparation, label and date solutions with the chemical or mixture name, as well as any applicable hazard warnings. See additional information in Hazard Identification/Labeling section.

Store incompatible chemicals separately by hazard class. Within a hazard class, chemicals may be stored alphabetically.

Store flammable and combustible materials in an approved storage cabinet. Flammables should be stored in an approved flammable storage cabinet away from chemical fume hoods and biological safety cabinets. Containers of 500 mls or less of flammables of current day working stock may be stored outside a flammable cabinet. Flammable working stock cannot be stored outside of flammables cabinet when not working with it. Keep cabinet doors closed.

Always store hazardous chemicals no higher than eye level and never on top of a storage unit. Do not overcrowd shelves.

Do not store chemicals on the floor.

Liquids should be stored on shelves with a lipped edge and in spill trays to hold the contents if the container breaks or leaks.

Store acids in a dedicated acid cabinet, preferably in the ventilated storage area beneath the chemical fume hood. Nitric, perchloric, chromic and sulfuric acids are strong oxidizers and must be kept isolated from organic acids.

Store bases in a corrosives cabinet.

Store highly toxic materials in a closed, dedicated poison cabinet.

Do not use the work surface of chemical fume hoods to store containers and equipment, as this prevents proper air flow, reduces available work space, and may increase hazards in case of fire or spill.

✓TIP Use work surface of a shelf to hold supplies inside a fume hood to avoid blocking the rear baffle and disrupting proper operation of the hood.

Chemicals to be stored in a refrigerator or freezer must be in units appropriately rated for hazardous material storage.

NEVER store hazardous chemicals in a cold room or other storage area with recirculating ventilation.

Store acid in a ventilated corrosive cabinet


Store bases in a corrosive cabinet


Store chemicals on spill trays to contain leaks or drips

Please consult Appendix D in the NIH Chemical Hygiene Plan for more information, https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf

- Do not store hazardous chemicals under a sink.
- Secure all compressed gas cylinders. Keep protective caps on cylinders when not in use (including during transport). Remove empty cylinders as soon as possible.
- Store chemicals away from heat and direct sunlight.
- Rotate chemical inventory. Dispose of chemicals by their expiration date.
- Inspect chemical containers regularly for deterioration and integrity.
- Store chemicals under appropriate conditions. Chemicals are stable only when stored in an inert gas such as nitrogen. Certain chemicals may burst into flame when exposed to air or moisture in the air. See the SDS for guidance.
- Consult safety references (e.g., SDS) before working with chemicals that are new or unfamiliar.

Considerations For Ordering:

- Purchase less hazardous alternatives whenever possible.
- Keep a chemical inventory to avoid duplicate purchases.
- Purchase chemicals in reasonable quantities that will be used within six months of purchase.
- Place chemicals in sturdy secondary containers

NOTE **If an old or expired container of a peroxide -forming chemical or reactive is found, do not move it. On Bethesda main campus** contact the Division of Environmental Protection (DEP) at (301) 496-4710 for assistance in disposing of the container.

RML: Contact the Industrial Hygienist (IH) at (406) 802-6398.

IRF-Frederick: Contact DEP at (240) 236-9575.

Baltimore: Contact DEP at (301) 346-6287 or pittj@mail.nih.gov.

Chemical Transport

Moving chemicals within your laboratory:

- Inspect each container's cap or closure seals for the formation of crystals.

ALERT **Do not tighten, open or move containers that have crystals forming on the caps and seals or inside the bottle in case they are shock sensitive; on Bethesda main campus** notify your IC safety specialist and supervisor immediately. Contact contact chemical waste services immediately for removal at (301) 496-4710. If believed to be an emergent situation (picric acid, diethyl ether, organic peroxides), express this when placing the call.

RML: Contact the IH at (406) 802-6398.

IRF-Frederick: Call DEP at (240) 236-9575.

Baltimore: Call DEP at (301) 346-6287.

Consult the CHP, Appendix D, for more detailed information.

- Use carts or bottle carriers to move chemicals short distances.

Proper use of chemical bottle carrier

- Place chemicals in sturdy secondary containers

Place chemicals in sturdy secondary containers

Inspect bottle caps for crystals.

Moving chemicals outside of your lab:

Chemical transportation services are available through the DEP. Please contact DEP (301) 496-7990 and your DOHS safety specialist for guidance when you are planning a laboratory move or before you move any chemicals.

RML: Chemical transportation services are available through the RML HAZMAT Team. If you are planning a laboratory move or before moving chemical stocks, please contact the HAZMAT Team Lead at (406) 363-9219 and the RML Industrial Hygienist (IH) at (406) 375-7467.

Baltimore: Contact DEP at (301) 346-6287 or pittj@mail.nih.gov and chemical technicians for your IC.

- **NIDA:** NIDASafety@mail.nih.gov.
- **NIA:** NIAIRPBaltimoreSafetyOffice@mail.nih.gov

Sturdy secondary containers on carts are used to transport chemicals safely

Chemical Waste Disposal

Waste disposal procedures are described in detail in the NIH Waste Disposal Guide (https://orf.od.nih.gov/EnvironmentalProtection/WasteDisposal/Documents/NIH-Waste-Disposal-Guide-2022-508Ready.pdf. Chemical waste disposal guidance tool (https://nems.nih.gov/Documents/Chemical_Waste_Tag_Guidance.pdf). Below are general guidelines:

DON'T:

Don't mix incompatible chemicals.

Don't discard chemicals in sinks, medical pathological waste (MPW) boxes, or general trash.

Don't treat chemical waste in any manner, including use of ethidium bromide filters.

Don't dispose of volatile chemicals by evaporation.

Don't put waste containers in hallways or other public locations.

Don't move chemicals with precipitation on or in the bottle.

❑NOTE **Picric acid is a commonly used reagent in biological laboratories which becomes a dangerous explosive if allowed to crystallize. If dehydrated picric acid is discovered, DO NOT MOVE THE BOTTLE. Call DEP for removal. Picric Acid is a Particularly Hazardous Substance (PHS). Consult the CHP, Appendix D, for more detailed information.**

DO:

Keep waste containers closed at all times.

Store waste in laboratory while awaiting pick up.

Place liquid waste containers in secondary containers (pans).

Have chemical waste picked up within 60 days of accumulation start date.

Dispose of empty chemical bottles as chemical waste or recycle.

Use only the safety cans provided by the chemical disposal service for disposing of flammables.

Attach and complete a chemical waste tag to ALL chemical waste not in its original container.

Contact DEP or your DOHS Safety Specialist if you are unsure how to dispose of a chemical.

***Certain items may require special handling based on the stability of the material.** These items may include peroxide formers, explosives, water reactive chemicals, as well as shock, air and temperature sensitive items. CALL DEP FOR REMOVAL OF THESE ITEMS.

Consider an annual chemical clean-up day to dispose of old or unwanted chemicals.

- Segregate acids and bases, whether dry or liquid, when collecting chemicals for pick up or when cleaning up the laboratory.
- Flammables should be stored in their own box for chemical waste pick up (separate from acids and bases). Exceptions exist for methanol/acetic acid/water solution and triethylamine (please call DEP for guidance).
- Leave original labels on bottles whenever possible.
- If the researcher cannot identify a chemical, please keep the unknown chemical(s) separated from other chemicals.
- Affix a Chemical Waste tag to each box, identifying contents.
- Call DEP for pick-up:

  Bethesda main campus: (301) 496-4710

  RML (HAZMAT team): (406) 363 -9219

  IRF-Frederick: (240) 236-9575

  Baltimore: (301) 346-6287

Pleaserefer to the NIH Waste Disposal Guidefor further information, https://orf.od.nih.gov/EnvironmentalProtection/WasteDisposal/Documents/NIH-Waste-Disposal-Guide-2022-508Readypdf.

