National Institutes of Health

Chemical Hygiene Plan

2026

Authored by the Division of Safety (DS) and the Occupational Safety and Health Committee (OSHC)

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ACRONYMS

ABSL	Animal Biosafety Level
ACGIH	American Conference of Governmental Industrial Hygienists
ACS	American Cancer Society
ACUC	Animal Care and Use Committee
ANSI	American National Standards Institute
BSC	Biological Safety Cabinet
CFH	Chemical Fume Hood
CFR	Code of Federal Regulations
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
DEP	Division of Environmental Protection
DS	Division of Safety
DRS	Division of Radiation Safety
EPA	Environmental Protection Agency
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
IARC	International Agency for Research on Cancer
ICO	Institutes/Centers/Offices
LD50	Lethal Dose 50%
LEV	Local Exhaust Ventilation Systems
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OACU	Office of Animal Care and Use
OMS	Occupational Medical Service
ORF	Office of Research Facilities (Development and Operations)
ORS	Office of Research Services
OSHA	Occupational Safety and Health Administration
OSHC	Occupational Safety and Health Committee
PEL	Permissible Exposure Limit
PI	Principal Investigator
PHS	Particularly Hazardous Substance
PPE	Personal Protective Equipment
SD	Scientific Director
SDS	Safety Data Sheet
IHCSB	Industrial Hygiene and Campus Safety Branch
TLV	Threshold Limit Value published by
TWA	Time Weighted Average

INTRODUCTION

Handling hazardous chemicals can pose a variety of known and potential risks for workers in research and diagnostic laboratories at NIH. To mitigate the risk of adverse effects to workers, the Occupational Safety and Health Administration (OSHA) has promulgated a Code of Federal Regulations (CFR) standard entitled *Occupational Exposures to Hazardous Chemicals in Laboratories* (29 CFR 1910.1450), referred to as the Laboratory Standard.

This regulation applies to laboratories which are defined by OSHA as a facility where relatively small quantities of hazardous chemicals are used on a non-production basis. This standard supersedes the provisions of all other OSHA health standards found in 1910 Subpart Z, with the following exceptions: for the permissible exposure limits (PELs) and substance-specific limits found within the OSHA *Air Contaminants Standard* (29 CFR 1910.1000) in Subpart Z, *Toxic and Hazardous Substances* as well as the prohibition of eye and skin contact where specified by any OSHA health standard. The Laboratory Standard requires the development and implementation of a formal, written, and employee-accessible program, referred to as a Chemical Hygiene Plan (CHP). This plan, when implemented, must be "capable of reducing employee exposure to health and physical hazards associated with chemicals used in the laboratory."

I. PURPOSE

To establish a formal written program that includes processes to acknowledge and communicate occupational risks, define prudent work practices, and provide resources to support the safety and wellbeing of personnel who handle and work with chemicals at NIH laboratories.

II. SCOPE

This plan applies to all personnel who use, store, and handle hazardous chemicals in the laboratories at the NIH. This is inclusive of any laboratories within the animal facilities. The scope excludes other services, e.g., contract laboratories, animal care, environmental services, or pharmacies, that handle hazardous chemicals.

III. RESPONSIBILITIES

The **NIH Occupational Safety and Health Committee** (OSHC) annually reviews and evaluates the effectiveness of the CHP and updates the plan as necessary.

The **Chemical Hygiene Officer (CHO)** provides technical guidance in the development and implementation of the Chemical Hygiene Plan. CHO serves as technical resource to laboratories, when requested assist with obtaining Safety Data Sheets (SDSs), works with personnel to assess risk of adverse exposure, arrange for exposure monitoring, and implement the CHP. The CHO is also responsible for working with OCHC to review and update the CHP annually.

The **Division of Safety (DS)** oversees and develops programs focusing on laboratory safety and the proper handling of chemicals to ensure compliance with NIH Manual Chapter 3034 (https://policymanual.nih.gov/3034) and the OSHA General Industry Standard (29 CFR 1910), which includes the Laboratory Standard. The DS branches assist with compliance. In addition to assisting and overseeing adherence to OSHA regulations, the DS is responsible for communicating any pertinent updates to the CHP to the stakeholder. The DS is responsible for conducting surveys of laboratories, at least annually, to identify practices or procedures that may pose potential hazards to the health and safety of personnel. The DS will collaborate with the IC Safety Chair and their committee on these surveys and will ensure IC participation as requested.

The **DS Industrial Hygiene and Campus Safety Branch (IHCSB)** provide direction and guidance on the proper selection, use, and functioning of protective equipment. They also oversee a comprehensive testing and certification program for engineering controls and provide exposure monitoring to measure and evaluate employee exposure to hazardous substances, and physical agents (like noise) within their work environment.

The **DS Research Safety Branch (RSB)** assists laboratory personnel in each Institute and Center (IC) in matters related to chemical safety and exposure monitoring. Upon request, they assist laboratories in conducting risk assessments for work involving hazardous chemicals to recommend appropriate exposure controls measures.

The Division of Occupational Medical Services (**DOMS), Occupational Medical services (OMS)** provides consultation and appropriate prophylactic or medical treatment in the case of exposure to hazardous substances. OMS provides medical surveillance when chemical exposure monitoring data reveals exposure at or above the action level for an OSHA regulated substance.

They are also responsible for overseeing the medical monitoring of employees and retention of employee medical records.

The **Office of Research Facilities (ORF) Division of Environmental Protection** (DEP) provides technical support and guidance in the proper packaging, labeling and temporary storage of laboratory waste. They oversee all NIH non-radioactive chemical, medical pathological, and solid waste handling, treatment, and disposal activities, monitor NIH activities for compliance with federal, state, and local environmental regulations and the impact of those activities on the environment. They also provide guidance on the recommended use of less hazardous chemical alternatives that may still achieve the desired efficacy in specific protocols.

The **ORF Division of Facilities, Operations, and Maintenance (DFOM) Facility Managers** serve as a liaison for directing laboratory staff towards resources for resolving facility issues, including issues with building engineering controls, such as chemical fume hoods, biosafety cabinets and general laboratory ventilation. DFOM is responsible for directing laboratory concerns about structural and mechanical issues to the appropriate ORF resources for corrective action.

Within DFOM maintenance personnel are responsible for conducting repairs to chemical fume hoods, safety showers, and general laboratory ventilation equipment and must be familiar with the signage regarding lab status and clearance stickers.

The DFOM Section Chief Shutdown Coordinator is responsible for notifying affected building occupants of utilities shutdowns.

The **Office of Animal Care and Use (OACU)** is responsible for notifying the IC **Animal Care and Use Committees (ACUCs)** when the CHP has been updated.

The **Scientific Director (SD)** of each **Institute/Center (IC)** is responsible for implementing and overseeing the CHP within their organization, which includes membership assignment of the Institute's safety committee. In some scenarios this responsibility may fall to the Clinical Director.

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The **Principal Investigator (PI)**, or their designee, is responsible for chemical hygiene in the laboratory. This person is responsible for ensuring all personnel under his/her direction know and follow the CHP rules and possess the requisite knowledge, training, education, and competency to handle hazardous chemicals in the laboratory in a safe and prudent manner. They are also responsible for making relevant reference materials and the Chemical Hygiene Plan available to personnel under their supervision. To demonstrate employee competency, training must be documented. A supervisors' safety review checklist for the purpose of documenting training is provided in Appendix J.

Laboratory personnel are responsible for planning and conducting each operation in accordance with prudent and hygienic work practices and procedures including the use of engineering controls, administrative controls, and PPE as appropriate. They should also acknowledge and communicate risks to coworkers and visitors and strictly adhere to procedures and policies for handling hazardous chemicals as described in the CHP. This includes reporting incidents and known or suspected chemical exposures promptly to their supervisor and OMS, and correctly segregating, packaging and labeling hazardous waste for disposal according to proper procedures listed in the NIH Waste Disposal Guide.

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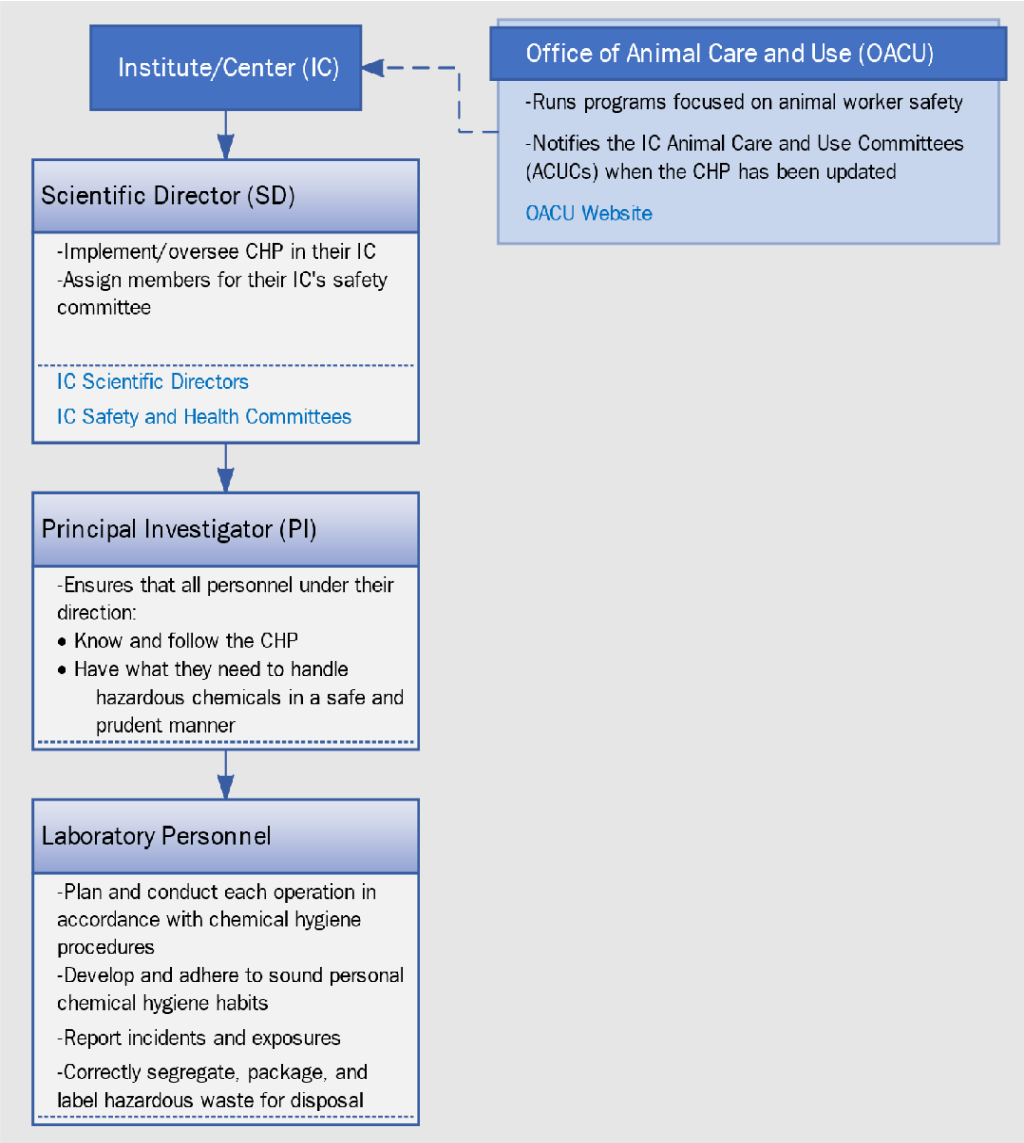

Figure 1. Overview of Responsibilities (IC level). This chart outlines the responsibilities related to the Chemical Hygiene Plan of the Office of Animal Care and Use, the Institute/Center, the Scientific Director, the Principal Investigator, and Laboratory Personnel.

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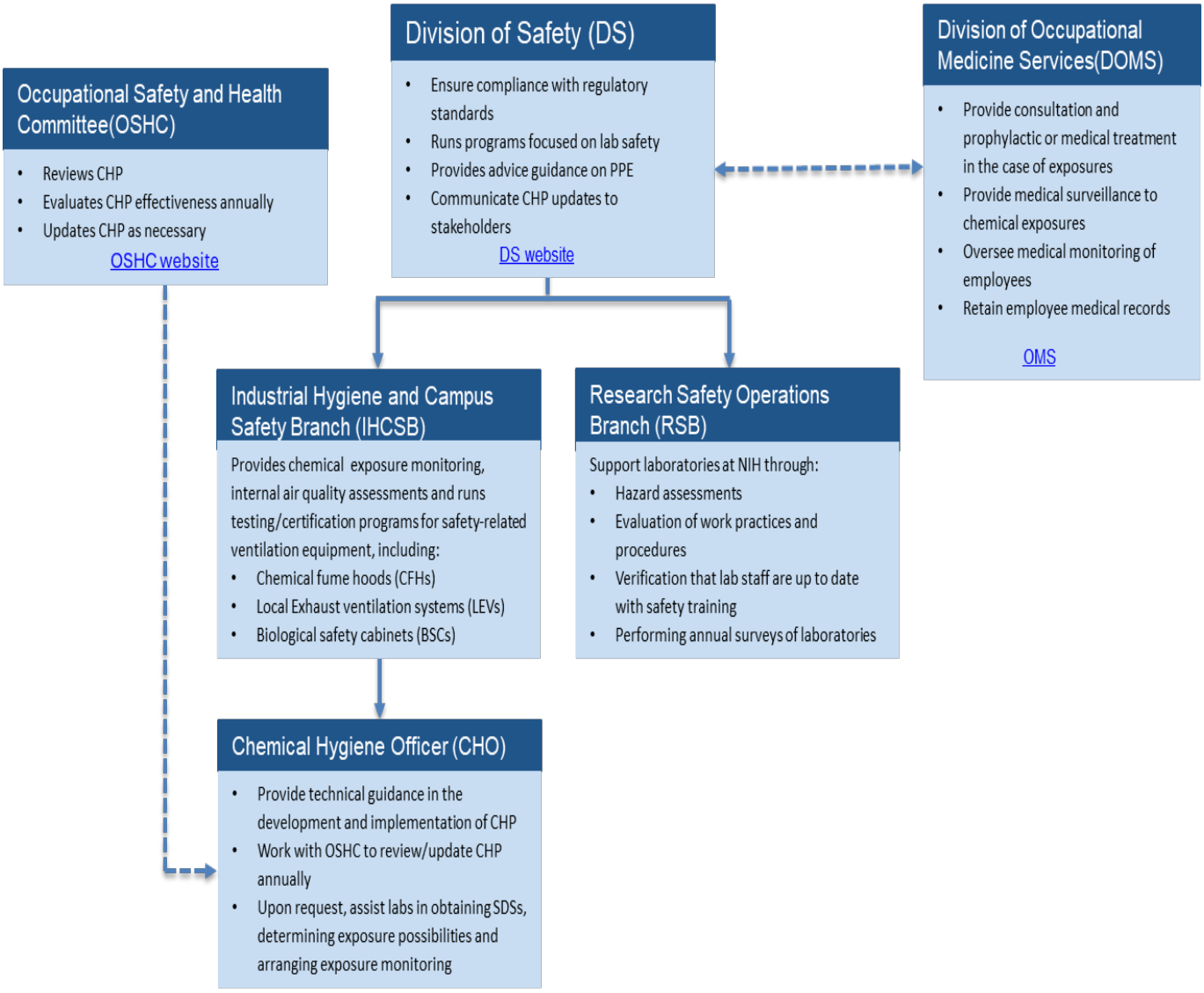

Figure 2. Overview of responsibilities (DS level). This chart outlines the responsibilities related to the Chemical Hygiene Plan of the Occupational Safety and Health Committee, the Division of Safety (DS), the DS Industrial Hygiene and Campus Safety Branch, the Chemical Hygiene Officer, the DS Research Safety Branch, and the Occupational Medicine Services.

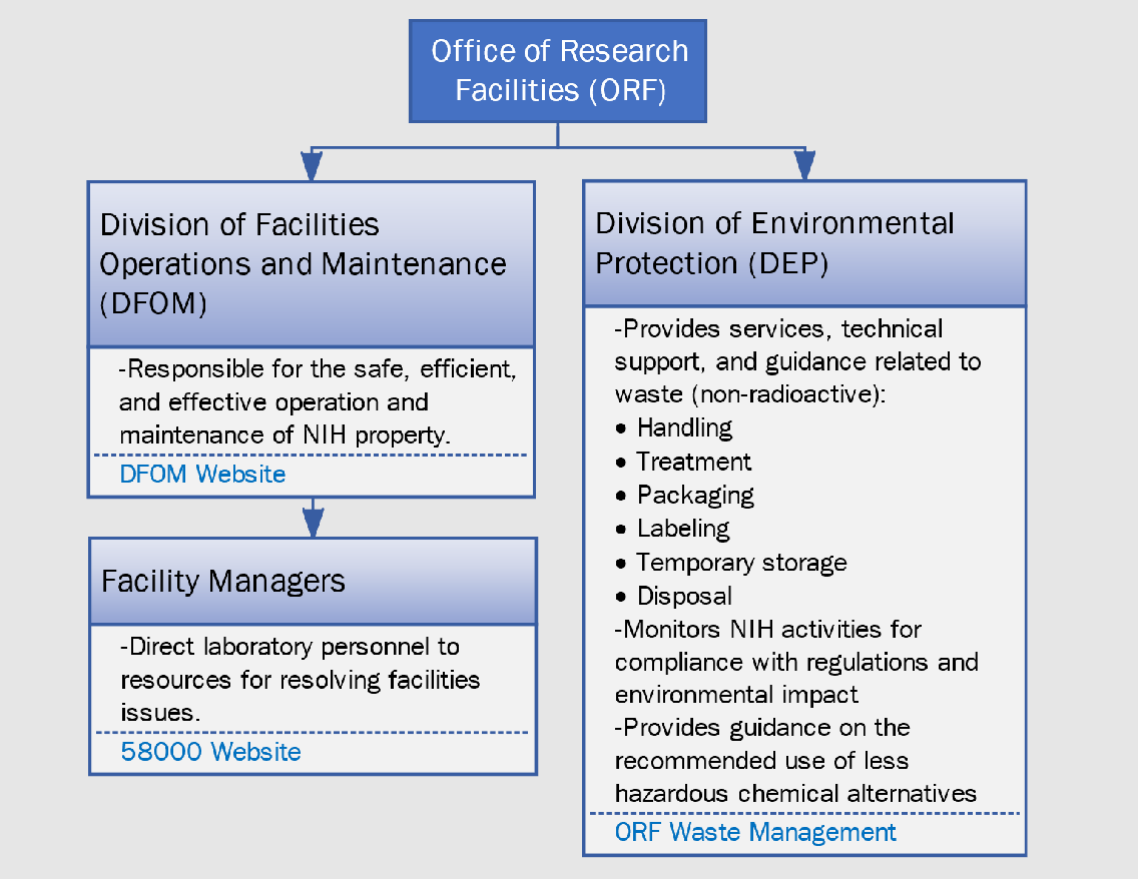

Figure 3. Overview of responsibilities (ORF level). This chart outlines the responsibilities, as related to the Chemical Hygiene Plan, of the Office of Research Facilities (ORF), the ORF Division of Facilities Operations and Maintenance, and the ORF Division of Environmental Protection.

IV. TRAINING

All staff working in laboratories must be trained and acknowledge the risks and controls for handling hazardous chemicals. Workers must be aware of the hazards present in their work area, safety requirements, how to properly utilize engineering and administrative controls, and the selection and use of PPE necessary to minimize their risk of adverse exposure or contamination of the environment. This information must be provided by their PI, supervisor, or Program Manager at the time of initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. Employees must be trained in the applicable details of their individual laboratory's written safety procedures. Appendix C outlines the requirements for employee training under the Laboratory Standard, 29 CFR 1910.1450.

DS provides basic safety training and information for laboratory personnel. Three training courses that address chemical hazards in the laboratory, as well as additional

guidance in identifying chemicals of concern, are available. PIs are responsible for conducting or arranging appropriate hazard-specific training applicable to the processes in use. To see a list of training offered by DS, visit the DS Training website.

A web-based training course, "Introduction to Laboratory Safety," covers basic laboratory safety and NIH policies and practices regarding safe conduct in NIH research laboratories. This course introduces laboratory personnel to risk management and common hazards/exposure risks; including chemical, biological, radiological, and physical hazards that are found in NIH research laboratories. All laboratory personnel, including PIs, must complete this course upon arrival at the NIH.

An annual web-based refresher course providing updates for safety procedures and policies that govern laboratory safety at the NIH titled "Laboratory Safety Refresher Course" is required of all NIH laboratory personnel, including PIs, summer students and summer research associates.

For additional information on laboratory safety training, contact the DS on 301- 496-3353 or visit the website.

V. LABELS AND SAFETY DATA SHEETS

Manufacturers are required to prepare and provide Safety Data sheets (SDS) for chemicals with hazardous properties. SDS for all hazardous chemicals used in a work area must be readily available to employees. Many vendors have SDS online and there are a variety of subscriptions and free collections of SDS to consult. Additional safety information should be reviewed before beginning work with new materials or a new process. The NIH Library can assist with safety information, including PubChem and PubMed which are valuable reference tools available through the National Library of Medicine. The DS is also available to assist workers with risk assessments.

Chemicals purchased from a manufacturer must be labeled properly in compliance with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Commercial labels must state the name of the chemical, signal words, pictograms, precautionary statements, and appropriate hazard statements. The universal pictograms for depicting chemical hazards are shown in Figure 4. Any chemical container with missing information should have the necessary additional information added without obscuring or removing any of the manufacturer's key label information. If a chemical or mixture is transferred into a different/secondary container, the complete name of the chemical/mixture and any associated hazards must also be placed on each new container. If a chemical is stored within secondary containment obscuring the original container label, the secondary containment must also be clearly labeled with the contents and hazards, GHS secondary container and containment labels are available for laboratory use from the NIH Store. See the Chemical Safety Guide for more information on GHS.

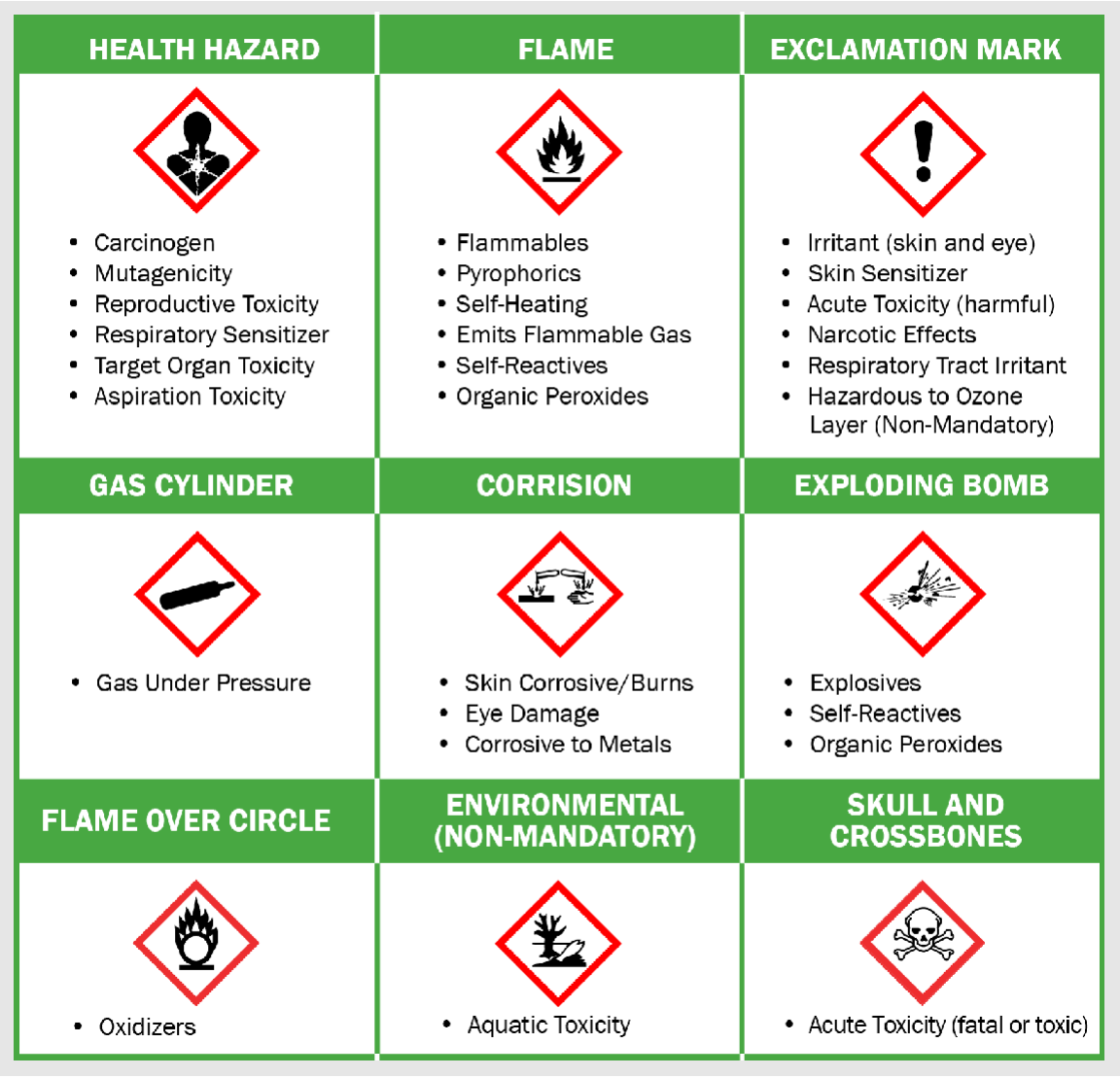

Figure 4. Universal pictograms for depicting chemical hazards. The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) requires the use of pictograms to alert users of the chemical hazards to which they may be exposed. The pictograms consist of a symbol which represents a distinct hazard on a white background, framed by a red diamond border.

Any laboratory prepared solution must be labeled with the chemical name (full name) and hazard warning(s). Containers, such as beakers and flasks left unattended, must have appropriate hazard warnings, date and the preparer's name/initials and expiration date if applicable. If a chemical is not commercially marketed, (*i.e.*, investigational) or is formulated in the laboratory and it is known or suspected to be hazardous, then appropriate labeling must be used, and employees need to be trained in the hazards and appropriate protective measures.

If a chemical or byproduct's hazard status is unknown, it shall be assumed that the substance is as hazardous as its most hazardous component. If the chemical is produced for use by others outside the producing laboratory, then the Hazard Communication Standard applies, including the requirement for labeling and preparing an SDS. Contact your IC Safety Specialist for additional guidance.

Laboratory personnel must be trained in the hazards of the chemicals they handle. Chemical SDS should be used when determining the hazards of working with the chemical and when generating standard operating procedures (SOPs). A SOP template is available in Appendix L. This template can be used for describing lab-specific procedures in which hazardous chemicals are used, and provides space to document the hazard summary, storage requirements, step-by-step operating procedure, emergency procedure, waste disposal, and training requirements for individuals following the SOP. For SOP templates for work involving Particularly Hazardous Substances (PHS), review Sections X, and Appendix B.

OSHA's 2024 Final Rule to Amend the Hazard Communication Standard

To maintain compliance with the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (29 CFR 1910.1200), as amended by the HAZCOM 2024 Final Rule, the NIH Hazard Communication Program is updated to incorporate the revised requirements aligned with the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS), Revision 7.

Some of the HAZCOM requirements, including chemical labeling, Safety Data Sheets (SDSs), and employee training—are incorporated into OSHA Laboratory Standard (29 CFR 1910.1450), which governs the safe use of hazardous chemicals in laboratories.

Although the HAZCOM 2024 Final Rule primarily applies to chemical manufacturers, importers, and distributors, NIH laboratories and workplaces must implement the updated requirements for revised labels, Safety Data Sheets (SDSs) and training.

Principal Investigators (PIs) and supervisors are responsible for:

- Verifying that newly procured small containers of hazardous chemicals are received with OSHA-compliant labels and ensuring that hazardous chemicals used or stored within their work areas are maintained in containers that are labeled in accordance with OSHA Hazard Communication requirements.
- Ensuring that outdated SDSs are replaced with revised 2024 HAZCOM compliant versions and are readily accessible to employees during each work shift.
- Ensuring that employees who work with or may be exposed to hazardous chemicals receive the required Hazard Communication update training.

The Division of Safety is responsible for:

- Updating the NIH Hazard Communication Program, guidance documents, and mandatory Hazard Communication update training, as appropriate, to reflect the requirements of the 2024 HAZCOM Final Rule.
- Providing guidance to NIH Institutes and Centers on implementation of the revised hazard classification, labeling, and Safety Data Sheet requirements.

VI. CHEMICAL TRANSPORTATION

Transportation of hazardous materials and compressed gas cylinders may present risk to building occupants and property. Laboratory areas have special design features that enable proper control of these materials that may be absent when transporting materials in public corridors or on elevators. Use freight elevators for the transport of hazardous materials. If you must use a passenger elevator, never ride with passengers, and for compressed gases have one person waiting at the elevator doors while the other person sends the cylinders on the elevator.
The following measures shall be taken to reduce the risk of an incident during transport:

a. Assess chemicals prior to moving to ensure that they are in good condition, properly sealed, and labels are well attached. Any chemical with signs of crystallization or other degradation should not be moved, contact your DS Safety Specialist.

b. Hazardous chemicals being transported outside the laboratory or between stockrooms and laboratories must be in break-resistant secondary containment, placed in a suitable outside container or bucket, or in carts specifically designed for safe transportation.

c. Personal protective equipment (PPE) should not be worn when transporting chemicals between floors, or outside a building. PPE may be left on when transporting materials between labs in the same corridor. To prevent the possibility of contamination spreading, either use no gloves or leave one clean hand exposed.

d. Compressed gas cylinders must always be strapped in a cylinder cart with the valve protected by a cylinder cap.

e. The NIH Policy Manual Chapter 26101-42-F "Shipping Policies & Procedures," should be consulted for further reference.

VII. CONTROL OF EXPOSURE TO HAZARDOUS CHEMICALS

Hazardous chemicals may be used only in laboratory facilities specifically designed, constructed, and maintained for such work. Hazardous chemicals may not be used in areas, including but not limited to offices, cold rooms, storage rooms, and other areas lacking the appropriate facilities and a proper means of ventilation.

Chemical exposures are minimized using engineering, administrative/work practice controls, and personal protective equipment (PPE), in that order. Employees must wear appropriate PPE (*e.g.*, respirator) when engineering and administrative controls are insufficient to contain the hazard or if there is potential for exposure. See Appendix F for guidance on selection of PPE.

Elimination/Substitution Controls:

a. Elimination is the complete removal of a hazardous chemical from a process or activity; and

b. Substitution is the replacement of the original hazardous chemical with a less hazardous chemical that can provide the desired results.

Engineering Controls:

a. Chemical Fume Hoods (CFH) and other Local Exhaust Ventilation (LEV) options, such as down draft tables and slot hoods, are the most common engineering control used in the laboratories to minimize exposure to hazardous chemicals. A CFH provides ventilation to carry away airborne contaminants and chemical vapors and exhaust them outside of the building. The sash of the fume hood provides shielding to protect the user and may also provide some containment for small fires and explosions. All CFH and LEV used at the NIH must meet the NIH design specifications. ICs may purchase CFH only through ORF. DS reviews all renovation plans affecting ventilation as required, per the NIH Design Requirements Manual (DRM);

b. Any alteration affecting CFH and LEV or associated ductwork must be approved by DS prior to the system's modification. Meeting design specifications alone does NOT ensure the proper functioning of the CFH or LEV devices. The CFH must be tested yearly for proper functioning. Laboratories must work closely with DS and ORF to ensure safe operation of all ventilation equipment. Contact the ORF DFOM for facility-related inquiries;

c. Ductless CFHs are not permitted to be used in NIH laboratories;

d. Conduct all work within the chemical fume hood (CFH) at a distance of at least six inches behind the face opening and position the vertical sash no higher than the height specified on the certification sticker. Avoid blocking the airfoil, baffles, and rear ventilation slot. Raise large items by 6 inches on platforms or shelves with legs above the ventilation slot to minimize airflow disruption across the work surface.

e. Minimize foot traffic around the CFH during use. Movement around the hood during operation can disrupt the airflow and may pull contaminants out of the hood.

f. Do not use the CFH for storage.

g. CFH equipped with alarms will alarm when the speed and volume of air moving through the hood falls outside of the set parameters. It is prudent to verify CFH pulling air inwards before each use by holding a tissue at the bottom edge of the sash and observing that the tissue flutters strongly into the cabinet. If a unit is in alarm mode or if the "tissue test" fails, mark the unit as "Do Not Use," and submit a work request to ORF. Contact DS to recertify the CFH prior to reuse, or if there is question about the function of the CFH; and

h. Biological Safety Cabinets (BSCs, also known as biosafety cabinets) are an important engineering control commonly found in NIH facilities. Their purpose is to serve as the primary means of containment for work involving infectious microorganisms, biological materials, and prions. The filters within these cabinets do not trap vapors or the chemicals. As their names suggest, BSCs are not interchangeable with CFH, as each is designed and functions in accordance with their respective primary purpose. However, biomedical research can require the use of small amounts of toxic and or volatile chemicals. Before using chemicals in a BSC, consult the Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Appendix A for further guidance on biosafety cabinet characteristics, which compares classes of BSCs with notes on nonvolatile and volatile chemical use. When in doubt, consult your safety specialist for guidance and do not use chemicals within a recirculating air BSC until you are sure it is safe to do so.