Chemical Waste Tag and examples of correct disposal techniques

Highly Reactive Chemicals

Highly reactive chemicals include those which are inherently unstable and susceptible to rapid decomposition. Also included in this category are those chemicals which can react alone or with other substances in a violent uncontrolled manner, liberating heat, toxic gases, or leading to an explosion.

Air, light, heat, mechanical shock (when struck, vibrated or otherwise agitated), water and certain catalysts can cause decomposition of some highly reactive chemicals, and initiate an explosive reaction. Hydrogen and chlorine may react explosively in the presence of light. Alkali metals, such as sodium, potassium and lithium react violently with water liberating hydrogen gas. Examples of shock sensitive materials include acetylides, azides, organic nitrates, nitro compounds and peroxides. When working with highly reactive chemicals, employees should conduct a Chemical Hazard Assessment.

Organic Peroxides are extremely sensitive to light, heat, shock, sparks and other forms of accidental ignition, as well as to strong oxidizing and reducing materials. All organic peroxides are highly flammable. Peroxides may deteriorate quickly. Always dispose of peroxides upon expiration.

Peroxide Formers can form peroxides spontaneously during storage and especially after exposure to the air. This is particularly dangerous if:

- Peroxides are present during a distillation, where applied heat to the concentrated solution may trigger a violent explosion.
- Peroxides evaporate, leaving the crystals of highly explosive peroxide at the bottom of the container.

Peroxide forming chemicals must be labeled with the date of receipt from the manufacturer and the "opened" date.

NOTE **Avoid the distillation, concentration, or evaporation of peroxide formers by first testing for the existence of peroxides. Peroxide detection test strips are available from most lab equipment supply companies.**

Chemicals that are sensitive to peroxide formation can be broken into three categories shown in the following table

Label peroxide forming chemicals with "received" and "opened" dates

NOTE **For more information consult the NIH Chemical Hygiene Plan at https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf**

Suggested Storage Time Limits for Common Peroxide Forming Compounds

CLASS A: MOST DANGEROUS	CLASS B: DANGEROUS		CLASS C: DANGEROUS
Chemicals that can form explosive levels of peroxides during storage without concentration.	These chemicals are a peroxide hazard during storage and on concentration (distillation/evaporation). A test for peroxide should be performed if concentration is intended or suspected.		Unsaturated monomers that may auto-polymerize as a result of peroxide accumulation if inhibitors have been removed or are depleted.
Discard after 3 months.	*Inspect every 6 months following date of opening*		*Inspect every 6 months following date of opening*
Isopropyl ether	Acetal	Dioxane	Acrylic acid
Butadiene	Cumene	Ethylene glycol	Butadiene
Chlorobutadiene (chloroprene)	Cyclohexene	Furan	Chlorotrifluoroethylene
Potassium amide	Cyclooctene	Methyl acetylene	Ethyl acrylate
Potassium metal	Cyclopentene	Methyl cyclopentane	Methyl methacrylate
Sodium amide	Diacetylene	Methyl-isobutyl ketone	Styrene
Tetrafluoroethylene	Dicyclopentadiene	Tetrahydrofuran	Vinyl acetate
Divinyl acetylene	Diethyl ether	Tetrahydronaphthalene	Vinyl chloride
Vinylidene chloride	Diethylene glycol dimethyl ether	Vinyl ethers	Vinyl pyridine

Adapted from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, Updated Version, National Research Council, 2011.

Safe Management of Particularly Hazardous Substances in NIH Laboratories

Proper chemical storage can be a challenge in the limited space of laboratories. The hazards associated with chemical storage can be reduced through prudent purchasing, handling and disposal practices.

What are Particularly Hazardous Substances (PHS)?

PHS are chemicals that may pose extreme hazards to laboratory employees. As defined by the OSHA Laboratory Standard (29 CFR 1910.1450) https://www.osha.gov/laws-regs regulationsstandardnumber/1910/1910.1450. PHS include substances with a high degree of acute toxicity, reproductive toxins, and select carcinogens (those strongly implicated as a potential cause of cancer in humans and/or those regulated by OSHA, https://www.osha.gov/carcinogens/ standards). OSHA and NIH require the development of protocols for the identification and management of PHS.

Who is responsible for identifying and mananging PHS in NIH labs?

The Principal Investigator (PI) has primary responsibility for determining which chemicals must be handled as PHS. Each PI is also responsible for ensuring that employees follow appropriate protective measures and receive training when working with any PHS. The DOHS Chemical Hygiene Officer (CHO) and safety specialist for your institute (301-496-2960) are available to assist upon request.

RML: Contact the RML IH (406) 802-6398).

IRF-Frederick: Contact IRF-DOHS at (301) 631-7244.

My laboratory uses numerous hazardous chemicals. How do I determine which ones must be classified as PHS?

First, review each chemical's properties. Chemicals that may be considered PHS include:

- substances that may cause severe, acute, or lethal effects through any exposure, route (inhalation, injection, skin absorption, or ingestion) in quantities of 50 micrograms per kilogram of body weight (50 µg/kg) or less;
- highly unstable or explosive materials, alone or in combination with other materials;
- carcinogens;
- reproductive toxins;
- materials that may generate acutely toxic by-products that could overwhelm control measures or penetrate personal protective equipment;
- substances that have been determined by DOHS to present a unique hazard or are used in an operation that requires approval above the level of the laboratory supervisor.

Then, if a substance meets **any of the above criteria,** the PI must consider whether its use poses a significant hazard. For instance,

- Is the chemical handled rarely, occasionally, or repeatedly?
- Is the procedure done on the open bench, in a laboratory hood, or in an enclosed apparatus?
- Is there a potential for the employee to be exposed to the chemical?
- Does the chemical's use pose a significant potential for exposure through any route (inhalation, skin, or ingestion)? For instance, is it highly volatile? Are dusts or aerosols formed? Is it heated or concentrated?
- Is this a reproductive hazard? Reproductive hazards are substances or agents that may affect the reproductive health of women or men or the ability to have healthy children. OMS may be consulted by all staff of reproductive capability (i.e., women, men, those who are pregnant, planning to become pregnant, or breastfeeding) when there is a concern for past exposure or potential future exposure to a reproductive hazard(s).
- Do any employees have known chemical sensitivities?
- Is there a potential for new or unknown substances to be created during the procedure?
- Are the signs and symptoms of exposure readily apparent?

For more information on how to determine if a chemical is a PHS, consult the NIH Chemical Hygiene Plan (Appendix B) at https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf#search=Chemical%20Hygiene%20Plan.

Once I have identified all the PHS in my lab, what do I do next?

1. Determine whether or not the chemical can be replaced with a less hazardous chemical.
2. If it cannot be replaced, follow the steps below to conduct a hazard assessment and create a PHS specific SOP. When PHS are used for the first time, perform a chemical hazard analysis using the Specific Chemical Hazard template in Appendix N of the Chemical Hygiene Plan. Assistance is available from the IC Safety Specialist and the DOHS Chemical Hygiene Officer (CHO). If the hazard analysis identifies that the PHS has antidotes or prophylaxis available, the CHO will consult with OMS to facilitate required medical services (e.g., counseling for laboratorians before they commence work with the PHS or hazard-specific incident response review for OMS staff). For detailed information, consult the NIH Chemical Hygiene Plan.
3. Once the PHS has been identified, then the PI will create their own PHS lab-specific Standard Operating Procedure (SOP) with available assistance from their Safety Specialist and the DOHS CHO using the Lab -Specific SOP in Appendix N of the Chemical Hygiene Plan to include:
   - description of the PHS
   - a step-by-step review of the work involving the PHS
   - the engineering controls and PPE for the PHS
   - special handling procedures and storage requirements
   - spill and accident procedures
   - exposure procedures in case of an emergency
   - waste collection and disposal
   - designated area and decontamination procedures.
4. Once the hazard analysis, SOP and OMS consultation, if applicable, have been completed, the laboratory can begin to work with the PHS safely.
5. The supervisor can approve the use of the PHS only after employees have been trained according to the safety protocol per the PHS requirement. Document that all employees who work with any PHS have received proper training and a copy of the written safety protocol.