For additional information on how to use, recertify and clean CFH, refer to the DS Chemical Safety and DS Primary Barrier Programs pages.

Work Practice Controls:

a. Read the SDS and become familiar with the chemical characteristics, hazards, and exposure limits before using a chemical;
b. Maintain a chemical inventory;
    i. DS recommends using LabArchives for chemical inventory. As of June 30, 2024, NIH IRP Investigators are required to use electronic resources to document new and ongoing research. One of the platforms available to researchers is LabArchives and 75% of PIs are enrolled in this program. LabArchives has a chemical inventory module that is available to all enrollees. This feature allows users to organize, manage and track chemicals including ordering and usage of each chemical. When adding a chemical LabArchives can automatically populate basic information like name, molecular weight, formula etc. and important safety information, including hazards and pictograms.
    ii. PIs are required to have accurate inventories of PHS present in that

lab and DS recommends PIs to use LabArchives to create chemical inventories to ensure the safety and security of chemicals used at NIH. DS has created a "how to use guide" to help the researchers to set-up the inventory. Laboratories with existing inventories can easily import the inventory to LabArchives using the bulk import option.

c. Keep work area clean and uncluttered, with chemicals labeled with complete and accurate names and hazards and stored properly based on chemical compatibility (Appendix D);

d. Vacuum lines shall be protected at the point of use, (*e.g.*, with an absorbent or liquid trap), to prevent entry of any material into the system. These systems are not appropriate for use with gases, combustible, flammable, or toxic materials and are designed for use with aqueous solutions only. There are specially designed vacuum systems available for use with hazardous chemicals;

e. Use a certified CFH or other appropriate engineering control when opening, transferring, or handling volatile hazardous chemicals;

f. Never store/consume food, beverages, or medications in the laboratory; never store and apply cosmetics in the laboratory.

g. Keep all doors to the laboratory closed to ensure negative room pressure to the corridor and proper air flow into the hood. Open laboratory doors can adversely affect CFH performance and appropriate air flow through the building.

h. Never pipette by mouth;

i. Transport laboratory chemicals using bottle carriers and suitable carts;

j. Follow the established procedures for the decontamination and safe movement of scientific and medical equipment;

k. In the event of a hazardous chemical spill, immediately call 911 (landline) or (301) 496-9911 (cell phone) and follow additional procedures listed in Spill in the Laboratory and Appendix H;

l. Ensure unimpeded access to all emergency laboratory equipment such as fire extinguishers, chemical spill kits, safety showers, and eyewash stations.

m. Minimize all chemical exposures and avoid underestimating the risk, always assume that any mixture of chemicals will be more hazardous than the most hazardous component. Avoid unnecessary exposure to chemicals by any route of exposure;

n. When diluting a concentrated acid or base, always add the acid or base to the water;

o. Handle glassware properly and carefully. Do not use damaged glassware, inspect glassware prior to use for fractures, chips, or cracks. Use extra care with Dewar flasks and other glass apparatuses intended for use with vacuum or pressure. Consider shielding or wrapping them to help contain chemicals and fragments should implosion or explosion occur. Use a designated container when disposing of broken glass; however, debris contaminated with chemicals shall be handled as chemical waste;

p. Any hazardous operations or procedures conducted alone should be discussed and approved by the PI. If it is not possible to have someone working with you, inform someone outside the lab and ask to be checked on at regular intervals;

q. If the laboratory is unattended while working with hazardous chemicals, then place an appropriate sign on the door, briefly stating the nature of the experiment, contact person, and phone number. Provide for the containment of substances in the event of failure of engineering control such as a fume hood or utility service;

r. Laboratory personnel flush eyewash stations weekly and document the date and initials of the individual who performed the test, following the NIH Policy on Emergency Eyewash Stations and Safety Showers. See the DS eyewash inspection sheet, which may be used as a template. ORF tests emergency safety showers annually and documents the date and initials of the individual who performed the test. If any test of a safety device fails, submit a work request to ORF to repair the unit;

s. The PI/supervisor or their designee should maintain proper oversight of inexperienced personnel working with hazardous substances – see NIH Policy Manual Chapter 3015 – "Admittance of Minors to Hazardous Areas";

t. Contact DS (301-496-2346) for clearance of the workspace when non-laboratory personnel must enter laboratories to perform required services (e.g., renovation or maintenance). Remove hazardous materials from equipment/facilities to be serviced and forewarn personnel of the need for protective equipment or work practices required. Decontaminate the equipment when possible. Ensure that repair and maintenance personnel have access to the appropriate personal protective equipment and have been trained in its use by their employer; and

Do not use or store hazardous chemicals, dry ice, or compressed gas in cold rooms and warm rooms due to inadequate ventilation and risk of asphyxiation. Contact your IC Safety Specialist at 301-496-2346 for assistance when a concern arises over potential exposure to a laboratory chemical. Specialized monitoring and chemical exposure determination is available from the DS.

The National Research Council publication "Prudent Practices in the Laboratory" is a very good resource on the handling and management of chemical hazards.

VIII. PERSONAL PROTECTIVE EQUIPMENT

NIH Policy Manual Chapter 1340, Appendix 1 has clear directions on minimal clothing attire and required personal protective equipment for work in NIH laboratories. Appropriate PPE is essential for worker protection and is used in combination with safe work practices and engineering controls such as CFH. PPE alone does not provide adequate exposure control of hazardous chemicals but is an effective method to reduce exposure if engineering and administrative controls cannot adequately minimize the risk. The IC Safety Specialist can assist the PI or researchers in performing Laboratory Hazard Analysis to identify hazards that are present, or likely to be present, during a particular operation. The Safety Specialist will provide information and guidance on proper engineering and administrative controls and selection and use of appropriate PPE. Information on the selection and use of PPE is also presented in the NIH Laboratory Safety training courses. Appendix F contains information to help choose

appropriate types of PPE. The PI/supervisor is responsible for training employees under their supervision on proper selection, use, and maintenance of PPE.

Various types of PPE, including chemical resistant gloves, lab coats, aprons, eye and face protection, etc., are available from the NIH Self Service Stores and numerous vendors. Consult the NIH Supply Catalog or call your IC Safety Specialist for additional advice (301-496-2346).

Disposable PPE that becomes visibly damaged, contaminated, or is suspected of being contaminated with hazardous materials must be replaced as soon as possible. PPE contaminated with hazardous materials must be disposed of in accordance with the NIH Waste Disposal Guide.

Gloves: Disposable gloves are one of the most used types of PPE in the laboratory. The proper use of disposable gloves provides protection for the wearer by providing a barrier to potential hazards. Gloves also provide product protection by protecting experimental materials from enzymes or DNA on the wearer's hands. Select the correct glove for the task (see Appendix F). Not all gloves afford appropriate chemical protection, and no single type of glove protects against all chemicals. All laboratory personnel are responsible for following the appropriate work practices when using disposable gloves.

- Remove your gloves carefully to avoid contacting the outside of the glove with bare skin; thoroughly wash your hands and forearms upon completion of work and before leaving the laboratory. Do not reuse disposable gloves;

- Gloves must not be worn in common-use areas, outside laboratory rooms, animal holding rooms, or procedure areas. Common areas include but are not limited to elevators, rest rooms, break rooms and corridors;

- Some types of gloves are reusable. These gloves should be cleaned after each use and inspected prior to each use and replaced as necessary; and
- Consideration of size and comfort is important for the use of both disposable and reusable gloves. Proper size will ensure dexterity and maintain glove integrity while providing comfort to encourage continued use by the wearer.

Protective Garments: Protect clothes and exposed skin by wearing laboratory coats and gowns. Open-toed shoes, sandals, shorts, and other apparel that leave skin exposed are not permitted to wear in any laboratory. Laboratory coats or other protective garments are required to be worn when working with hazardous materials in the laboratory. This practice will help reduce exposures to hazardous materials in the laboratory by covering personal clothing and exposed skin. Remove laboratory coats before leaving the laboratory to prevent the spread of contamination outside of the laboratory. Never take reusable laboratory coats home for laundering.

Eye and Face Protection: Safety glasses provide protection for the eyes from flying objects. Safety goggles and a face shield must be worn to protect the face and eyes if there is a potential for a hazardous chemical splash.

Non-prescription safety glasses/goggles may be obtained from third party vendors. Styles should be selected which fit snugly to the user's face. All eye protection must meet requirements of American National Standards Institute (ANSI) Z87.1.

Respiratory Protection: To assure workers have the correct fit and type for the hazard, respirators including N95 should not be purchased, and/or used without prior approval by the

DS. Laboratory supervisors are not authorized to select or recommend the use of respiratory protection, regardless of the type. Dust masks and surgical masks are not appropriate for protection against chemical exposures. Special filtering face-pieces are required for chemical vapors, gases, and mists. Call your IC Safety Specialist for a consultation when there is a risk of inhalation of a chemical or particulate at your worksite. It is the policy of the NIH to provide respiratory protection at no cost to the employee when:

- The substitution of the chemicals that present respiratory hazards with less hazardous chemicals is not feasible;
- The best available engineering controls fail to adequately reduce employee exposure to respiratory hazards; or
- When modification of hazardous operations fails to reduce exposures to below acceptable levels.

NIH abides by the OSHA Respiratory Protection Standard. The DS is responsible for ensuring compliance with the standard and assisting workers exposure assessments and respiratory protection. OMS provides medical clearance prior to issuance or use of a respirator. Refer to the DS webpage on Respiratory Protection for more information

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IX. CHEMICAL STEWARDSHIP

The prudent selection, purchase, and use of chemicals in the laboratory and the liabilities and costs of transfer, treatment, and/or disposal of chemical wastes are inextricably linked. The American Chemical Society found that the cost of chemical waste disposal at a licensed permitted facility is on average ten times the original purchase price.
Minimizing the NIH's costs and liabilities associated with hazardous waste disposal can be achieved by adhering to the following measures:

u. Order chemicals in the least amount needed to perform the work;

v. Request an assessment of your hazardous waste stream from the DEP. Both the Division of Radiation Safety (DRS) and DEP have restrictions on how to collect and label waste. If mixing a hazardous agent with "diluent," the entire container may now be considered a hazardous waste. Appendix D contains guidelines on the safe storage of chemicals in the laboratory; and

w. Participate in DEP implemented Recycling and Toxic Chemical Reduction Initiative Programs like Surplus Chemical Redistribution Recycling Program for the Bethesda main campus.

X. WORKING WITH PARTICULARLY HAZARDOUS SUBSTANCES (PHS)

PHS includes select carcinogens, reproductive toxins and chemicals that have a high degree of acute toxicity. Substance-specific information is contained in each chemical's SDS (GHS pictograms and hazard statements). Appendix B contains a reference list of suggested PHSs, and those for which OSHA has specific standards. This list is not comprehensive but represents chemicals of concern that may be found in laboratories.

The Industrial Hygiene and Campus Safety Branch (IHCSB) of DS has established surveillance programs that monitor for exposure to certain chemicals such as formaldehyde, ethylene oxide, xylene, dichloromethane, and others. Contact DS IHCSB (301-496-3353) for details on the surveillance program and to discuss if your lab should be monitored. Additionally, OMS has medical surveillance programs when using some hazardous chemicals. For more information contact your IC Safety Specialist.

The PI is responsible for ensuring that all PHS used in the lab are identified, that appropriate precautions are taken by laboratory workers when working with PHS and that appropriate training and developed SOPs are provided before working with these materials. For guidance on how to identify PHS, manage PHS in the lab, develop SOPs and understand specific work practices for PHS refer to Appendix B. These chemicals should be stored in secondary containment and should only be opened in the CFH when needed and stored in marked cabinets when not in use.

When a PHS is used for the first time, the PI must also notify their safety specialist of its use. The PI must develop a lab-specific SOP based on a hazard analysis. Use the specific chemical hazard analysis template found in Appendix I and a lab-specific SOP template (Particularly

Hazardous Substances SOP Table) for completing these tasks. If the hazard analysis identifies that the PHS has antidotes or prophylaxis available, the CHO will consult with OMS, providing the hazard analysis and SOP for use of the chemical 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). Examples of chemicals with requirements include hydrofluoric acid, MPTP, phenol, and hydrogen cyanide. Exposure to all these chemicals require immediate medical attention. The below first aid measures may be employed while waiting for medical attention.

- Skin exposure of hydrofluoric acid- topical application of 2.5% calcium gluconate gel has been recommended after irrigation;
- Phenol- for small skin exposures, immediately swab the area with a solution of Polyethylene Glycol 300 (PEG) changing the swab frequently; and for large skin exposures, wash the area with copious amounts of water for 15 minutes and swab with PEG 300;

Laboratories working with these chemicals are advised to keep the required antidotes available to the workers for emergencies.

Implementation of the New Methylene Chloride (Dichloromethane, DCM) Regulation

To address the health risks associated with DCM the EPA has issued the 2024 Methylene Chloride Regulation under the Toxic Substances Control Act (TSCA). Under the new EPA regulation most commercial and industrial uses of DCM, including the use of any products/mixtures containing above the de minims threshold of 0.1% DCM are banned. All non-laboratory units currently using products containing DCM must discontinue its use and identify appropriate substitutes or alternate workplans. DS is available for consultation.

The new EPA rule permits the use of DCM for research with certain restrictions, including the establishment of a workplace chemical protection program (WCPP).

WCPP is required to have the following components to ensure the safety of potentially exposed employees:

- Exposure limits set forth in the new ruling
- Initial and periodic exposure monitoring at a frequency determined by the results of the initial monitoring.
- Establishment of a regulated area
- Development and communication of an exposure control plan
- Respirator selection criteria
- Recordkeeping and notification to potentially exposed people
- Training

NIH Division of Safety (DS) Methylene Chloride Health and Safety Plan has detailed information on how NIH is complying with new regulations and controlling worker exposure to methylene chloride (dichloromethane, DCM). This plan includes an outline of initial and periodic exposure monitoring, development of exposure control plan, recordkeeping and worker training on safe work practices. NIH will be enforcing the new EPA inhalation exposure limit (Existing Chemical Exposure Limits (ECEL)) 2 ppm as an 8-hr Time Weighted Average (TWA) and 16 ppm as a 15-min TWA.

Laboratories working/storing DCM must contact your safety specialist for an initial assessment, scheduling initial monitoring and establishing WCPP if needed. Refer DS fact sheet on learning more about working safely with DCM in the laboratories.

XI. 3D PRINTERS

Three-dimensional (3D) printing refers to the manufacturing process where a three-dimensional solid object is generated from a computer aided design (CAD) model by laying down many successive, thin layers of a material. There are many processes like material extrusion, powder bed fusion, vat-polymerization etc. are used in 3D printing.

Health and Safety Risk for 3D Printers

3D printers pose several health and safety hazards. Main hazards associated with 3D printing are health hazards due to exposure to volatile organic compounds (VOCs), ultrafine particles (UFPs) that fall within the nanoparticle range (smaller than 100 nanometers in size) and exposure to various hazardous chemicals. Exposure can occur during all the stages of printing including pre-printing, printing, post-printing and cleaning/ maintenance. Health and safety hazards depend on the type of 3D printing process and the print material(filament) used. Below are examples of some of the hazards:

- Exposure to VOCs and UFPs including particles in nanomaterial range
- Exposure to organic solvents, corrosive chemicals and PHS
- Chemical and thermal burn
- Electrical shock during maintenance and other activities involving opening the machine
- Potential for fire/explosion due to flammable solvents, combustible dust (in powder printing) and electrical/printer malfunction etc.
- Noise exposure
- Injury caused by moving parts of the machine
- Lasers and UV light in some processes

PIs/supervisors are responsible for conducting risk assessments, developing SOPs to mitigate the hazards and train all the users. Refer to NIH 3D Printing Health and Safety Plan for additional information and SOP templates.