NOTE **Commonly used PHS are chloroform, formaldehyde, sodim azide and ethylene oxide. PHS examples that have antidotes or prophylaxis are hydrogen fluoride, MPTP, phenol and hydrogen cyanide. Please refer to the NIH Chemical Hygiene Plan for further information,** https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf

NOTE **Medical counseling through the Occupational Medical Service (OMS) is offered for employees working with hazardous chemicals. OMS provides additional services to employees working with potentially hazardous chemicals that monitor individuals for adverse health effects and determines treatment strategies that can help to prevent or significantly reduce adverse health effects if exposed. These include medial surveillance and post-exposure treatment and follow-up programs.**

Where can I get more information?

For assistance with PHS or any other lab safety questions, contact the DOHS at (301) 496-2960.

RML: Contact the RML IH at (406) 802-2960.

IRF-Frederick: Contact IRF-DOHS at (301) 631-7244.

NIA Labs: Contact NIA Safety at NIAIRP Baltimore SafetyOffice@mail.nih.gov.

NIDA Labs: Contact NIDA Safety at NIDASafety @mail.nih.gov.

See also:

NIH Chemical Hygiene Plan (CHP), https://ors.od.nih.gov/sr/dohs/Documents/chemical-hygiene-plan.pdf#search=Chemical%20Hygiene%20Plan.

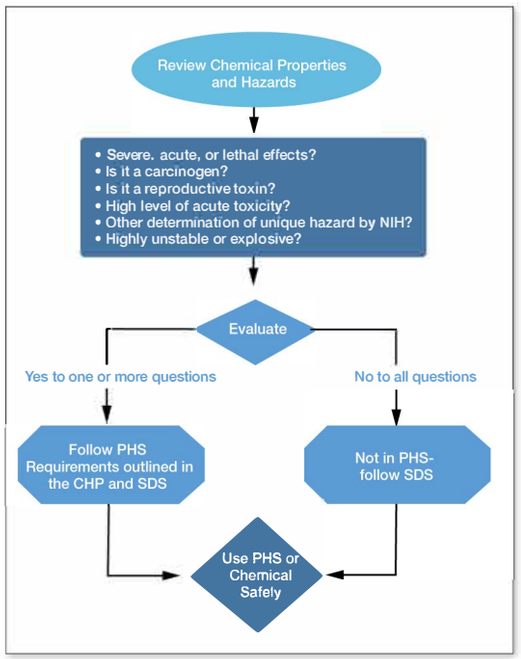
National Research Council, Prudent Practices in the Laboratory: Handling and management of Chemical Hazards, National Academy Press https://nap.nationalacademies.org/catalog/12654/prudent practices in the laboratory - handling and-management of chemical

OSHA standard 29 CFR 1910. 1450. Occupational exposure to hazardous chemicals in laboratories, https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450

Appendix B of the OSHA laboratory standard(1910.1450) contains a list of references, at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450AppB.

OSHA Laboratory Safety Guidance booklet, OSHA 3404-11R, 2011, available at https://www.osha.gov/sites/default/files/publications/OSHA3404laboratory-safety-guidance.pdf

Safe Management of Particularly Hazardous Substances in NIH Laboratories



- Is it OSHA regulated (required standards)?
- Does it have severe, acute or lethal effects?
- Is it a carcinogen or reproductive toxin?
- Does it have acutely toxic by-products?
- Does it present a unique or significant hazard? (Consult DOHS if needed)
- For more info and how to identify PHS see Appendix B of the NIH CHP
- Identify all potential physical and health effects
- Perform a step-by-step review of the work
- Identify engineering controls, work practice and PPE to be used
- Establish a clearly marked, designated area for the PHS
- Identify decontamination procedures (see "Hazard Control" section for more detail)
- Write a PHS-specific safety protocol
- Ensure primary barriers (e.g., chemical fume hoods, downdraft tables, etc.) are functioning properly
- Ensure availability and use of appropriate PPE
- Train employees according to the safety protocol
- Document training

Toxic Chemical Reduction Initiative

NIH developed the Toxic Chemical Reduction Initiative in conjunction with the requirement for strict control of Particularly Hazardous Substances, and in response to the mandate of Executive Order 13514 and NIH's environmental goal to reduce toxic and hazardous chemical use, NIH developed the Toxic Chemical Reduction Initiative. This initiative identified alternatives that are less toxic and more environmentally friendly than their more hazardous counterpart. This venture was spearheaded by the Division of Environmental Protection through the NIH Environmental Management System (NEMS). About 200 toxic chemicals were scored numerically and ranked based on the following four criteria for reduction:

- Health and safety risk
- Quantity generated
- Mandated regulatory reduction
- Alternative availability and feasibility

(For more information about this initiative, visit the NIH Environmental Management System (NEMS) website at https:// nems.nih. gov/environmental-programs'/ Pages/default.aspx)

Compressed Gases

Hazards associated with compressed gases include:

- Oxygen displacement
- Fires
- Explosions
- Toxic gas exposures
- Physical hazards associated with high pressure systems

Special storage and handling precautions are necessary to control these hazards.

Storage

All cylinders must be secured to a wall, bench or fixed support using a chain or strap placed at 2/3 the height of the cylinder. Cylinder stands are an alternative to straps.

Store cylinders in cool, well-ventilated, fire-resistant areas in compliance with local, state, and federal regulations.

Separate flammable gases from oxygen by a minimum distance of 20 feet.

Do not store full and empty cylinders together.

Keep the number of cylinders in the laboratory to a minimum and ensure that the cylinder contents are properly and prominently labeled.

Keep empty compressed gas cylinders closed, capped, secured, and stored so that they may be removed with a minimum handling of other cylinders.

Empty cylinders should be stored so that they may be removed easily.

Handling

Be familiar with the hazards of the compressed gas (consult the SDS).

Use a suitable hand truck or cart equipped with a chain or belt for securing the cylinder to the cart, even for short distances.

Cylinder caps should be secured on each cylinder unless in use. Cylinder caps protect the valve on top of the cylinder from damage. Never tamper with pressure relief devices in valves or cylinders.

Use a crescent wrench, not a pipe wrench (it roughens the edges of the nut), when manipulating the regulator.

Keep the cylinder valve closed except when in use.

Use compressed gases only in a well-ventilated area; never use or store them in a cold room. Cold rooms are built to be closed systems without ventilation and expose the user to risk of asphyxiation if compressed gases are used.

Toxic, flammable and corrosive gases should be handled in a chemical fume hood.

Where more than one type of gas is in use, label gas lines.

Inspect valves and tubing regularly for wear and tear, and for leaks using the soap bubble test.

Use the appropriate regulator for the cylinder; never substitute another regulator.

Don't use oil or grease to seal the O-ring on the regulator.

For more information, visit us at the DOHS Oxygen Monitoring Devices website at https://ors.od.nih.gov/sr/dohs/safety/Pages/oxygen.aspx

Cryogenic Liquids and Solids

Nitrogen and helium

Nitrogen and helium are the most commonly used cryogenic liquids. Liquid nitrogen (LN2) is commonly used for storing laboratory samples and/or components; liquid helium may be used for cooling superconducting magnets. Both are extremely cold (-195.8°C/-384.4°F for nitrogen and -268.9°C/-516°F for helium) while in a compressed, liquid state. In their gaseous state, they are inert, colorless, odorless, noncorrosive and nontoxic.