XII. MEDICAL CONSULTATION AND MEDICAL EXAMINATION

Employees who work with hazardous chemicals shall be provided with the opportunity to receive medical attention and/or consultation for health concerns. All medical examinations and consultations shall be performed by or under the direct supervision of an independently licensed provider. Nurse practitioners and others can provide medical services within state regulations and shall be at no cost to the employee and at a reasonable time and place. A written opinion shall be obtained from the provider.
Specific circumstances that would enable employees who work with hazardous chemicals to receive medical attention or consultation include the following:

1. When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory or other NIH worksite;
2. When exposure monitoring reveals an exposure level routinely above the Action Level, or in the absence of an Action Level, the Permissible Exposure Level (PEL);
3. When a substance is regulated by OSHA and requires exposure monitoring and/or medical surveillance regardless of exposure level (see OSHA's medical screening and surveillance standards); and
4. When an event takes place in the work area resulting in the likelihood of hazardous exposure.

Working with Reproductive Hazards

Working in research laboratories can have potential for exposure to reproductive hazards. Reproductive hazards are substances or agents that may affect the reproductive health of women or men or the ability to have healthy children. The "Health Hazard" pictogram on the GHS-compliant chemical label is an initial indication of the possibility of a chemical being a reproductive toxin. The Safety Data Sheet (SDS) Section 2 can provide further details such as standardized Hazard Statements (e.g., "May Cause harm to breast-fed children", "May damage fertility or the unborn child", etc.). You can also contact your safety specialist for assistance. OMS may be consulted by all staff of reproductive capability (i.e., women, men, women who are pregnant, women who may soon become pregnant, women who are breastfeeding) when there is a concern for past exposure or potential future exposure to reproductive hazard(s).

Exposure Control Using the Hierarchy of Controls When Working with Reproductive Hazards

Exposure depends on the time, dose, and type of interaction with the substance. Accordingly, an individual's overall risk can be reduced by minimizing any of the three variables. The hierarchy of controls should be used to minimize risks;

Elimination

Elimination is completely removing the hazards. For example, consider someone else performing potentially hazardous tasks temporarily, or using a different methodology (in consultation with PI) that removes the hazards.

Substitution of Hazards

Consult with your PI/supervisor, and/or your safety specialist for any potential substitutions of the reproductively harmful chemical(s) with less hazardous ones.

Engineering and Administrative Controls

If elimination and substitution are not possible, the next best options are engineering and administrative controls. Engineering controls such as fume hoods, glove boxes, etc., can be slightly restrictive during the advanced stages of pregnancy and this should be included in the

planning process (DS Ergonomic program is available for consultation).
SOPs, training and other administrative controls can also help reduce exposure.

Personal Protective Equipment (PPE)
PPE should be of the right size and fit for providing the required protection. The sizes at the start of the pregnancy may not be appropriate when it progresses, especially for lab coats and gloves. Choose appropriate PPE for the chemicals in use, ensure the sizes are correct and change the gloves frequently and immediately if contaminated.

Prudent work practices described in NIH CHP and chemical specific control measures outlined in the SOP developed by the PI/Lab Manager after performing a thorough risk assessment can help in controlling exposures.

What to Expect When Expecting in Lab: A Review of Unique Risks and Resources for Pregnant Researchers in the Chemical Laboratory can be a source of information for pregnant researchers trying to evaluate their risks while handling chemicals in the laboratories. The Division of Safety (DS) cannot provide medical advice but along with the advice of a medical provider/OMS can be a resource available to employees when evaluating the safety of handling hazardous chemicals while pregnant.

XIII.CHEMICAL HYGIENE PLAN EVALUATION AND RECORD KEEPING

The NIH CHP is reviewed annually and updated as needed by the NIH OSHC and the CHO. Comments and suggestions on the improvement of this document should be directed to DS (301-496-2960). See Appendix K for the template used during the annual program evaluation and improvement.

Records of DS provided laboratory safety training are maintained by the DS. Individuals may request their training records online or by contacting the DS Training Officer (301- 827-6091). PIs are responsible for documenting and maintaining training records for laboratory-specific safety training. The IHCSB/DS maintains appropriate area monitoring records and OMS maintains employee medical and exposure records.

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APPENDIX A
General References

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APPENDIX A
General References

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APPENDIX B
Guidance for Identifying and Managing Particularly Hazardous Substances (PHS)

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APPENDIX B

Guidance for Identifying and Managing Particularly Hazardous Substances (PHS)

The OSHA Laboratory Standard requires that special precautions be taken when working with substances with high acute toxicity, select carcinogens and reproductive toxins. If a PHS is used, be sure to specifically address its storage, use, disposal, and potential spill. This information should be documented, and employees trained appropriately.

Guidance set forth in this Appendix is intended to assist researchers in safely handling PHS in the workplace. In addition to common chemicals found in the laboratory, some investigative drugs, cytotoxic agents, or other compounds used in laboratories may have characteristics that would classify them as PHS. For many substances in these categories, an SDS may not be immediately available. When chemical properties are not available for an investigational substance, workers should be prudent and consider similar substances to categorize the risk and take appropriate actions to protect themselves from adverse exposures.

For more well-characterized drugs, consult the NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings, 2016. When used in a laboratory setting, drugs found on this list should be carefully evaluated to determine whether they meet the PHS definition.

It is the responsibility of the PI to determine whether the use of chemical or drug warrants classification as PHS. Contact IHCSB/DS for assistance. The NIH DEP has developed criteria for identifying Substances of Concern (SoC) and has developed a list of functional use categories under which many SoC fall. These criteria and functional use categories may be consulted as a reference.

For specific advice or clarifications please contact IHCSB/DS, at (301) 496-3353.

Acutely Toxic Substances

Substances of high acute toxicity include materials that may be fatal or cause damage to target organs from a single exposure or from exposures of short duration. They also include materials capable of causing intense irritation that can result in pulmonary edema (fluid and swelling in the lungs), chemical asphyxia, and systemic (body wide) poisoning. The SDS should be consulted to determine the toxicity of all substances.
Criteria to classify a chemical as acute toxin:

- Can cause severe, acute, or lethal effects upon exposure by any route: refer to SDS Section 11 for the specific toxicity information. Chemicals with toxicity values under the below threshold values are considered as PHS:
    - Oral LD50 (rats): < 50 mg/kg
    - Dermal LD50 (rabbits): < 200 mg/kg

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- Inhalation LC50 (rats): < 200 ppm in air

Chronically Toxic Substances

Chronic effects are due to repeated exposures to low doses of toxic substances, usually over a longer period. Chronic illnesses can occur either from a build-up of a substance in the body or from an accumulation of the damage. Examples of chronically toxic substances are heavy metals such as mercury (central nervous system impairment) and organic solvents such as n-hexane (peripheral neuropathy). Chronically toxic substances also include carcinogens.

Reproductive Toxins

Reproductive toxins are agents that may affect reproductive capabilities including chromosomal damage (mutagens) and produce effects on developing fetuses (teratogens). Reproductive toxins can affect both men and women. Examples of adverse reproductive health effects include birth defects, spontaneous abortion, fetal developmental damage, and infertility. It is important to note that the first trimester of pregnancy is the period of most concern to the developing fetus because this is when the organs and the limbs are being formed. During this period, many women may not yet be aware that they are pregnant. For this reason, it is important that the use of reproductive toxins have been identified and that control measures are in place to protect a woman and her fetus from harmful exposure levels. Women who are (or are trying to become) pregnant may consult with OMS before the start of any activity involving reproductive toxins.

Carcinogens

Carcinogens are agents that cause neoplasms (tumors) in humans and/or animals. Carcinogenic agents may be organic chemicals, inorganic chemicals, or hormones. Some carcinogens react directly with a cell's genetic information (the DNA), causing changes (mutations) that are incorporated into subsequent generations of that cell. Select carcinogens are agents that are strongly implicated as sources of cancer in humans.
A select carcinogen is any substance which meets one of the following criteria:

- It is regulated by OSHA as a carcinogen;
- It is listed under the category "Known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP);
- It is listed under Group 1 "Carcinogenic to humans" by the International Agency for Research (IARC) Cancer Monographs; or
- It is listed in either Group 2A or 2B by IARC or under the category "Reasonably anticipated to be carcinogens" by NTP.

The American Cancer Society (ACS) has conveniently compiled the above mentioned lists into one website on Known and Probable Human Carcinogens.
If you work with any of the OSHA-regulated chemicals, you need to be aware of and

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comply with the specific OSHA standards governing their use. OSHA has established standards for carcinogens under the "Occupational exposure to hazardous chemicals in laboratories" standard. In some cases, the chemical specific standard may require special signs, medical surveillance, and routine air monitoring of your workplace. If you use these chemicals routinely, even for short periods of time, contact DS for a review to assure that your work practices and engineering controls are sufficient to keep your exposures below the OSHA specified limits (https://www.osha.gov/chemical-hazards/standards).
The Environmental Protection Agency (EPA) also has lists of different types of hazardous wastes which may be of benefit to reference.

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Decision tree for identifying particularly hazardous substances (PHS)

Category	Definition and Resources
Select Carcinogen	Any substance that meets one of the following criteria: - Regulated by OSHA as a carcinogen https://www.cdc.gov/niosh/npg/nengapdxb.html. - Listed under the category "Known to be carcinogens" in the 15th Report on Carcinogens published by the National Toxicology Program (NTP). - Agents Classified by the IARC Monographs, Volumes 1–135 – IARC Monographs on the Identification of Carcinogenic Hazards to Humans (who.int). • American Cancer Society (ACS) has compiled the above-mentioned lists into one on its website. - Known and Probable Human Carcinogens. • **Refer Safety Data Sheet (SDS) Section 2** for hazard classification and pictogram
Reproductive toxin	• Agents that can have adverse effects on various aspects of reproduction: fetal development (teratogens), chromosomal damage (mutagens), fertility, gestation, lactation, and sterility. • Reproductive toxins can affect both men and women. • **Refer Safety Data Sheet (SDS) Section 2** for hazard classification and pictogram.
Acute toxins	• OSHA doesn't provide any clear guidance on this category. Chemicals with high acute toxicity are those having oral, inhalation, or dermal LD50 and LC50 values below the specified threshold. The threshold values: - Oral LD50 (rats): < 50 mg/kg - Dermal LD50 (rabbits): < 200 mg/kg - Inhalation LC50 (rats): < 200 ppm in air **Refer Safety Data Sheet (SDS) Section 2 and 11** for Toxicological Information (threshold values). Registry of Toxic Effects of Chemical Substances (RTECS) is also a good source of information on acute toxins.

Figure 5. Decision tree for identifying particularly hazardous substances (PHS).

PHS Requirements:

- An assessment of the hazards and controls in place conducted by the PI is necessary to limit employee exposure to these agents. Contact your IC Safety Specialist for assistance with performing an assessment and for creating signage indicating the presence or usage of a PHS.

- PIs are responsible for developing standard operating procedures for work involving PHS. DS has developed SOP templates for PHS using the concept of control banding(Particularly Hazardous Substances SOP Table)). "Control Banding" assigns protection strategies to chemicals with similar hazards that are grouped into "bands" and one SOP can cover all the chemicals in the "band". Chemicals that cannot be grouped or "banded" with other chemicals based on the hazardous characteristics will have chemical specific SOPs. OSHA requires that the following four categories of controls be considered for operations and activities involving PHS:
    - Establish posted designated areas. A designated area may be a room, a section of a room, a bench top, or a containment device (such as a laboratory hood). The designated areas of PHS use/storage must be posted with a warning sign depicting hazards and emergency contact information. DS has developed "Designated Area" signage. Storage locations for PHS should also be designated.

    - Use containment devices (such as CFH, downdraft table, LEV, gas cabinet, glove box or the equivalent);

    - Implement contaminated waste removal procedures; and

    - Establish decontamination procedures. These are necessary to prevent the spread of contamination to other areas. Decontamination procedures include practicing good housekeeping by wiping down work surfaces at the end of the day and cleaning up drips, residues, and spills. Cleanup materials used (such as absorbents and rags) must be disposed of as hazardous waste.

The following controls are required for PHS:

Training and Information

- Employees, supervisors, and PIs must complete the Laboratory Safety training and the annual refreshers; and

All employees who either handle or who may be exposed to PHS in addition to standard laboratory work

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must be trained in specific hazards, exposure control plan, and the laboratory specific SOPs for PHS use. Employees will sign the SOP following training and review of the document. Furthermore, employees working in designated areas need to be informed of the specific hazards and controls of the materials used. Area-specific training is a line management responsibility. IHCSB/DS is available to aid.

Substitution and Chemical Inventory Management

- Identify and use safer chemical alternatives if possible;
- If a safer alternative cannot be used, limit the amount that is purchased or borrow the necessary quantity from a colleague;
- Maintain an accurate inventory of all PHS present in the lab. When transferring a PHS to a colleague or receiving a PHS from a colleague make notes in the laboratory chemical inventory; DS recommends the use of LabArchives to create chemical inventories and DS has created a "how to use guide" to help the researchers to set-up the inventory.
- Conduct periodic cleanouts to prevent accumulation of unneeded chemicals; and
- Procure and use the minimum amount of material required for the operation.
- PIs are required to have an accurate inventory of PHS present in the lab.

Ventilation

- Use CFH or glove box when handling PHS in a manner that may produce an airborne hazard (such as fumes, gases, vapors, and mists). This includes transfer operations, weighing, preparation of mixtures, blending, sonication, spraying, heating, and distilling. See Engineering Controls for more information. Refer to PHS fact sheet.
- Do not work with PHS outside of engineering control without conducting a detailed risk analysis and consulting DS If primary barrier controls used are in alarm and not operating properly do not begin work, contact the DS primary barrier program at PrimaryBarrier@mail.nih.gov or 301-496-3457.

Work Practices

- Control access to the laboratory using appropriate signs that warn of the hazards and indicate the precautions or approvals necessary for entry. Use designated areas for use and storage of PHS. Contact your IC Safety Specialist for assistance;
- Consult the regulations, IHCSB/DS or OMS to determine if medical surveillance may be warranted if toxicologically significant quantities of PHS are used on a routine or frequent basis;
- Contact the DEP at 301-496-7990 for assistance with specialized waste disposal;
- Keep PHS in secondary containment to help prevent breaks and spills. The secondary containment should be opened only inside a CFH. Attach a hazard warning label to the

secondary containment to alert others of the hazards;

- Protect work surfaces from contamination with disposable, absorbent, plastic backed paper (plastic side down). Replace paper when contaminated or after each use and handle as hazardous waste;
- Use additional containment devices (such as shielding or protective filters) to safely handle, store or protect equipment and workers when using these chemicals;
- Transfer containers in bottle carriers;
- Open bottles or carboys slowly and carefully in the CFH and wear PPE to protect from splashes and vapors/gases;
- Wipe drips/residues from containers and work surfaces;
- To facilitate easy decontamination, use stainless steel or plastic trays, absorbent paper with a moisture-proof lining, or other impervious material. Upon completion of the operation, decontaminate or discard the protective covering material as hazardous waste; and
- Wash hands before leaving the work area and prior to consuming food/beverages.

Personal Protective Equipment

Skin and eye contact with PHS shall be prevented. The following PPE must be worn when handling these materials**:**

- At a minimum, safety glasses with side shields, appropriate gloves, and laboratory coats (see the Guidance for the Selection of Laboratory Coats for more information; coveralls are acceptable in shop settings) must be worn when handling PHS. These measures are minimum protection and must be upgraded if necessary;
- Additional PPE such as safety goggles, face shields, chemical aprons, disposable coveralls, chemically resistant gloves, and respiratory protection must be worn if there is a greater chance of chemical exposure. An IC Safety Specialist may be contacted for assistance in selecting appropriate gloves and respiratory protection. The use of respiratory protection requires an industrial hygiene hazard evaluation and a medical clearance followed by a fit test and training by IHCSB/ DS (Section VIII.);
- Consult "Eye and Face Protection" in the PPE Section for guidance on the selection, uses, and limitations of safety glasses, chemical goggles, and face shields;
- Since many chemicals can be absorbed through skin (i.e., agents that readily pass through the skin), it is important to select gloves that are chemically resistant to the material. If gloves are contaminated or suspected to be immediately disposed of and replaced with clean PPE. Consult Appendix F for guidance on the selection, uses, limitations and disposal of gloves; and
- Additional information on PPE may be found in Section VIII**.**
- Properly doff/remove all protective apparel/PPE and thoroughly wash exposed skin (*e.g.* face, forearms, etc.) upon completion of work and before leaving the laboratory.