ALERT **Cryogen contact with skin may cause serious freezing (frostbite) injury. Wear cryo-protective insulated gloves when working with cryogenic liquids. Cryogenic gloves used in research are not designed/rated to protect against immersion into cryogenic liquids or prolonged handling of cryogenically chilled materials. Seek training to safely work with cryogens and liquid nitrogen. Consult manu-facturer's instructions before using. For more information about cryogen safety, including how to respond to a cryogen-related injury, please see the DOHS Cryogen Fact Sheet.**

When liquid nitrogen or helium are dispensed they release gases, which act as simple asphyxiants and displace oxygen. Displacing oxygen creates the potential for a hazardous environment. OSHA specifies that a hazardous atmosphere may include onewhere the oxygen concentration is below 19.5% or above 23.5%.

The following are some of the most common locations where cryogenic liquids are found, potentially creating an oxygen deficient atmosphere:

- Magnetic Resonance Imaging (MRI) rooms (or magnet rooms)
- Nuclear Magnetic Resonance (NMR) Spectroscopy rooms
- Liquid Nitrogen Tanks (freezer farms)
- Transmission Electron Microscope (TEM) rooms

Oxygen monitoring devices may be needed in these areas to continuously monitor oxygen levels where cryogenic liquids are stored. To determine if an oxygen monitoring device is needed in your location, call the DOHS Oxygen Monitoring Program Mananger for an assessment on **Bethesda main campus** at (301) 496-2960.
RML: Call the IH at (406) 363-9429.
IRF-Frederick: Call any IRF-DOHS staff for assistance.

These devices require preventive maintenance and calibration on an annual basis, or as specified by the manufacturer. There is also a DOHS protocol for using these devices.

For more information, visit the Oxygen Monitoring Devices section on the DOHS website at https://ors.od.nih.gov/sr/dohs/safety/Pages/oxygen.aspx

Oxygen monitoring devices:

- are typically installed in locations where compressed gases or cryogenic liquids are stored and/or dispensed in a manner that would create the potential for displacement of oxygen
- may be required by the NIH Design Requirements Manual for Biomedical Laboratories and Animal Research Facilities
- alarm occupants of dangerously low oxygen levels
- must be serviced and maintained by the NIH Institute or Center, including calibration every six months (or more frequently if recommended by the manufacturer)

ALERT **If the device alarms, evacuate the space and call 911 (off campus call 9-911) to have the Fire Department verify oxygen levels.**

RML: Call the SCC at (406) 363-9400.

IRF-Frederick: Call any IRF-DOHS staff for assistance.

Baltimore: Call Facilities
- **GSH (BRC):** (443) 740-2766
- **Camelot (Triad):** (410) 558-9797.

Cryogenic solids

Dry ice is a cryogenic solid and should be treated in a manner different than regular ice. Dry ice is extremely cold, solid CO2 and is a simple asphyxiant. Safety measures for handling and transporting the material include:

- Wear protective clothing. Use insulated gloves that are made of a thick material; also wear proper clothing (long-sleeves and pants) to be sure that no skin is exposed.
- If possible, use tongs while wearing gloves instead of your properly gloved hands to pick up dry ice.
- Handle the dry ice in a well-ventilated room and NEVER use dry ice in a cold room.
- Do not place dry ice in an airtight container; the pressure caused by the dry ice sublimating may cause the container to explode or rupture.
- Do not dump dry ice down the drain as it may damage the sink or plumbing; allow it to sublimate at room temperature, ideally in a CFH or local exhaust device or if unavailable, in a large well-ventilated space.

Liquid nitrogen tanks

Chemical Fume Hoods and Other Local Exhaust Ventilation

The best way to prevent or reduce exposure to hazardous airborne chemicals is through the use of ventilation systems. Local exhaust ventilation (LEV) provides containment of airborne hazards at the source and directs contaminated air away from the work area.

All LEV must be certified by DOHS when installed and on an annual basis.

A chemical fume hood (CFH) is a ventilated enclosure in which gases, vapors and fumes are exhausted. A fan on the roof of the building pulls air and airborne contaminants through the hood and ductwork and exhausts them to the atmosphere.

✓TIP **Place a shallow shelf at the back of the hood to hold supplies - this helps ensure proper airflow.**

The CFH sash provides protective shielding and maximizes hood performance by optimizing the velocity of the air through the front. Keep the sash at the appropriate level (as indicated by the green sticker- preferred height = 18", lowest allowed = 8") to ensure optimal face velocity. Improper positioning of the sash can result in loss of containment (i.e. if the sash is too high, air velocity will be insufficient, if the sash is too low, air velocity will be too high, resulting in turbulence which can force contaminants out of the hood). All work in a CFH should be conducted at least 6" inside (past) the sash. Close the sash when the CFH is not in use.

The baffles direct the air being exhausted, and in many hoods, they can be adjusted to improve performance. It is important that the baffles are not closed or blocked since this blocks the exhaust path.

❑NOTE **When working with heavy vapors such as halogenated solvents, consult with DOHS for optimal adjustment of the baffles.**

The airfoil or beveled frame around the hood face provides more even airflow into the hood by avoiding sharp curves that can create turbulence.

Class II Type B biosafety cabinets provide protection from biohazardous materials as well as small quantities of potentially hazardous vapor-producing chemicals. Air is pulled through the cabinet and a HEPA filter and exhausted outside the building. If considering a Type B biosafety cabinet for your work, contact DOHS (301-496-2960) to discuss suitability.

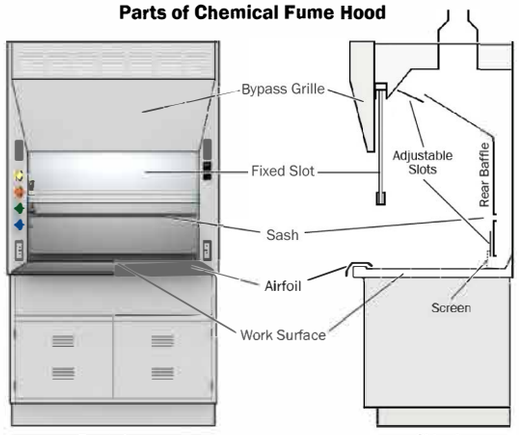
✓TIP **Use Biological Safety Cabinet (BSC) Surface Decontamination Guidance for proper procedures.** https://ors.od.nih.gov/sr/dohs/safety/laboratory/BioSafety/Pages/ih_biocabinets.aspx

Downdraft Tables. Like chemical fume hoods, downdraft tables exhaust air to the outside atmosphere. Unlike chemical fume hoods, the blower is usually mounted below the work area so that air is pulled down through a perforated surface and then exhausted to the outside. Downdraft tables are used for applications involving heavier-than-air gases and materials such as anesthetic gases and histological chemicals.

Other Local Exhaust Ventilation, (e.g., slot hoods, snorkels and cage changing tables) must be certified when installed and on an annual basis.

❑NOTE **Ductless CFHs are not permitted to be used in NIH laboratories. Captured organic vapors may desorb from the charcoal filters, resulting in capture failure.**

Parts of Chemical Fume Hood



Use a tissue to check for proper airflow.

Downdraft table

Class II Type B biosafety cabinet

Negative Airflow

In any laboratory where hazardous materials are handled, the air must flow from outside of the laboratory into the laboratory. It is critical to keep doors closed to maximize ventilation efficiency. The laboratory's negative airflow serves as a secondary barrier to chemical hazards by keeping hazardous airborne particles and noxious odors inside the laboratory.

Cold Rooms

Overview

Cold rooms have closed air-circulation systems and re-circulate any vapors from spills and leaks within the chamber.

The refrigeration coils in cold rooms are aluminum and subject to damage from corrosive atmospheres.

Electrical equipment used in cold rooms:

- Should have Ground Fault Circuit Interrupter (GFCI) protection, as cold rooms are often damp.
- Should be plugged directly into an outlet. Do not use extension cords.
- Should be allowed to equilibrate prior to use after removal from a cold room, as condensation can occur.

Cold room chemical hazards

Compressed gas, dry ice, liquid nitrogen and liquid helium can pose an asphyxiation hazard by displacing oxygen and should never be used or stored in a cold room.

Flammable chemicals can release sufficient vapors to form explosive atmospheres. Cold rooms have fans and electrical equipment that are potential ignition sources.

Noxious fumes may be released by materials that have been heated on a hot plate. Only use stir plates (not hot plates) in the cold room

Recommendations for cold room work

- Ensure door release mechanisms are working and doors are free of obstructions.
- Avoid working alone. If you must work alone, let others know you are working inside and have someone check on you periodically.
- Take a 10-minute break every 50 minutes while working inside the cold room.
- Ensure that shoes have no-slip soles; water and ice are common in cold storage and pose slip and trip hazards.
- Dress appropriately: layer clothing for warmth and wear insulated gloves to protect your hands.
- NEVER store flammables, dry ice, or hazardous liquid chemicals in the cold room.
- It is critical to keep doors closed to maximize ventilation efficiency.
- Avoid mold contamination by keeping cardboard or other paper products out of the cold room.
- Include emergency contact information posted outside of the cold room.

Prevent Asphyxiation
No fresh air circulates in a cold room!

NO hazardous chemicals, pressurized gases or dry ice

Avoid Mold Contamination
Preserve your health and scientific data!

NO food, drink, cardboard or other paper products

Maintain Equipment Integrity
Prevent rust and corrosion!

AVOID moisture build-up; keep the door closed

AVOID cluttering and trash accumulation

CLEAN UP all spilled materials immediately

PPE General Guidelines

Using personal protective equipment is often essential, but it is generally the last line of defense after engineering controls, work practices, and administrative controls.

Minimum protection

All persons working in the lab should have clothes that cover their legs and arms, and closed-toe shoes. **When handling hazardous chemicals, appropriate eye protection, appropriate gloves and laboratory coats must be worn.** This is the minimum protection required and must be upgraded as appropriate for the risk.

Additional PPE

Additional PPE must be worn if indicated by the potential exposure, such as:

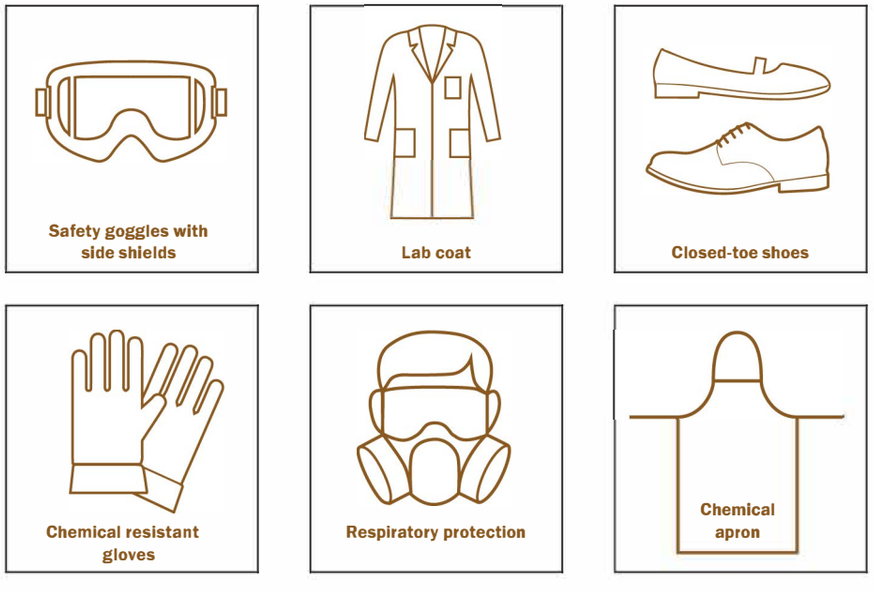
- splash goggles
- face shields
- chemical aprons
- disposable coveralls
- chemical resistant gloves
- respiratory protection
- chemical resistant footwear

Factors to consider are the type of potential chemical, length and route of exposure, and type of contact (splash, mist, vapor, occasional or continuous immersion). Contact a DOHS safety specialist for assistance in selecting appropriate gloves and respiratory protection. The use of respiratory protection requires an industrial hygiene hazard assessment and a medical clearance by OMS, followed by a fit test and training by the DOHS TAB.

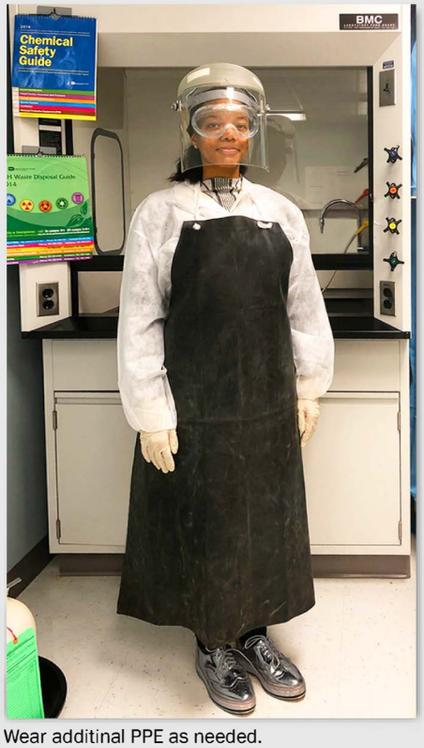
Chemical resistant gloves

Gloves must be selected on the basis of their chemical resistance to the material(s) being handled, their suitability for the procedures being conducted, their resistance to wear as well as temperature extremes. Consult the Glove Selection section for detailed guidance for selecting chemical resistant gloves, or contact your DOHS safety specialist.

ALERT **Improper selection may result in glove degradation, penetration of the chemical through the glove, and ultimately exposure to the chemical.**



Lab coats, gloves and eye protection provide minimum safeguarding.



Wear additinal PPE as needed.

Wear respiratory protection as needed.

Contact DOHS for enrollment in the respiratory protection program and fit-testing at nihrespirator@mail.nih.gov.

Lab Coat Selection

Lab coat selection and use:

- Fabric weight and weave affect how easily material ignites and burns; select tight weave, heavy weight, and tightly fitted sleeves/cuffs for work with flammables and pyrophorics.
- Launder weekly or earlier if contaminated; use commercial laundry only.
- Cuffed sleeves prevent exposure to wrists and arms.
- Closeable lapel is preferred for maximum coverage from hazards.
- Consider sturdy chemical-resistant aprons for high-hazard work such as with pyrophorics, flammables, corrosives, etc.
- Most synthetic material resist ignition but once ignited will melt and can cause severe localized burns.
- Blended fabrics often have a high rate of burning combined with fabric melting.
- Reusable lab coats should be cleaned and dried when contaminated, and replaced when damaged. Do not clean at home.
- Use only fire-retardant lab coats with pyrophoric or highly flammable chemicals.
- Follow lab coat supplier's instructions for laundering and replacement.
- Consider heavy-duty materials such as Tychem® for chemical contact. Tychem® is a Tyvek® fabric coated with polyethylene and provides protection against minor chemical spills and splashes.
- In most cases, lab coats will need to be supplemented with additional protective equipment.
- Lab coats should extend to the knees and be fully buttoned down with sleeves rolled down.
- Don't wear lab coats in public places, such as offices, lunchrooms or lounge areas as they can transfer hazardous materials and contaminate these areas.
- Tyvek® coveralls can be used over street clothes for protection against particles. However, they do not provide sufficient protection against liquids.
- Cotton lab coats are preferred over polyester as they are more breathable and flame resistant.