Storage

Secondary containment should be utilized when storing PHS to prevent spills or mixing with other materials and hazards. Consult Appendix D for storage information regarding hazardous chemical incompatibility.

Emergency Procedures

Refer to Appendix H for response procedures for chemical spills and personal exposure to chemicals.

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APPENDIX C
Employee Training and Information

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APPENDIX C
Employee Training and Information

Information that must be provided to employees:

DS provided online Lab Safety Training and annual refresher covers:

- The contents of the 29 CFR 1910.1450 standard and its appendices;
- The location and availability of NIH CHP;
- Health and physical hazards of chemicals;
- The measures employees can take to protect from physical and health hazards of chemicals include specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and PPE. The PELs for OSHA-regulated substances and recommended exposure limits for other hazardous chemicals where there are no applicable OSHA standards, and;
- Information on medical consultation and how to get help after exposure occurs.

Information that must be provided to employees by the PI/Supervisor:

- The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to, SDSs received from the chemical supplier and SOP made by the PI/Supervisor;
- The physical and health hazards of chemicals in the work areas;
- Location of the SDS and how to read an SDS;
- Signs and symptoms associated with exposures to hazardous chemicals used in the lab;
- The selection, proper use, and maintenance of appropriate PPE. Employees should be instructed on the proper fit, use, maintenance, and limitations; and
- Lab/task specific training and standard operating procedures developed for PHS with retraining when appropriate. All training and SOP reviews must be documented.

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APPENDIX D
Proper Storage of Chemicals in the Lab

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APPENDIX D
Proper Storage of Chemicals in the Lab

Storage Considerations

- Not all areas are suitable or permittable for chemical storage. Areas including office spaces, break rooms, common spaces, and cold rooms, with recirculating ventilation or a portion of the exhaust air is recirculated back into the building supply air are not suitable for chemical storage. Any chemical release in such spaces would be dispersed to other areas of the building via the HVAC system. When bringing in new or moving old laboratory chemical storage equipment, contact DS to evaluate the area for its suitability for chemical storage;

- Store class 1,2 and 3 flammables in an appropriate flammable storage cabinet. Do not exceed the listed capacity of the cabinet. The cabinet vent must stay plugged. Cabinet doors must always remain closed to ensure proper functioning of the cabinet.

- Flammable chemicals requiring refrigeration, in any quantity, must be stored in refrigerators/freezers that are explosion proof and appropriately rated for the storage of flammable materials;

- Strong acids and bases must be stored in separate approved corrosive cabinets when utilizing large quantities. Small quantities of strong acids and bases can be stored inside the same cabinet, placed within secondary containment, and stored on separate shelves. Within a designated storage area, separate organic acids from inorganic acids and organic bases from inorganic bases using appropriate secondary containment. The cabinet vent must be connected to the building exhaust system. Cabinet doors must remain closed to keep vapors exhausting through the vent;

- Nitric acid, sulfuric acid, perchloric acid, and chromic acid are strong oxidizers. They may be stored in the same acid cabinet with other corrosive chemicals only if they are kept isolated with secondary containment from all other acids;

- CFH shall not be used for storage for chemicals as containers block proper air flow, reduce available workspace, cause inadvertent and unnoticed chemical exposure, and exacerbate hazards in case of fire or spill;

- Refrigerators or freezers used for chemical storage must be rated appropriately for hazardous material storage and clearly labeled with ‘No Food or Drink’ signage;

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- Do not store chemicals under a sink, except for water-soluble cleaning solutions;

- Provide secondary containment for all hazardous chemicals. At a minimum, secondary containment must hold the volume of the largest primary container or 10% of the total volume of all primary containers, whichever is greater. The secondary containment should be made of non-reactive material and be clearly labeled if obstructing or obscuring the manufacture label information.

- Ensure all containers of hazardous chemicals (including secondary containers, working bottles, etc.) are properly labeled with the identity of the hazardous chemical(s) with full chemical names (abbreviations are not acceptable labeling method), appropriate hazard warnings such as pictograms, and signal words. Consider utilizing the GHS labels available through the NIH Supply Center. For guidance on storage and labeling certain chemical classes like PHS and peroxide formers, refer to appropriate sections of the CHP (Appendix B and Appendix D Table 2 respectively). Full labeling of a secondary container, including flasks and beakers, is required in the following circumstances:
    - When the secondary container will be used/stored for longer than a single work shift;
    - The person who transferred the chemical to the secondary container leaves the work area; or
    - The chemical is left in a different location by the person who transferred it.

- Record the date of receipt on each chemical to assist with inventory management. The date of receipt, the date of opening and date of expiration be on each peroxide former (Peroxide Labels Avery 5196312, Peroxide Label Avery Business Card Size 5132024) and dispose or test for peroxides as directed (see Appendix D Table 2 for more information);Avery Business Card Size 5132024) and dispose or test for peroxides as directed (see Appendix D Table 2 for more information);

- Segregate all incompatible chemicals for proper storage by hazard class (refer to Table 1). In other words, store chemicals with same hazards together and away from other groups of chemicals that might cause reactions if mixed;

- Only store chemicals alphabetically within each group of compatible chemicals/hazard classes;

- Hazardous chemicals should not be stored above the eye level and never on the top shelf of a storage unit. Do not overcrowd shelves. Each shelf should have an anti-roll lip;

- Avoid storing chemicals on the floor (even temporarily) or extending into aisles;

- Pyrophoric materials (e.g., boranes, n-butyllithium, white phosphorus) ignite spontaneously in contact with air. Avoid spills by storing breakable glass bottles inside secondary containment made of compatible plastic or other shatterproof materials like rubber or plastic. Use and store all pyrophorics in an inert atmosphere (e.g., stored

under nitrogen or argon). Pyrophoric and water reactive chemicals must be stored and handled by following DS guidelines.;

- Only compressed gas cylinders that are "in use" (according to NFPA 45, a compressed gas is considered "in use" when it is connected through a regulator to deliver gas to a laboratory operation, attached to a manifold being used for gas delivery, or is a single reserve cylinder secured alongside a cylinder currently in use delivering gas to a lab operation) and secured in place shall be kept in the laboratory. All others, including empties, shall be sent to the compressed gas cylinder storage area for the facility. Compressed gas storage areas must be labeled appropriately based on the hazards associated with the gas. Laboratories working with flammable, corrosives, toxic and oxidizer gases must follow additional recommendations with appropriate segregation and signage. Keep all stored chemicals, especially flammable liquids and peroxide formers away from heat and direct sunlight; and,
- Periodically inspect stored chemicals to verify container integrity.

Safety Tips:

- Do not purchase hazardous chemicals in quantities greater than can be used in 6 months or within the specified storage period;
- Some materials are more stable when stored under an inert gas such as nitrogen. See the manufacturers' information/SDS for guidance;
- Always test for the presence of peroxides before distilling/evaporating any peroxide-former and following the peroxide testing schedule (Appendix D);
- Consult safety references (e.g., SDSs) before working with chemicals which are new, used in new processes, or if any of the hazards are unfamiliar;
- If old containers of peroxide-forming chemicals are found, do not move them. Contact the DEP at (301) 496-3537 for assistance in disposing of the container;
- Follow the disposal guidelines provided by the NIH Waste Disposal Guide.
- Do not dispose of chemicals down the drain or by evaporation. For questions regarding what may be approved for drain disposal, refer to DEP Drain Discharge Guide. Properly collect, tag and date all waste in the lab starting on the date of accumulation. For guidance on filling out hazardous waste tags, consult DEP's Waste Disposal Guide. Keep chemical waste containers closed/sealed. Use secondary containment for waste containers to prevent spills;
- Refer to the EPA's chemical compatibility chart before mixing chemical wastes;
- If you are no longer working with a chemical or will be away from said chemical for an extended period, the chemical should be returned to its dedicated storage location;

- If crystallization has occurred or there are other concerns regarding the condition of stored chemicals;
    - Do not touch or handle the bottles in case they are shock sensitive. Contact your IC Safety Specialist, PI/supervisor **and** Chemical Waste. Pictures of the chemicals, location, and phone number should be provided to the chemical waste services contractor and the Division of Safety. Based on the information provided, Chemical Waste Services will determine if the fire department should be called. The contractor will send out a specialist to assess the situation and determine the next steps for appropriate disposal. The typical response time for the reactive specialist to visit and assess the lab is 24 hours. When the call is placed, the chemical waste services group will determine if the situation is emergent and requires a more immediate response, based on the chemicals involved. If the reporting researcher believes this is an emergency, this should be expressed when reporting the situation. Such emergency situations include crystallization around the cap or inside the container of chemicals such as picric acid, diethyl ether, and organic peroxides, or if crystallization has spread to the exterior of multiple chemicals; Once you have notified the listed groups, isolate the area using tape, cones, signage, etc., to prevent the area from being disturbed. Contact your IC Safety Specialist to assist;
    - Once contacted, the IC Safety Specialist will perform an onsite review and follow up with the lab shortly after the remediation to address any further concerns; and
    - Additional campus-specific contacts that must be notified:
        - Bethesda campus: Chemical Waste Services: 301-496-4710
        - Baltimore campus: The Environmental Manager assigned to BRC (currently LCDR James Pitt): 667-312-5762
        - Rocky Mountain Lab campus: Industrial Hygienist at 406-802- 6398 and Security Control Center at (406) 363-9400
        - IRF- Frederick: DEP at 240-236-9575 and Security Control Center by dialing 0
        - Research Triangle Park campus: 981-287-3400

Storage of Flammable and Combustible Liquids in the Laboratories

Improper storage and handling of flammable and combustible liquids can cause fires/explosions leading to personal injury and property damage. Strict storage and handling requirements are essential for safety and required by law.

Flammable and combustible liquids

OSHA defines all liquids having a flashpoint at or below 199.4 F (93^0 C) as flammable liquids. With the implementation of the Globally Harmonized System (GHS), OSHA no longer uses the term combustible liquids.
Flash point is defined as the temperature at which the liquid gives off vapor in sufficient quantities to ignite in air.
Other standards that are important for ensuring the safety of these liquids are the National Fire Protection Association (NFPA) and International Building Codes (IBC)/International Fire

Codes (IFC). Several of the NFPA Codes have been incorporated into OSHA Standards.

NFPA/IBC classification of flammable and combustible are listed below:

Flammable liquids-: flash point < 100°F (38°C)

Class	Flash point	Boiling point	Examples
I-A	<73°F (23°C)	<100°F (38°C)	diethyl ether, petroleum ether, heptane
I-B	<73°F (23°C)	>100°F (38°C)	Hexane, cyclohexane, acetone, benzene, ethanol, toluene
I-C	73-100°F (24-38°C)	----	Xylene, naphtha

Combustible liquids per NFPA/IBC: Flash point ≥ 100°F (38°C

II	101-140°F (39-60°C)	----	diesel fuel, motor oil, kerosene
III-A	141-199°F (61-93°C)	----	Formaldehyde, benzaldehyde, pine oil, mineral oil
III-B	≥200°F (93°C)	----	Ethylene glycol, vegetable oils, glycerin, animal fat, hydraulic fluids

All three standards (OSHA, NFPA and IBC/IFC) set limits on the amount of flammable and combustible materials that can be stored in a laboratory. The threshold limits depend on many factors like construction, size of the laboratory, flash point of the liquids stored, type of containers used for storage (glass bottles, safety can etc.) and the location of the lab (floor level). The limits vary between these standards.

Allowed storage of flammable/combustible liquids in laboratories

NIH Design Requirement Manual stipulates that laboratory units at NIH are classified at minimum as Class C requiring 1-hour fire rated separation. Maximum allowed quantities of flammable and combustible liquids stored in a Class C laboratory at NIH are 50 gallons[1] (class I, II and III combined). No more than 10 gallons of Class I flammable liquids can be stored in a laboratory. Limit flammables and combustibles outside of flammable cabinets to what is actively in use (maximum 10 gallons any given time). Anything that is not in active use must be stored in an approved flammable cabinet. The total amount described above should include flammable waste stored in that area.

[1] *MAQ is calculated in consultation with the NIH Fire Marshal in compliance with NFPA, IBC, OSHA and NIH DTR guidance/ recommendations.*

Types of containers and sizes that are allowed to be used in the laboratories for the storage of flammable liquids

Type	Class 1A	Class 1B	Class 1C	Class II	Class III A-B
Glass	1 pint	I quart	1 gallon	1 gallon	1 gallon
Metal or approved plastic	1 gallon	5 gallons	5 gallons	5 gallons	5 gallons
Safety cans	2 gallons	5 gallons	5 gallons	5 gallons	5 gallons

All flammable and combustible liquids stored and used in laboratories must be in approved containers.

Flammable Storage Cabinet

OSHA/NFPA compliant flammable storage cabinets must be used for storage of flammable liquids in the laboratories. Refer to NIH Division of Technical Resources Bulletin on purchase, installation and use of flammable cabinets and DS fact sheet for details. For installation of new cabinets consult the NIH Design Requirements Manual (DRM) and Division of Safety's Safety Engineering Activity (SEA) branch. Never store more than 60 gallons of flammable/combustible liquids inside a flammable storage cabinet.

Refrigerators

Store flammable liquids only in specially designed flammable storage refrigerators/freezers. Never store flammable liquids of any volume in a standard or domestic refrigerator or freezer.

Steps to avoid chemical storage area fires/explosions and unwanted reactions

Hazardous chemicals that are stored in an inappropriate state, condition or place can result in fires, explosions and violent reactions. Below are some general situations that can lead to dangerous conditions in chemical storage areas:

- Degradation of the container/container failure;
- Incompatible and improper storage;
- Extended storage of peroxide forming chemicals; and
- Flammable liquids and vapors stored improperly.

Recommendations for improving safety in chemical storage areas in the laboratory include regular inspections of the storage area(s), segregation/secondary containment, proper closure and sealing of containers, compatibility and integrity. Refer to DS Fact Sheet for additional information.

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Table 1. Chemical Segregation and Storage Table

Always consult the SDS

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The Chemical Segregation and Storage Table begins on the next page.