Lab Coat Type	Fabric Type	Protective Use	Improper Use
Standard	100% cotton (preferred for maximum protection) or cotton/polyester blend fabric (burns more readily than 100% cotton)	Minimal risk chemicals with low risk of exposure to fire. Radioactive materials, cryogenics, and lasers (general benchwork)	Moderate to high volume use of chemicals, flammables, pyrophorics when the risk of exposure to fire is high
Fluid/Splash and Tear Resistant	Polyethylene-coated polypropylene (disposable)	Human and animal blood and body fluids, BSL2/3 and BSL3 and bloodborne pathogens	Use with flammables and pyrophorics
Chemical resistant apron and sleeves	Polyethylene-coated high density polyethylene, neoprene, vinyl, pvc, polyester or polyethylene -coated polypropylene	Select chemical exposure	Use with flammables and pyrophorics
Nomex (Flame Resistant)	Flame resistant fabric	Flame or pyrophoric liquids and solids. Wear with a chemical apron when working with non-polar organic solvents such as acetone, dichloromethane, diethylamaine, ethyl acetate, n-hexane, tetrahydrofuran, toulene	Non-flammable or pyrophoric liquids and solids
Spunbonded olefin such as Tyvek®	Tear resistant fabric/high -density polyethylene fibers	Biological material or particulate and clean rooms	Best at protecting against dry substances but minimal protection against liquids/splashes

Glove Selection

Glove selection and use:

- All gloves are permeable and the changes are not always apparent.
- Visible degradation of gloves can include swelling, softening, hardening and discoloration. https://www.aaesi.com/wp-content/plugins/pdf-poster/pdfjs/web/viewer.html?file=https://www.aaesi.com/wp-content/uploads/2020/07/Ansell_8th EditionChemicalResistanceGuide.pdf&download=true&print=&openfile=false.
- Different gloves are resistant to different chemicals.
- Multiple gloves can be worn together for greater protection (use smallest size that will provide adequate dexterity and comfort).
- Reusable gloves can be used for intermittent chemical work. They must be properly rinsed and air dried. Always inspect reusable gloves for integrity before use.
- Disposable gloves provide barrier protection for small amounts of chemicals. They should be replaced immediately when contaminated, and never be reused.
- Glove liners may be reused, but must be replaced when contaminated.
- Latex deteriorates quickly when exposed to petroleum products.
- Surgical latex gloves are thicker than latex exam gloves.

Factors to consider when choosing a chemical resistant glove:

- frequency and duration of chemical contact
- nature of contact (immersion and/or splash)
- concentration of chemical
- chemical compatibility
- temperature of chemical
- abrasion-resistance requirements
- puncture, snag, tear, and cut-resistance
- length of hand and arm to be protected
- dexterity requirements
- grip requirements and conditions (e.g., wet or oily)
- thermal protection - to protect against heat and cold
- size
- comfort

Always consult the manufacturer's glove selection guidelines, and your DOHS safety specialist for help in selecting the appropriate glove.

Consider using:

- **Knit glove liners** to absorb perspiration.
- **Extended cuffs** to protect wrists and forearms.
- **Ultra-thin gloves** to provide greater tactile sensitivity.
- **Textured finishes** to provide better grip.

Always consult the manufacturer's glove selection guidelines, and your DOHS safety specialist for help in selecting the appropriate glove. Consult the following resource for glove permeability information: https://www.aaesi.com/ansell_8th-edition-chemical-resistance-guide/

Glove Type	Uses	Caution
Disposable: vinyl, latex, nitrile	Dry powders, aqueous solutions	Do **NOT** use for solvents and corrosives. Disposable gloves must be replaced immediately upon chemical contamination.
Reusable: Neoprene (Black)	Corrosives, solvents and alcohols; Resists oils and offers less fatigue	Must be properly rinsed and dried after each use.
Reusable: Nitrile (Blue or Green)	Organic solvents (non-halogenated); Puncture and abrasion resistant	Must be properly rinsed and dried after each use.
Reusable: Nomex® or Zetex®	Temperature extremes	Must be properly rinsed and dried after each use.
Reusable: Butyl	Aldehydes, ketones and esters	Must be properly rinsed and dried after each use.
Reusable: Viton®	Chlorinated and aromatic solvents	Must be properly rinsed and dried after each use.

Eye and Face Protection Selection

Eye and face protection selection and use:

- Eye protection is mandatory where there is potential for injury.
- Eye protection must be appropriate for the type of hazard (e.g. chemical splash and vapors, impact hazards, lasers, ultra violet light).

Safety Glasses/Spectacles: Designed to protect against impact hazards. Additional PPE, such as face shields, are to be used simultaneously when working with chemicals.

When working with chemical substances which may result in eye contact in the form of splash, mists, vapors or fumes one of the following should be used:

Safety Goggles: Protect the eyes, eye sockets, and facial area surrounding the eyes from chemical hazards. They provide a seal around the eyes preventing entry under or around goggles. Safety goggles must be fitted to worker's face, poorly fitted goggles will not offer necessary protection.

- **Non-vented goggles** protect eyes from vapors, mists, fumes or other hazards. Eyes must be completely covered, but the material hazard does not require covering all exposed skin.

- **Vented goggles** protect from moderated quantities of liquids with no vapor or mist danger. Several types exist. For example, the common, hardware-store goggle has holes drilled into the plastic. This is unsuitable for laboratory work because liquids can get through the holes. Vented laboratory goggles have a series of buttons embedded into the plastic. These buttons house a baffle plate that allows air to pass but present a physical barrier to liquids.

Face Shields: Shield entire face from a range of hazards. Face shields are secondary protectors to be used in addition to primary protection such as safety glasses or goggles.

OSHA's Eye and Protection eTool can be used as an additional resource: https://www.osha.gov/etools