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 burn, respiratory distress • Use NIOSH approved gloves, eye protection, face shield & 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 containment 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 should be handled only by trained personnel. Requires extra handling precaution and stored in a secondary container (this chemical 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, burns, respiratory distress and even death • Use NIOSH approved gloves, eye protection, face shield & apron
Corrosive Bases-Organic/Caustic	• Hydroxylamine • Tetramethyl ethylamine • Diamine • Triethylamine • Propylene diamine • 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 the sink)	• Acids • Oxidizers • Flammable Liquids/ Solids • Inorganic Bases • Poisons/Toxins • Amines are generally incompatible with Isocyanates, halogenated organics, peroxides, acidic phenols, epoxides, anhydrides, & acid halides	• Heat • Gas Generation • Violent Reaction • Causes 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 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 • Causesskin burn and irritation • Respiratory distress • Use NIOSH approved gloves, eye protection, face shield & apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemical Types	Possible Reaction If Mixed/Health Concerns
Flammable Solids 	• Paraformaldehyde Phosphorus • Magnesium • Sulfur • Potassium sulfide • 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, burn fiercely • Use NIOSH approved gloves, eye protection, face shield & 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) i.e.: 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 • Violet Reaction • Watch for vapor mist • Causes eye and skin irritation • Keep away from ignition or sparks • Use NIOSH approved gloves, eye protection, face shield & apron
Toxic 	• Chloroform • Cyanides • Heavy metal compounds (e.g. Cadmium, Mercury, Osmium, Arsenic, Barium) • Formamide • Phenol • Carbon Tetrachloride • 2-Mercaptoethanol • Acrylamide • Ethidium Bromide • Sodium Azide Solution	• Store in a dark, dry, ventilated, cool area in an unbreakable chemically resistant secondary containment (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 & apron

Explosives 	• Picric Acid (Dry) • Ammonium Nitrate • Nitro Urea • Trinitroaniline • Benzoyl Peroxide (Dry) • Trinitrobenzene • Trinitrobenzoic acid • Trinitrotoluene • Urea Nitrate • Diazo isobutyl nitrile • 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". It must never be stored with any chemicals of any kind	• Explosion Hazard • Violent Reaction • Heat • Shock Sensitive • Avoid Friction • Regular Inspection maybe required, to check for deposits or crystallization • Use spark proof tools • Use NIOSH approved gloves, eye protection, face shield & apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemical 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. It's 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 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) andthe 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) andthe 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 & apron

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemical 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 deg F (51.7 deg 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 & 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, face shield & apron • Wear safety shoes

Toxic Compressed Gases 	• Carbon Monoxide • Hydrogen Sulfide • Nitrogen 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 storage and compatibility requirements • Contact DS 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, airway problems (bronchial constriction) in some asthma patients; • Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness and slight conjunctivitis to name a few symptoms and effects • Use NIOSH approved gloves, eye protection face shield & apron Wear safety shoes

Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemical Types	Possible Reaction if Mixed/Health Concerns
Carcinogens	• Benzene • Benzidine • Methylene Chloride • Carbon Tetrachloride • Cadmium & Compounds • Arsenic & Compounds • Asbestos • Aflatoxins • 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 & apron
Teratogens	• Tegretol • Aminopterin • Chlorobiphenyls • Coumarins • Tetracycline • Tapazole • Propylthiouracil (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 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 & apron
Flammable Aerosols Cans	Pressurized Aerosol Cans containing flammable liquid not limited to: • Acetone • Thinner • Toluene • Petroleum Distillates • Butyl Cellosolve • Xylenes • Methanol	Content under pressure: • Store at room temperature; or store above 120F; • Do not use near heat, sparks and open flames; • Always use secondary containment when storing with other chemicals	• See incompatibles for flammable liquids; • Do not store with acids, oxidizer, toxic and reactive chemicals • Use secondary containment with flat surface for stability	• Keep away from children reach; • Read instructions and usage as directed; • Review SDS prior to use; • Use NIOSH approve gloves or PPE rinse skin thoroughly with soup and water; • Consult your medical emergency for severe skin or eye contact; • Use fire extinguisher in case of fire or dial 911
Non-Flammable-Corrosive-Toxic Aerosols Cans	Pressurized Aerosol cans NOT contain flammable liquid but not limited to Corrosive or Toxic carrier: • Ammonia • Sodium Hydroxide • Sodium Hypochlorite • Amines	Content under pressure: • Store at room temperature; or store above 120F; • Do not use near heat, sparks and open flames; • Always use secondary containment when storing with other chemicals	• See incompatibles for corrosive acid, base and toxic items above; Use secondary containment with flat surface for stability	• Read instructions and usage as directed; • Review SDS prior to use; • Use NIOSH approve gloves or PPE rinse skin thoroughly with soup and water; • Consult your medical emergency services for severe skin or eye contact; • Use fire extinguisher in case of fire or dial 911

Adapted from Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Research Council, 1995, University of Texas/Health Science at Houston and Boston University Environmental Health & Safety.

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Table 2. Storage and Testing Requirements for Common Peroxide Forming Chemicals

Under proper conditions, these chemicals will form explosive peroxides which can be detonated by shock or heat. Follow manufacturer's storage time limits and expiration date. On each peroxide container, note the date of receipt, the date of opening and date of expiration. DS approved labels are available to use. Although storage under inert gas or with a stabilizer may prolong shelf-life, test the container for peroxides before use beyond the expiration date or before any possible distillation procedure.
Below is a list of commonly found peroxide formers in the lab.

Class A: These chemicals can form explosive levels of peroxides during storage without concentration. Test open bottles for peroxide formation before using or discard after 3 months. Dispose of after 12 months even if unopened.

Isopropyl ether Butadiene Chlorobutadiene (Chloroprene)	Potassium amide Potassium metal	Sodium amide Tetrafluoroethylene	Divinyl acetylene Vinylidene chloride

Class B: Test every 6 months for peroxide formation following the date of opening. These chemicals are a peroxide hazard during storage and on concentration (distillation/evaporation). Dispose of after 12 months unless testing indicates no peroxides present. Test for peroxides immediately before evaporation or distillation.

Acetal
Acetaldehyde
Benzyl alcohol
Benzaldehyde
2-butanol
Cumene Cyclohexanol
2-Cychlohexen-1-ol Cyclohexene
Cyclopentene Diacetylene
Dicyclopentadiene
Diethylene glycol-dimethyl ether
Diethyl ether
Dioxane
Ethylene glycol Furan
Methyl acetylene
Methyl cyclopentane
Methyl-isobutyl ketone
2-pentanol
4-pentene-1-ol
1-phenyl ethanol
2-propanol *(test prior to concentration or distillation only)
Tetrahydrofuran Tetrahydronaphthalene
Vinyl ethers

Class C: Test every 6 months following the date of opening. Unsaturated monomers may auto-polymerize because of peroxide accumulation. Open bottles without inhibitors must be discarded within 24 hours. Open bottles with inhibitors must be disposed of after 12 months unless testing indicates no peroxides present.

Acrylic acid Butadiene Chlorotrifluoroethylene	Ethyl acrylate Methyl Methacrylate Styrene	Vinyl acetate Vinyl chloride Vinyl pyridine

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

This list in Table 2 is illustrative, not comprehensive. Check the SDS of your chemical to determine if it forms peroxides. If so, there will be a warning under the heading *Precautionary Labeling or Fire* and *Explosion Hazard Data* on the SDS.

If a substance does not appear on the lists and the SDS does not indicate that it is a

peroxide former, but you suspect that it is a peroxide former, evaluate the molecular structure of the chemical for peroxide forming functional groups and the chemical families of peroxide formers below:

Organic

A. Ethers, acetals
B. Olefins with allylic hydrogens, chloro- and fluoro-olefins, terpenes
C. Dienes, vinyl acetylenes
D. Aldehydes
E. Ureas, amides, lactams
F. Vinyl monomers including vinyl halides, acrylates, methacrylates, vinyl esters

Inorganic

A. Alkali metals, particularly potassium
B. Alkali metal alkoxides and amides
C. Organometallics

Testing for peroxides

Test Class A peroxide formers every 3 months regardless of procedure. Test Class B and C peroxide formers every 6 months and prior to distillation or evaporation to confirm that the level of peroxides is within the safe range (Table 3). Test the peroxide forming chemicals with a commercial test strip (available from many chemical vendors). Commercial test strips have a test range of approximately 0.5 to 100 ppm. When testing for peroxide, use the guidelines in **Table 3** to interpret results and determine action to take. High Hazard peroxide formers such as pyrophoric, water-reactive, acutely toxic, solid chemicals like potassium metal, potassium amide, and sodium amide should not be tested for peroxide formation. Only use visual signs for peroxide formation for those chemicals.

<25 ppm	Considered safe for general use
25-100 ppm	Not recommended for distilling or concentrating
>100 ppm	Avoid handling and contact Chemical Waste Services for safe disposal immediately.

Table 3

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Administrative controls for peroxide formers

1. Write the date of receipt, date of opening and date of expiration on all peroxide formers. DS approved peroxide former labels are available at Peroxide Labels Avery 5196312, Peroxide Label Avery Business Card Size 5132024;
2. Test open bottles of Class A peroxide formers before using or discard after 3 months (Table 3). Discard of all Class A peroxide formers 12 months after opening regardless of testing;
3. Test open bottles of Class B and C peroxide formers every 6 months after the opening date (test 2-propanol only if you are planning to distill or concentrate) and inspected. Discard Class B and C peroxide formers in accordance with the SDS or testing indicates peroxide levels are not within the safe range (Table 3); and
4. During inspection and testing of peroxide formers, if any of the following are observed, do not handle, or move. Call Chemical Waste Services, your IC Safety Specialist, and PI/supervisor. Chemical Waste Services will determine if the fire department should be called.
    - Crystallization or any solid precipitate, either around the cap or in solution
    - Discoloration
    - Stratification (oily layer or second liquid phase)
    - Rusty or excessively old containers
    - Peroxide levels are above the acceptable levels (Table 3)

Refer to DS Fact Sheet for additional information

Contact numbers:

- Bethesda campus: Chemical Waste Services: 301-496-4710
- Baltimore campus: The Environmental Manager assigned to BRC (currently LCDR James Pitt): 667-312-5762
- Rocky Mountain Lab campus: Industrial Hygienist at 406-802-6398 and Security Control Center at 406-363-9400
- IRF- Frederick: DEP at 240-236-9575 and Security Control Center by dialing 0
- Research Triangle Park campus: 981-287-3400

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APPENDIX E
Cryogenic Material Safety

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APPENDIX E
Cryogenic Material Safety

Cryogenic materials pose a unique set of hazards. These include:

- Extreme cold (causes frostbite, burns, blisters, or eye damage);
- Asphyxiation (vaporization of cryogenic materials can displace oxygen in rooms that are not adequately ventilated);
- Explosion (if pressure builds up in cryogenic material containers as the liquid boils off, the container may pressurize and explode);
- Fire (oxidizing and flammable cryogenic materials can increase the risk of fire; and
- Damage to building materials (damage to flooring systems, including asbestos-containing floor tiles).

Guidelines for safe usage of cryogenic materials:

- Always store cryogenic materials in well-ventilated rooms. Cryogens need to release pressure as they boil off over time. Occasional release may cause oxygen to be displaced. The storage of cryogenic liquids in cold rooms is not permitted.
    - When purchasing a cryogenic liquid for the first time, or when storing a cryogenic liquid in a new location, contact DS to perform a risk assessment of the area. DS may recommend the placement of oxygen monitoring devices in some cases, or other safety precautions. For more information on the oxygen monitoring program, refer to the NIH Protocol for Use and Maintenance of Oxygen Monitoring Devices.
- Only use manufacturer-rated containers which are specifically designed to hold cryogenic liquids. These containers should be insulated, impact resistant, have handles (or secondary tray), and a loose-fitting lid. Steel, plastic, and glass containers are not allowed, as they can break due to thermal variation. Lids must be loose fitting, as tightly sealed containers may build up pressure, and as the liquid boils off, may cause an explosion. If there are any issues with the container, reach out to the vendor or contract entity;
- Always wear appropriate PPE when handling cryogenic liquids. PPE must be worn including manufacturer-rated cryogloves, close-toed shoes, long pants, and safety goggles. When dispensing cryogenic liquids into an open container, face shields must be worn in addition to the PPE listed above. Fact sheet on Cryogen safety can provide additional safety information.
- Never leave the area unattended during the manual filling of cryogenic liquid in dewars;

- Cryogenic liquids should be stored in the upright position. When moving cryogenic liquid cylinders, always use a specifically designed cylinder cart. Avoid excessive movement of the container, as this may cause pressure buildup and explosion. If a container tips over, request assistance as it is likely too heavy for one person to lift;

- A damp cloth can be used to remove any ice or frost build-up on a pressure relief valve. When performing this task, appropriate PPE listed above must be worn. Do not chip away ice that has built up on the pressure relief valve or piping. Do not plug, cap, seal, or remove any relief or venting device on cryogenic liquid storage containers; and

- Signage should be posted near cryogenic storage freezers, compressed gas storage areas, and cryogenic liquid dispensing stations to remind users of appropriate PPE and of safe work practices. Examples of such signs may be found on the DS website. Refer to compressed gas and cryogen safety guidelines for additional information

If a leak is suspected, or there is a spill or rupture of a container:

- Call the Fire Department;
    - Bethesda main campus: Contact the NIH Fire Department (911 from a landline or 301-496-9911 from a cell phone)
    - All other locations (including Bethesda off-campus locations): Call 911

- Evacuate the area, but have someone remain nearby at a safe distance to prevent entry to the space by others; and

- Treat any cold burns immediately by flushing with tepid water or placing them in a warm water bath. Do not rub the skin to try to warm it.
    - Seek medical attention;
        - Bethesda: 911 from a landline or 301-496-9911 from a cell phone
        - All other locations (including Bethesda off-campus locations): Call 911
    - When safe to do so, notify supervisor and OMS; and
    - DS may be contacted to review the incident and develop preventative actions;
        - DS phone number: 301-496-2960

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APPENDIX F
Selection of PPE

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APPENDIX F
Selection of PPE

Glove Selection Information

- All gloves are permeable, and the resulting changes are not always visible;
- Visible degradation can include swelling, softening, hardening, and discoloration;
- Different gloves are resistant to different chemicals;
- Multiple gloves can be worn together for greater protection (use smallest size that will fit comfortably for dexterity purposes);
- Reusable gloves can be used for intermittent chemical work in the lab, but care must be taken to properly rinse and air dry and they must be inspected before each use;
- Appropriate disposable gloves provide barrier protection for lab chemicals but need to be immediately replaced when they become contaminated and should never be reused;
- Never use latex gloves for chemical manipulations; and
- Always consult manufacturer's glove selection guidelines for chemical compatibility and permeation rate.

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Glove Selection Guide (unsupported)

GLOVE TYPE	USES	CAUTION
Disposable: vinyl and latex,	Dry Powders Aqueous Solutions	*Do **NOT** use for solvents and corrosives *Disposable gloves must be replaced immediately upon chemical contamination
Disposable Nitrile gloves	General chemical use including nonhalogenated organic solvents (refer to manufacture's guidelines on permeability and breakthrough time)	Disposable gloves must be replaced immediately upon chemical contamination and never reused.
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	*Do **NOT** use for Asbestos *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 TM	Chlorinated and aromatic solvents	Must be properly rinsed and dried after each use

Eye and Face Protection Selection Information

- Eye protection is mandatory where there is potential for eye injury/exposure;
- Eye protection must be appropriate for the type of hazard (e.g. chemical splash and vapor, impact hazards, lasers, ultraviolet light);
- Safety glasses/spectacles are designed to protect against impact hazards.

- 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;
        - Provide seal around eyes preventing entry under or around goggles; and
        - Must be fitted to worker's face, as poorly fitted goggles will not offer necessary protection.
    - **Face Shields:**
        - Shield entire face from a range of hazards; and
        - Are secondary protectors to be used **in addition** to primary protection such as safety glasses or goggles.

Laboratory Coat Selection Information

For information on selecting laboratory coats, please refer to the NIH Guidance for the Selection of Laboratory Coats.

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APPENDIX G
Glossary of Terms

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APPENDIX G
Glossary of Terms

Action Level: A concentration designated in 29 CFR 1910 for a specific substance, calculated as an eight-hour time-weighted average (TWA) that initiates certain required activities such as exposure monitoring and medical surveillance.

Antineoplastic: Blocking the formation of neoplasms (growths that may become cancer).

Antineoplastic Antibiotic: A type of anticancer drug that blocks cell growth by interfering with DNA, the genetic material in cells. Also called anticancer antibiotic and antitumor antibiotic.

Chemical Hygiene Officer: A qualified individual who provides technical guidance in developing and implementing CHP.

Chemical Hygiene Plan: A written program developed and implemented by the employer which sets forth policies and procedures, equipment, personal protective equipment, and work practices that can protect employees from the hazards associated with the chemicals used in that workplace.

Combustible liquid: Any liquid having a flashpoint at or above 100ºF (37.8ºC), but below 200ºF (93.3ºC), except any mixture having components with flashpoints of 200ºF (93.3ºC) or higher, the total volume of which makes up 99% or more of the total volume of the mixture.

Corrosives: Material that causes visible destruction of, or irreversible alterations in, living tissue at the site of contact. Corrosives can be solids or liquids, and they can be acids or bases. An eyewash and safety shower must be readily accessible in areas where corrosives are used and stored.

Cytotoxic agent: A substance that kills cells, including cancer cells. These agents may stop cancer cells from dividing and growing and may cause tumors to shrink in size.

Designated Area: A predetermined and well-labeled area in which carcinogens, reproductive toxins (teratogens/embryo toxins), or other chemicals with significant acute or chronic toxicity are used/kept in the laboratory.

Emergency: An unexpected event that poses a risk of injury/death, or environment contamination and requires immediate action. Common laboratory emergencies include chemical spills (rupture of containers or failure of control equipment which results in an uncontrolled release of hazardous chemical), fires/explosions, electric shock, and personnel injuries.

Explosive: A chemical that causes sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable: A chemical that falls into one of the following categories:

- **Aerosol, flammable** – An aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

- **Gas, flammable** – A gas that:

  - at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or

  - at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit.

- **Liquid, flammable** – Any liquid having a flashpoint below 100ºF (37.8ºC), except any mixture having components with flashpoints of 100ºC or higher, the total of which make up 99% or more of the total volume of the mixture.

- **Solid, flammable** – A solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than 1/10" per second along its major access.

Flashpoint: The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

- Tagliabue Closed Tester (American National Standard Test Method (ASTM D 56-79)) for liquids with a viscosity of less than 45 Saybolt Universal Seconds at 100ºF (37.8ºC) that do not contain suspended solids and do not have a tendency to form a surface film under test; or

- Pensky-Martens Closed Tester (American National Standard Method (ASTM D

93-79)) for liquids with viscosity equal to or greater than 45 SUS at 100°F (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

- Setaflash Closed Tester (American National Standard Method (ASTM D 3278- 78)).

*Organic peroxides, which undergo auto-accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous Chemical: A substance which presents a physical hazard and/or has one or more properties for which there is statistically significant evidence that acute or chronic health effects may occur in exposed individuals. "Health effect" categories of chemicals include, but are not limited to, carcinogens, toxic agents, reproductive toxins, irritants, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucus membranes. Physical hazards include, but are not limited to, chemicals which are explosive, flammable, or corrosive.

Hazardous Drug: A drug that is approved for use in humans by the FDA; is not otherwise regulated by the U.S. Nuclear Regulatory Commission; and either a) is accompanied by prescribing information in the "package insert" that includes special handling information to protect workers handling the drug, or b) exhibits one or more of the following types of toxicity in humans, animal models, or *in vitro* systems: carcinogenicity; teratogenicity or other developmental toxicity; reproductive toxicity; organ toxicity at low does; genotoxicity; or structure and toxicity profile that mimics existing drugs determined hazardous by exhibiting any one of the previous five toxicity types.

Highly Toxic: A substance with a lethal dose (LD) or lethal concentration within the following limits. Oral: LD50< 50 mg/kg (oral rat), Inhalation: LC50 < 200 ppm / 1 hr. or 2000 mg/m3 / 1 hr. Skin Contact: LD50 < 200 mg/kg (rabbit).

IC: Institutes and Centers. An acronym used at the NIH that refers to organizational and management structure.

Irritant: Non-corrosive chemicals that cause reversible inflammatory effects (swelling and redness) on living tissue by chemical action at the site of contact.

Laboratory: A facility where "lab use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a nonproduction basis, including any laboratory located within an animal facility.

Laboratory Personnel: Any person working in an NIH laboratory that handles or uses potentially hazardous, and other, chemicals. At the NIH visiting scientists, guest researchers, special volunteers, students, and other similar personnel are included in the scope of the CHP.

Laboratory Scale: Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory Use: The handling and use of chemicals in which all the following conditions are met:

- Chemical manipulations are carried out on a laboratory scale;
- Multiple chemical procedures or chemicals are used;
- The procedures involved are not part of a production process, nor in any way simulate a production process; and
- "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

High-level hazard spill: A spill that cannot be controlled by the lab personnel and requires response from the Fire Department/outside agency. High-level hazard spills include spills of any volume of PHS, unknown chemicals, and pyrophoric/water reactive materials. Emergency response by the Fire Department must be initiated for any spill when any of the following criteria are met: the employee is uncomfortable or not trained to respond, the spill is likely to result in an uncontrolled release of hazardous substances, spill is not contained in the lab, appropriate spill kits are not readily available, the spill is more than 500 ml outside containment or more than 1 liter inside containment (e.g. CFH), or the response to a release poses a potential safety or health hazard to the responder.

Low-level hazard spill: Low-level hazard spills can be cleaned by a laboratory employee without the assistance from the Fire Department/outside agency. As a general guideline, spills that are less than 500 mL outside containment and less than 1 liter inside containment of non-PHS, are within a lab or contained area (such as inside the chemical fume hood) AND are low hazard (NOT pyrophoric, water reactive, unknown chemical) are considered low-level hazard.

Medical consultation: A consultation that takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where significant exposure to a hazardous chemical may have taken place.

Organic peroxide: An organic compound that contains the bivalent –o-o- structure and which may be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced with organic groups.

Oxidizer: A chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases. Oxidation reactions are a frequent cause of chemical accidents. When stored, segregate oxidizers from flammable and combustible materials, organic material, and

reducers.

Particularly Hazardous Substances: These include "select carcinogens," reproductive toxins, and substances that have a high degree of acute toxicity. See Appendix B for guidance in identifying particularly hazardous substances.

Permissible Exposure Limits (PELs): An exposure limit for OSHA regulated substances specified in 29 CFR part 1910.1000, Subpart Z, Toxic and Hazardous Substances.

Peroxide-forming chemicals: Peroxide forming chemicals are a group of chemicals that can under proper conditions form explosive peroxides which can be detonated by shock or heat.

Physical hazard: According to OSHA physical hazard means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust.

Protective laboratory practices and equipment: Laboratory procedures, practices, and equipment accepted by laboratory health & safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Pyrophoric Chemicals: Pyrophoric materials (e.g., boranes, n-butyllithium, white phosphorus) ignite spontaneously in contact with air. Avoid spills by storing breakable glass bottles inside secondary containment made of compatible plastic or other shatterproof material. Use and store all pyrophorics in an inert atmosphere (e.g., stored under nitrogen or argon). Follow DS guideline for handling pyrophoric and water reactive chemicals.

Reactive Chemicals: Highly reactive chemicals include those which are inherently unstable and susceptible to rapid decomposition as well as chemicals which, under specific conditions, can react alone or with other substances in a violent uncontrolled manner, liberating heat, toxic gases, or leading to an explosion. Reaction rates almost always increase dramatically as the temperature increases. Therefore, if heat evolved from a reaction is not dissipated, the reaction can accelerate out of control and possibly result in injuries or costly accidents.

Reproductive Toxins: Chemicals that affect an individual's reproductive ability including chromosomal damage (mutations) and/or have an adverse effect on a fetus (teratogenesis).

Secondary Container: A container (different from the original packaging) in which substances have been aliquoted or diluted in for use (I.e., 10% bleach solution in a spray bottle). Some of these secondary containers require appropriate labeling.

Secondary Containment: A protective measure that prevents spills or leaks from hazardous chemicals spreading if primary containment system fails. Typically, secondary containment is tear and puncture resistant, impervious to moisture and leak-proof, and requires labeling.

Select Carcinogen: A substance which meets one of the following criteria:

- It is regulated by OSHA as a carcinogen; or
- It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IRAC) (latest editions); or
- It is listed in either Group 2A or 2B by IRAC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
  - After inhalation exposure of 6-7 hours per day, 5 days per week, for significant portion of a lifetime to dosages of less than 10mg/m3;
  - After repeated skin application of less than 300 (mg/kg of body weight) per week; or
  - After oral dosages of less than 50 mg/kg of body weight per day.

Sensitizer: A chemical that causes exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Shock-Sensitive/Explosive Materials: Can spontaneously release large amounts of energy when struck, vibrated, dropped, or agitated. Some chemicals become increasingly shock sensitive with age, so inspect your stock of reactive chemicals regularly to see if they are degraded and should be disposed of.

Target organ effects: Effects on specific body systems which may occur because of exposure to a hazardous substance. These effects include hepatotoxins, nephrotoxins, neurotoxins, agents which act on the blood or hematopoietic system, agents which damage the lung, reproductive toxins, cutaneous hazards, and eye hazards.

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Threshold Limit Value (TLV): An airborne concentration of a specific substance under which it is believed that nearly all workers may be exposed for 8 h/day, 5 days/week for a working lifetime, without suffering adverse health effects. TLVs are exposure guidelines established by the American Conference of Governmental Industrial Hygienists (ACGIH).

Toxic: A chemical that falls in one of the following categories:

- Has a median lethal dose (LD50) of more than 50 mg/kg but not more than 500 mg/kg of body weight when administered orally to albino rats weighing between 200 and 300 grams each; or
- Has a median lethal dose (LD50) of more than 200 mg/kg but not more than 1,000 mg/kg of body weight when administered by continuous contact for 24 hrs. (or less if death occurs before 24 hrs.) with the bare skin of albino rabbits weighing between 2 and 3 kg each; or
- Has a median lethal concentration (LC50) in air of more than 200 parts per million (PPM) but not more than 2000 PPM by volume of gas or vapor, or more than 2mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1hr (or less if death occurs within that hour) to albino rats weighing between 200 and 300 grams each.

Unstable (reactive): A chemical, which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure, or temperature.

Volatile: Having the tendency or ability to evaporate readily.

Water-reactive: A chemical that reacts with water to release a gas that is either flammable or presents a health hazard. .Follow DS guideline for handling pyrophoric and water reactive chemicals.

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APPENDIX H
Hazardous Material Spill Procedure

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APPENDIX H
Hazardous Material Spill Procedure

Laboratory emergencies such as spills require prompt action to prevent or reduce undesirable effects. Laboratory employees must be able to immediately take control of the situation, quickly assess the existing and potential hazards, and carry out the appropriate response actions.

Immediate hazards of fire, explosion, and release of toxic vapors and gases are of prime concern. The following emergency response procedures contain minimum specifications that must be followed by all NIH laboratory workers. In addition, written emergency response plans for specific hazards in the laboratory must be developed by the PI/supervisor and provided to all laboratory members. These written emergency response procedures must also specify the proper spill control equipment or material to be used.

Even a small amount of spilled flammable liquid or reactive substance presents a significant fire hazard as there are many spark sources in laboratories. Any uncontained chemical that can disperse fumes, gases, or dust may be hazardous to your health and the health of those around you.

Spill Control Equipment

Each department must have appropriate spill control items available for each laboratory. Items may include commercial spill control items such as HAZMAT absorbents (absorbents that can be used for any chemical spill-acid, base, solvents, unknowns, etc.), inert absorbents and absorbent pads, pillows and rolls, as well as collecting devices such as scoops, brooms, and dustpans. Spills of most liquid acids or bases can also be neutralized (neutralize acids with soda ash or sodium bicarbonate. Bases can be neutralized with citric acid or ascorbic acid). Since the neutralization of acids and bases can be very vigorous causing splashes and exothermic reactions, it is recommended not to use the neutralization approach. Spills of acids and bases can be absorbed using HAZMAT absorbents.

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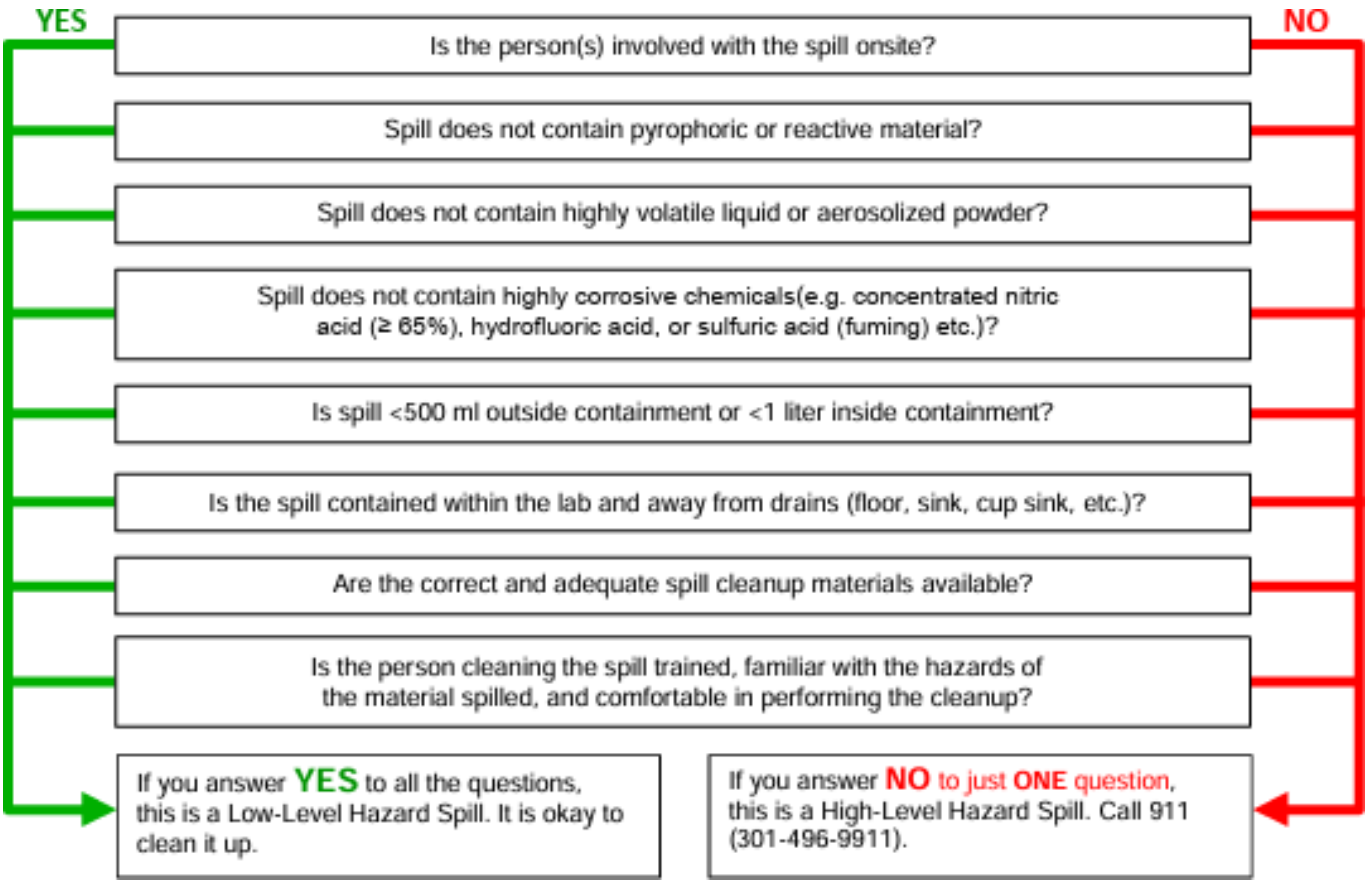
Spill Response

Is the Spill a High-Level Hazard or Low-level Hazard? Answer the questions below.



Responding to high-level hazard spills (a spill that requires help from Fire Department):

- Everyone leaves the area closing doors behind exiting staff;
- Prevent others from entering the area;
- Initiate first aid at the work site to any exposed or injured employees:

- **Eyes:** Begin using the eyewash immediately. Remove contact lenses as soon as practical, but do not delay eye irrigation while waiting for contact lens removal. Irrigate the eyes for 15 minutes, or as stipulated by the chemical's SDS, holding the eyelids open with thumb and index fingers, rolling the eyelids to permit thorough cleaning.

- **Skin:** Remove contaminated clothing. Use the nearest emergency shower for 15 minutes, or as stipulated by the chemical's SDS. Use a clean lab coat or spare clothing for cover-up.

- Call or have a co-worker call the Fire Department: 911 on-campus and 9-911 off-campus. If calling from a cell phone on Bethesda campus, call 301-496- 9911;

- Notify the supervisor;

- Report to OMS, Building 10, Room 6C306 (301-496-4411) within one hour of exposure (Monday-Friday 7:30 AM to 5:00 PM) or site-specific OMS location. If OMS is closed, promptly call the Clinical Center Operator at 301-496-1211 and ask them to page the on-call OMS physician immediately; and

- Do not reenter the room until the Fire Department or appropriate authorities determine that the area is safe.

For low-level hazard spills: As a general guideline, spills <500 ml outside containment (inside the lab on a bench top etc.) or <1 liter inside containment (CFH) of non-PHS AND are low-level hazard (NOT chemicals which are pyrophoric, water reactive, unknown) are considered low-level hazard. However, DO NOT attempt to clean up a spill unless you are comfortable cleaning up, have the training, and an appropriate spill kit is available to clean the spill with no risk to yourself or others.

- Use appropriate absorbent material to absorb the spill;

- Bag separately; and

- Follow the NIH Waste Disposal Guide for instructions on disposal.

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Spill Control for Powders

Powders can spread easily, and caution must be used to prevent the contamination of entire lab and adjacent areas.

In the event of a powder spill:

- Step slowly as you leave the lab;
- Leave your shoes and any contaminated clothing (lab coat) at the door to prevent spreading the contamination;
- Secure the lab preventing access;
- Minimize ventilation; and
- On the Bethesda campus call 911 (landline) or (301) 496-9911 (cell phone).

Spill Control for Acids, Alkalis and Solvents

As a general guideline, spills of less than 500 mL outside containment (such as inside the lab on a benchtop) and less than 1 liter inside containment (such as CFH) of these materials are considered small- (refer to the above spill response flowchart above).