Chemical Segregation and Storage Table

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemical Types	Possible Reaction if Mixed/Health Concerns
Corrosive Acids-Organic 	• Acetic acid • Butyric acid • Trifluoroacetic acid • Propionic acid • Formic acid • Carbonic acid • Benzoic acid	• Store in ventilated corrosives cabinet on protected shelving using secondary containment, keep away from incompatible chemicals • Do not store under the sink • Do not store acids on metal shelving • See compatibility chart for storage	• Flammable liquids • Flammable solids • Bases • Oxidizers • Inorganic acids • Cyanides • Sulfides • Poisons/toxins	• Heat • Gas generation • Violent reaction • DO NOT POUR WATER INTO ACID • Causes skin burns • Respiratory distress • Use NIOSH approved gloves, eye protection, face shield and apron
Corrosive Acids-Inorganic 	• Nitric acid • Sulfuric acid • Phosphoric acid • Hydrochloric acid • Hydrofluoric acid	• Store concentrated nitric acid (≥68%) and sulfuric acid (≥93%) in a secondary container. Store in a corrosive cabinet labeled “Acid” or on shelving using a secondary containment • Do not store under the sink • Do not store acids on metal shelving • **Hydrofluoric acid (HF)** should only be handled by trained personnel as it requires extra handling precautions. Store in a secondary container. HF is a bone decalcifier.	• Flammable liquids • Flammable solids • Bases • Oxidizers • Organic acids • Cyanides • Sulfides • Poisons/toxins	• Heat • Gas generation • Violent reaction • DO NOT POUR WATER INTO ACID • Hydrofluoric acid can result in skin irritation and causes burns • Respiratory distress • Use NIOSH approved gloves, eye protection, face shield and apron
Corrosive Bases-Organic/Caustic 	• Hydroxylamine • Tetramethylethylamine • Diamine • Triethylamine • Proplylenediamine • Cuprietylenediamine solution • Dicyclohexylamine	• Store in separate cabinet preferably with ventilation, corrosive cabinet or storage area with a spill tray, away from potential water sources (DO NOT store under sink)	• Acids • Oxidizers • Flammable liquids/solids • Inorganic bases • Poisons/toxins • Amines are generally incompatible with isocyanates, halogenated organics, peroxides, acidic phenols, epoxides, anhydrides, and halides	• Heat • Gas generation • Violent reaction • Skin irritation and burn • Respiratory distress • Foul odor • Use NIOSH approved gloves, eye protection, face shield & apron
Corrosive Bases-Inorganic/Caustics 	• Ammonium hydroxide • Potassium hydroxide • Sodium hydroxide • Calcium hydroxide • Sodium hydroxide • Sodium hypochlorite solution (bleach) • Magnesium hydroxide	• Store in separate cabinet preferably with ventilation, corrosive cabinet or storage area with a spill tray, away from potential water sources (DO NOT store under the sink) • Store solutions of inorganic hydroxides in labeled polyethylene containers	• Acids • Oxidizers • Flammable liquids • Flammable solids • Organic bases • Poisons/toxins	• Heat • Gas generation • Violent reaction • Skin burn and irritation • Respiratory distress • Use NIOSH approved gloves, eye protection, face shield and apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemicals Types	Possible Reaction if Mixed/Health Concerns
Flammable Solids 	• Paraformaldehyde Phosphorus • Magnesium • Sulfur • Potassium sulphide • Naphthalene • Camphor	• Keep in a dry, cool area away from oxidizers and corrosives • Follow specific safety procedures • Conduct work on small scale if possible • Keep amounts on-hand to a minimum • Keep away from other flammables	• Acids • Bases • Oxidizers • Poisons/toxins	• Fire hazard • Violent reaction • Generates toxic fumes • Respiratory distress • Keep away from ignition & sparks • Ignites readily, burns fiercely • Use NIOSH approved gloves, eye protection, face shield and apron
Flammable Liquids 	• Ethanol • Ethyl acetate • Methanol • Acetone • Benzene • Xylene • Toluene • Diethyl ether • Tetrahydrofuran • Acetonitrile • Propanol • Gasoline	• Flammable storage cabinet or refrigerator rated for flammable/ hazardous storage/explosion proof • Peroxide-forming chemicals must be dated upon delivery and opening (two dates) ie., di-ethyl ether, tetrahydrofuran, furan, methyl butanol, methyl acetylene, heptanol, dioxanes, diglyme • Please consult NIH Chemical Hygiene Plan Peroxide Formers	• Oxidizers • Acids • Bases • Reactives • Poisons/toxins	• Fire hazard • Heat • Violent reaction • Watch for vapor mist • Causes eye and skin irritation • Keep away from ignition or sparks • Use NIOSH approved gloves, eye protection, face shield and apron
Toxic 	• Chloroform • Cyanides • Heavy metal compounds (e.g. Cadmium, Mercury, Osmium, Arsenic, Barium) • Formamide • Phenol • Carbon tetracholride • 2-Mercaptoethanol • Acrylamide • Ethidium bromide • Sodium azide solution	• Store in a dark, dry, ventilated, cool area in an unbreakable chemically resistant secondary container (polyethylene) • Store volatile toxic materials with evaporation rate above 1.0 - (ether =1.0) in flammable cabinet • Store non-volatile liquid poisons in a refrigerator or cabinet; amounts less than 1 liter can be stored in a cabinet above bench level, ONLY if the cabinet has sliding doors (not swinging) • Sodium azide, must be kept refrigerated	• Flammable liquids • Acids • Bases • Reactives • Oxidizers • Corrosives • Please consult Division of Environmental Protection (DEP) for assistance	• Generation of toxic and flammable gas • Combustible • Heat • Fire hazard • Explosion hazard • Violent reaction • Chloroform explosively reacts with chemically-reactive metals (e.g., aluminum or magnesium powder, sodium, and lithium), strong oxidizers, strong caustics (e.g., alkalis), and decomposes in sunlight • Some toxins are mutagenic and carcinogenic • Review your SDS before working with toxic material • Use NIOSH approved gloves, eye protection, face shield and apron
Explosives 	• Picric acid (dry) • Ammonium nitrate • Nitro urea • Trinitroaniline • Benzoyl peroxide (dry) • Trinitrobenzene • Trinitrobenzoic acid • Trinitrotoluene • Urea nitrate • Trinitrophenol • Diazoisbutylnitrile • Sodium azide (solid)	• Store in a secure location away from other chemicals; store in an area away from friction or shock • Store Picric acid in cool location or in a hazard rated fridge to prevent explosive crystallization • Storage regulations DO NOT apply to binary explosives until mixed. Consult Explosive Expert of DEP	• Please consult the SDS and the DEP • Explosives must be stored as "STAND ALONE." They must never be stored with any chemicals of any kind	• Explosion hazard • Violent reaction • Heat • Shock sensitive • Regular inspection may be required, to check for deposits or crystallization • Use spark proof tools • Use NIOSH approved gloves, eye protection, face shield and apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemicals Types	Possible Reaction if Mixed/Health Concerns
Oxidizers 	• Peroxides • Nitrates • Perchlorates • Permanganates • Sodium hypochlorite (solid) • Potassium dichromate • Chlorates • Chlorites • Chromates • Bromates • Superoxides	• Store in secondary containment separately from combustibles and flammable materials • May explosively decompose on shock, friction, or concussion • May EXPLODE ON HEATING, to form irritating toxic fumes and gases of Benzoic Acid and Carbon Monoxide. Its a strong oxidant and reacts violently with combustible, organic and inorganic acids, and reducing materials, causing fire and explosion hazard. Attacks some forms of plastics, rubber or coatings	• Combustibles • Flammables • Organic materials • Reducing agents	• Fire hazard • Gas generation • Toxic gas • Explosion hazard • Forms irritating toxic fumes • Use NIOSH approved gloves, eye protection, face shield & apron
Peroxide Formers 	• Acrylonitrile • Isopropyl alcohol • Ethers (e.g. diethyl ether, isopropyl ether) • Acetals and ketals, especially cyclic ethers and those with primary and/or secondary alkyl groups or aldehydes (e.g. acetaldehyde, benzaldehyde • Vinyl and vinylidene compounds • Dienes • tetrahydrofuran dioxane • Butylated hydroxytoluene (BHT)	• Store in airtight bottles, away from light and heat in a dark, cool dry area; avoid using containers with loose fitting lids and ground glass stoppers; crystallization, discoloration, and formation or deposition of layers are signs a peroxide former may have become shock sensitive; do not use or move such containers, contact DEP • All bottles of peroxide-forming chemicals must have the received date marked on the container; when the bottle is first opened, the container must be marked with the date opened	• Always consult the Safety Data Sheet (SDS) and the Division of Environmental Protection (DEP)	• Explosion hazard • Violent reaction • Shock sensitive • Combustion (exothermic reaction) • If an old or expired container of a peroxide-forming chemical or reactive is found, do not move it. Contact the DEP at 301-496-4710 for assistance in disposing of the container. • Use proper PPE • Use NIOSH approved gloves, eye protection, face shield & apron
Water Reactive 	• Sodium Metals • Lithium Metals • Potassium Metals • Sodium Borohydride • Alkali Metal Hydrides • Cesium Metal	• Store in a dry, cool area away from potential spray from fire sprinklers and other water sources (DO NOT store under the sink) • Label this area for water-reactive storage • Do not store with any other chemicals	• Aqueous solutions • Oxidizers • Please consult the Safety Data Sheet (SDS) and the Division of Environmental Protection (DEP)	• Heat evolution • Violent reaction when mix with water • Liberates hydrogen gas with water • Reacts violently with water • Use NIOSH approved gloves, eye protection, face shield and apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemicals Types	Possible Reaction if Mixed/Health Concerns
Flammable Compressed Gases 	• Methane • Acetylene • Butane • Propane • Hydrogen • Silane • Ethane • Arsine • Germane	• Handle flammable compressed gases in a chemical fume hood • Store in well-ventilated areas; store away from oxidizers, open flames, sparks, and other sources of heat ignition; post NO SMOKING signs around storage area(s) or entrance(s) to storage room(s); flammable gases stored outdoors where ambient temperatures exceed 125 degrees F (51.7 degrees C) shall be protected from direct sunlight • Must be secured in upright position, bonded or chained against the wall • Use a spark proof wrench to attach regulators and make other connections; install a flame/flash arrestor at the regulator outlet flow valve	• Oxidizers • Toxic compressed gases	• Fire hazard • Explosion hazard • Use NIOSH approved gloves, eye protection, face shield and apron • Wear safety shoes
Oxidizing Compressed Gases 	• Oxygen • Chlorine • Fluorine • Nitrogen oxides • Gas mixtures containing oxygen higher than atmospheric concentrations (above 23%)	• Store oxidizers separately from flammable gas containers or combustible materials; minimum separation requirement from these materials is 20 ft. or a 5 ft. noncombustible barrier with a fire resistance rating of at least 30 minutes • Must be secured in upright position, bonded or chained against the wall • Clean equipment used for Oxygen and Nitrous Oxide with Oxygen compatible materials free from oils, greases and other contaminants • Fluorine shall be handled in specially passivated containers and associated equipment	• Flammable compressed gases • Toxic compressed gases	• Fire hazard • Explosion hazard • Use NIOSH approved gloves, eye protection and apron • Wear safety shoes

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemicals Types	Possible Reaction if Mixed/Health Concerns
Toxic Compressed Gases 	• Carbon monoxide • Hydrogen dioxide • Arsenic • Pentafluoride • Boron tribromide • Bromine • Chlorine • Fluorine • Chloropicrin • Cyanogen	• Handle toxic compressed gases in a chemical fume hood • Must be secured in upright position, bonded or chained against the wall • Indoor storage or use of toxic compressed gases shall be provided with a gas cabinet, exhausted enclosure, or gas room • Refer to the SDS information for additional guidance on the storage and compatibility requirements • Contact DOHS to determine if a fail-safe valve and/or continuous monitoring for toxic gas may be required during use	• Flammable compressed gases • Oxidizing compressed gases • Please consult the specific SDS and DEP	• Release of toxic gas • Hydrogen sulfide is a colorless, flammable, extremely hazardous gas with a “rotten egg” smell; • Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep, or bronchial constriction in some asthma patients • Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness and slight conjunctivitis • Use NIOSH approved gloves, eye protection, face shield, & apron • Wear safety shoes
Carcinogens 	• Benzene • Benzadine • Methylene chloride • Carbon tetrachloride • Cadmium & compounds • Arsenic & compounds • Asbestos • Alfatoxins • Beryllium & compounds	• Label all containers as "Cancer Suspect Agents" or the equivalent • Store according to the hazardous nature of the chemical, using appropriate security when necessary	• Please consult the specific SDS and DEP	• Please consult the specific SDS and DEP • Use NIOSH approved gloves, eye protection, face shield, and apron
Teratogens 	• Tegretol • Aminopterin • Chlorobiphenyls • Coumarins • Tetracycline • Tapazole • Propylthioracil (PTU)	• Label all containers as "Suspect Reproductive Hazard" or “Reproductive Effecter” • Store according to the hazardous nature of the chemical, using appropriate security when necessary	• Aniline is incompatible with nitric acid and hydrogen peroxide • Please consult the specific SDS and DEP	• Please consult the specific SDS and DEP • Use NIOSH approved gloves, eye protection, face shield, and apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemicals Types	Possible Reaction if Mixed/Health Concerns
Flammable Aerosol Cans 	Pressurized Aerosol cans containing flammable liquid not limited to: • Acetone • Thinner • Toluene • Petroleum Distillates • Butyl Cellusolve • Xylenes • Methanol	Content under pressure: • Store at room temperatur; or store above 120°F • Do not use near heat, sparks and open flames • Always use secondary containers when storing with other chemicals	• See incompatibles for flammable liquids • Do not store with acids, oxidizers, toxic and reactive chemicals • Use secondary container with flat surfaces for stability	• Read instructions and usage as directed • Review SDS prior to use • Use NIOSH approve gloves or PPE. Rinse skin thoroughly with soap and water • Contact emergency services for severe skin impact or eye exposure • Use fire extinguisher in case of fire or dial 911
Non-Flammable-Corrosive-Toxic Aerosol Cans 	Pressurized aerosol cans **NOT** containing flammable liquid but not limited to corrosive or toxic carrier: • Ammonia • Sodium hydroxide • Sodium hypochlorite • Amines	Content under pressure: • Store at room temperature • Do not use near heat, sparks and open flames • Always use secondary containers when storing with other chemicals	• See incompatibles for corrosive acid, base and toxic items above • Use secondary container with flat surface for stability	• Read instructions and use as directed • Review SDS prior to use • Use NIOSH approve gloves or PPE. Rinse skin thoroughly with soap and water • Contact emergency services for severe skin impact or eye exposure • Use fire extinguisher in case of fire or dial 911

1. Adapted from Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Research Council, 2011.
2. Boston University Environmental Health and Safety. (2011) Chemical Segregation and Storage.
3. The University of Texas Health Science Center at Texas. (2022). Chemical Segregation & Incompatibilities Guidelines. Chemical Hygiene Plan.

Contact

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National Institutes of Health Resources

Division of Environmental Protection (DEP)
https://orf.od.nih.gov/AboutORF/Organization/Pages/dep_info.aspx
301-496-3537

Chemical Waste
https://orf.od.nih.gov/EnvironmentalProtection/WasteDisposal/Pages/chemicalwaste.aspx
Pick-up: 301-496-4710
Assistance: 301-496-7990

Radioactive Waste
https://orf.od.nih.gov/EnvironmentalProtection/WasteDisposal/Pages/radwaste.aspx
Pick-up: 301-496-4551
Assistance: 301-496-5774

Division of Fire Rescue Services (DFRS)
https://ors.od.nih.gov/ser/dfrs/Pages/default.aspx
Pick-up: 301-496-2372
Email: NIHFiredep-l@ors.od.nih.gov

Useful Websites

National Library of Medicine Gateway
https://www.nlm.nih.gov/

Agency for Toxic Substances and Disease Registry
https://www.atsdr.cdc.gov/

PUB CHEM
https://pubchem.ncbi.nlm.nih.gov/

NIOSH Pocket Guide to Chemical Hazards
https://www.cdc.gov/niosh/npg/default.html

OSHA Laboratory Standard – Safety & Health Topics
https://www.osha.gov/laboratories/standards

OSHA Hazardous & Toxic Substances
https://www.osha.gov/chemical-hazards/standards

Chemical Safety Board – Video on Lab Accidents, "Experimenting with Danger"
https://www.csb.gov/videos/experimenting-with-danger/

Argonne National Labs
https://www.anl.gov/

DrugBank
https://www.drugbank.com/

Sigma-Aldrich
https://www.sigmaaldrich.com/US/en

Physicians' Desk Reference (PDR) Health
https://www.pdr.net/

Chemical Compatibility Chart
https://www.ehs.harvard.edu/sites/ehs.harvard.edu/files/chemical_waste_chemical_compatibility_chart.pdf

NIH personal Property Management Guide
https://policymanual.nih.gov/26101-25-2/

Chemical Safety Guide, 5th Ed.

https://ors.od.nih.gov/sr/dohs/Documents/chemical-safety-guide.pdf