Whenever a spill occurs, treat the spill as a potentially dangerous situation until the spill is cleaned up or there are positive indications (for example, instrumental monitoring) that no hazard is present. ICs, in conjunction with DS, must develop spill response contingency plans to deal with potential releases of extremely hazardous materials that are used in their department.

Mercury Spills

The NIH has developed a policy on Procurement, Use and Disposal of Mercury and Its Compounds. This policy; (1) restricts the procurement of mercury-added products with NIH appropriated funds; (2) prohibits the use of mercury, and its compounds, on all facilities owned, operated or leased by NIH, when an acceptable substitute is available; (3) requires the elimination of existing devices containing mercury in use on all NIH facilities; and (4) provides exceptions, and procedures, for obtaining exceptions for necessary scientific and medical uses of mercury. The Campaign for a Mercury Free NIH seeks to eliminate all unnecessary uses of mercury in the NIH facilities; encourage use of safer alternatives in biomedical research; increase general awareness of mercury hazards; and prevent mercury spills and pollution.

Liquid mercury is a proven neurotoxin. It has been decided that mercury containing equipment will not be used at the NIH if possible. While mercury salts are toxic by ingestion, the prime toxicity of liquid mercury is in the form of vapor. Mercury spills present a special problem because of the difficulty in picking up the tiny droplets and the hazards of undetected residues. Metallic mercury remaining in cracks and crevices will give off toxic vapors for years. NEVER ADD MERCURY WASTE TO ANY OTHER WASTE OR VICE-VERSA. It all becomes mercury waste, which requires costly disposal. All mercury spills are 'High-Hazard' spills and require immediate evacuation of the space and notification of the Fire Department,

For all Mercury Spills:

- Leave the area immediately;
- Close the doors;
- Remove all potentially contaminated items such as shoes and lab coats;
- Prevent others from entering the area; and
- Call the Fire Department at911 on-campus and 9-911 off-campus. If calling from a cell phone on Bethesda campus, call 301-496- 9911

Refer to Assistance with Mercury Spills for details.

Biohazard Spills

- Quickly assess whether there are any injured people and attend to any person who may have been contaminated;
- Remove contaminated clothing immediately and decontaminate;
- Close the laboratory door;
- To clean up the spill and decontaminate the area, wear PPE (appropriate lab coat, gloves, and eye protection - safety glasses or goggles). Wear a mask if necessary;
- Cover spill area with absorbent material;
- Apply a 1:10 solution of household bleach (sodium hypochlorite) directly to the spill area;
- Allow the solution to remain for at least 30 minutes before rinsing; and
- Dispose of all contaminated and clean-up material using a mechanical device such as forceps and place in a BIOHAZARD BAG.

Radioactive Spills

Only trained radiation workers should clean radioactive spills. Consult the DRS website or Radiation Safety Guide for additional details on radioactive spill response.

Notify

You may call DRS for any radioactive spill. However, spills must be reported to DRS (301-496-5774) promptly if any of the following occur (after hours call the NIH Fire Department or ECC)

- Personnel contamination or injury involving the radioactive material (lifesaving actions and response always takes precedence over contamination issues);
- Contamination is in an unrestricted area (hallway, office, unposted lab, etc.);
- Spill involves >1 liter of liquid;
- Spill involves >1 mCi of activity; or
- Spill involves >10 ft^2 (not necessarily contiguous) area.

Actions

- ALERT – make sure others in the area are aware a spill has occurred and to stay clear of the area – cordon off area if it is well-defined;

- PPE – anyone addressing the spill should be in a lab coat, shoe covers/booties and gloves; change gloves and booties regularly to avoid spreading contamination;
- MONITOR – make sure anyone who was in the area when the spill was discovered is checked for contamination, especially shoes, before allowing them to leave; bag up any contaminated clothing and check skin underneath;
- SKIN – monitor for skin contamination; if any is found, record the count rate and gently wash the area in the nearest sink; note reductions in count rate; STOP if no longer reducing the count rate or if skin becomes irritated from washing;
- COVER/CLEAN – cover the spill with absorbent paper; if cleaning the spill, work from the outside edges inward and minimize the amount of water added; DO NOT ask housekeeping staff to assist or borrow their equipment;
- MITIGATE – limit movement in and out of the spill area; check anything leaving the spill area carefully for contamination;
- COLLECT WASTE – treat all cleaning materials and disposable PPE items as radioactive waste;
- RECOVERY – monitor cleaned area with survey meter appropriate for the nuclide involved; final survey to clear area should ALWAYS be a smear/swipe survey, regardless of nuclide; and
- RECORDKEEPING – Retain copies of incident notes and final smear/swipe survey results; these are subject to DRS review.

Leaking Compressed Gas Cylinders

Occasionally, a cylinder or one of its component parts develops a leak. Such leaks often occur around the manifold in areas such as valve threads, safety devices, valve stems and valve outlets.

If a leak is suspected:

- Leave the area immediately;
- Secure the area and deny access;
- On the Bethesda campus call 911 (landline) or (301) 496-9911 (cell phone);
- Notify Lab manager; and
- Do not return to area until the Fire Department has cleared the area.

Note: Cryogenic liquid containers such as liquid nitrogen, liquid argon, liquid oxygen, and liquid helium may vent periodically to relieve head pressure build up caused by vaporization of product from leakage of heat from the environment into the container. This is a normal process of functioning containers. If a venting event appears abnormal (larger volume or longer duration than normal) follow the procedures listed above.

Refer to compressed gas and cryogen safety guidelines for information on the management of compressed gas cylinders in the laboratories.

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General Decontamination Procedures

Hand Decontamination

- Wash hands completely with soap and water; and
- Rinse completely; dry with a clean towel or air dry.

Clothing, Tool/Equipment Decontamination

- Contact DS, DRS, the Fire Department, and/or the DEP for guidance on cleaning and disposal of contaminated objects;
- Never take contaminated clothing home for cleaning. Use an approved laundering service;
- Do not immerse electrical or battery-operated tools/equipment in water or disinfectant solutions. Clean exterior with a rag soaked with soap and water or disinfectant solution and air dry thoroughly before re-use
- For decontamination of primary barrier equipment review the CFH Cleaning Fact Sheet and/or https://ors.od.nih.gov/sr/dohs/Documents/biological-safety-cabinet-enhanced-surface-cleaning-nih.pptx as appropriate.

Decontamination and Disposal/Surplusing of Laboratory Equipment

NIH policy 26101-25-2-04-Perasonal Property Management Guide provides policies and procedures related to the Disposal phase of the Property Management Lifecycle including decontamination, disposal/surplusing and recordkeeping. Equipment that are contaminated with hazardous materials must be decontaminated by following appropriate protocols and tagged with NIH Form 2683, Certification that Property is Free from Hazards, prior to turn-in as excess. ICs are responsible for ensuring the proper decontamination and sanitization certifications for property are completed prior to reporting the property as excess. Property users must refer to DS decontamination guidelines or contact their DS Safety Specialist for chemical and biological decontamination requirements. PCOs/ICs shall retain all records including NIH Form 2683 in accordance with current NIH Records Management and Federal guidelines. Contact your IC Records Liaison or the NIH Records Officer for additional information.

APPENDIX I
Laboratory Hazard Analysis

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The Laboratory Hazard Analysis form is on the next page.

APPENDIX I
Laboratory Hazard Analysis

Name of process:

Chemical name / CAS #:

Identify (if any) environmental conditions (temperature, pressure, anaerobic, etc.):

Describe general procedure:

List physical/health hazards & assoc. engineering controls:

Administrative practices (including storage and waste procedures, OMS requirements):

Personal protective equipment (PPE):

***All laboratory work requires DS online and in-class training**: https://www.safetytraining.nih.gov/.*

List additional training required for this laboratory hazard analysis:

Additional comments:

PI Name: _____ Signature: _____ Date:_____

Lab Identifier (e.g. Research Name, Room #):

Researcher(s) Name(s):

1. _____ Signature:_____ Date:_____
2. _____ Signature:_____ Date:_____
3. _____ Signature:_____ Date:_____
4. _____ Signature:_____ Date:_____
5. _____ Signature:_____ Date:_____
6. _____ Signature:_____ Date:_____
7. _____ Signature:_____ Date:_____
8. _____ Signature:_____ Date:_____
9. _____ Signature:_____ Date:_____
10. _____ Signature:_____ Date:_____

APPENDIX J
Laboratory Personnel Safety Check List

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The Laboratory Personnel Safety Check List is on the next page.

APPENDIX J
Laboratory Personnel Safety Check List

Employee/Student Name: _____ Date: _____
IC/Branch/Unit: __ Bldg.: _____ Rm. #: _____
Principal Investigator: and/or Lab Supervisor: _____

The following procedures have been reviewed with this person prior to working in the laboratory.

Has the PI/Lab Supervisor discussed the nature of the research being conducted in the laboratory? ☐

Has the PI/Lab Supervisor discussed all hazardous components of the research? ☐

a. Chemical ☐
b. Biological ☐
c. Physical ☐

Has the employee/student received instruction on known symptoms associated with exposure to highly toxic chemicals or infectious agents used in the laboratory? ☐

Has the PI/Lab Supervisor discussed the need for the employee/student to inform health care providers of the hazardous substances used in the laboratory during each medical visit? ☐

Has the PI/Lab Supervisor reviewed the laboratory Chemical Hygiene Plan, Laboratory Hazardous Analysis and/or safety operating procedures with the employee/student? ☐

Has the PI/Lab Supervisor identified the location of Safety Data Sheets to the employee/student and demonstrated methods of access? ☐

Has hazard assessment information concerning Personal Protective Equipment required in laboratory been reviewed, and has the supervisor and employee signed off? ☐

Does the employee/student need a respirator? If yes, arrange for exposure evaluation, training, and fit testing through the Division of Safety. ☐

Have all Emergency Equipment locations/procedures been identified to the employee/student?

d. Emergency Shower ☐
e. Emergency Eyewash ☐
f. Fire Alarm Pull Station ☐
g. Fire Extinguisher ☐
h. Spill Kit ☐
i. Telephone (9-1-1) ☐

Has the PI/Lab Supervisor reviewed with the employee/student the laboratory signage system as indicated on the door? ☐

Have basic laboratory safety requirements been explained & reinforced? ☐

Has the employee/student signed up for the appropriate Laboratory Personnel Training? Refer to the page ☐

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All laboratory personnel must:

- ☐ **know** the hazards
- ☐ **understand** the hazards
- ☐ **have skills** to execute safe practices

Employee/Student _____ _____
Signature Date

Principal Investigator/ _____ _____ Lab
Supervisor Signature
Date

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APPENDIX K
Program Evaluation and Improvement

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The Program Evaluation and Improvement template is on the next page.

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Program Evaluation and Improvement

CHP CY [2025]

This table will be completed in accordance with the guidance provided by OSHA's webpage on Recommended Practices for Safety and Health Programs

Requirement	Not Implemented	Partially Implemented	Implemented with only Minor Deficiencies	Fully Implemented	Evidence of Implementation	Planned Improvements
Performance indicators are used to track progress toward program goals.				✓		
Performance is tracked using both lagging and leading indicators.				✓		
Performance data are analyzed and shared with workers.				✓		
Management does an initial review (and subsequent annual reviews) to evaluate the program and ensure that it is fully implemented and functioning as planned.				✓		
Workers are involved in all program review activities.				✓		
Program reviews examine key processes to ensure that they are operating as intended.				✓		
The program is modified as needed to correct shortcomings.				✓		

This is a template only – as such it is filled out each year and used internally to guide future improvements.

APPENDIX L
Lab-specific SOP Templates

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The Lab-specific Chemical SOP template is on the next page.

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Lab-specific Chemical SOP Template

The purpose of this template is to be used to describe specific procedures used when working with chemicals.

STANDARD OPERATING PROCEDURE (SOPs)			
Title:			
Document No.	Document Page(s):	Author's Branch:	Effective Date:
Revision:	Revision Date:	Reviewed/Approved by:	Date:
Overseeing Official's Signature:		Date:	Procedure Location:

1 PURPOSE OF STANDARD OPERATING PROCEDURE

☐ **Specific laboratory procedure or experiment [Examples: synthesis of chemiluminescent esters, general organic synthesis, 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 solvents, 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 & 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.]

3. References
   [List all references you are using for the safe and effective design of your process or experiment, including safety literature and peer-reviewed journal articles.]

4 STORAGE REQUIREMENTS

[Describe special handling and storage requirements for hazardous chemicals in your laboratory, especially for highly reactive/unstable materials, highly flammable materials, and corrosives.]

5 STEP-BY-STEP OPERATING PROCEDURE

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

a. **Guidance on Engineering and Ventilation Controls – Review safety literature and peer-reviewed journal articles to determine appropriate engineering and ventilation controls for your process or experiment. Guidance is available from health and safety specialists through DS (301) 496-2960.**

b. **Guidance on Personal Protective Equipment - To assist with your PPE selection, contact your health and safety specialists through DS (301) 496-2960. Respiratory protection is generally not required for lab research, provided the appropriate engineering controls are employed. For additional guidance on respiratory protection see the** NIH respiratory protection program**.**

c. **Designated work area(s)** - *Required whenever* ***Particularly Hazardous Substances*** *(PHS) - carcinogens, highly acutely toxic substances, or reproductive toxins are used. Refer to the Chemical Hygiene Plan, Section X: Working with Particularly Hazardous Substances for more information.* The intent of a designated work area is to limit and minimize possible sources of exposure to these materials. The entire laboratory, a portion of the laboratory, or a laboratory fume hood or bench may be considered a designated area.

Describe the possible risks involved with failure to follow a step in the SOP in the right-hand column.]

Step-by-Step Description of Your Process or Experiment	**Potential Risks if Step is Not Done or Done Incorrectly (if any)**

1. Don personal protective equipment. ☐ appropriate street clothing (long pants, closed-toed shoes) ☐ gloves; indicate type: _____ ☐ safety goggles ☐ safety glasses ☐ face shield ☐ lab coat ☐ flame-resistant lab coat ☐ other: _____		
2. Check the location/accessibility/certification of the safety equipment that serves your lab:		
Item	**Status**	
Laboratory Fume Hood/Glove Box or other Ventilation Control	Location: _____ *Check sticker to ensure that hood was certified within last 12 months.*	
Eyewash/Safety Shower	Location: _____ *Ensure that it is accessible, not blocked.* *Check tag that it has been tested within last month.*	
First Aid Kit	Location:	
Chemical Spill Kit	Location:	
Fire Extinguisher	Location:	
Telephone	Location:	
Fire Alarm Manual Pull Station	Location:	
3. [*Describe the next step in the procedure.]*		
4. [*Describe the next step in the procedure. Insert additional rows in table, as needed.]*		

5. Dispose of hazardous solvents, solutions, mixtures, reaction residues, etc. as hazardous waste.	
6. Clean up work area and lab equipment. *[Describe specific cleanup procedures for work areas and lab equipment that must be performed after completion of your process or experiment. For carcinogens, acutely toxic substances, and reproductive toxins, designated areas must be immediately wiped down following each use.]*	
7. Remove PPE and wash hands.	

6 EMERGENCY PROCEDURES

1) Fire and/or Explosion Procedure

a) Have everyone evacuate to a safe area. If possible, close doors behind you as you leave.

b) Call the NIH Division of Fire and Rescue Services (fill out information for your site as appropriate below).

Bethesda (main campus): 911 on-campus;
9-911 off-campus,
301-496-9911 from a cell phone

Baltimore, MD
911 (cell phone)

Frederick, MD
911

Hamilton, MT
911

Research Triangle Park, NC
911 (landline)
919-541-2800 (cell phone)

c) Do not reenter the room until the Division of Fire and Rescue Services or appropriate authorities determine that there is no immediate detriment to life or health.

2) High-Level Hazard Spill Procedure

a) Spills >100 mL of any material or spills of Particularly Hazardous Substances of any volume may generate vapors above exposure limits; therefore, these spills may require the use of respiratory protection.

b) Cover spill, if possible, to minimize vapors. If the spill is in a chemical fume hood or biosafety cabinet, close the sash before leaving.

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c) Evacuate area and restrict access. Close the windows and doors upon exit. Attend to injured or exposed persons using emergency shower or eyewash. Follow procedures for chemical exposure below.

d) **MANDATORY: As soon as possible, you must report the spill in a safe area by notifying NIH Division of Fire and Rescue Services (see above).**

e) Stay near the site (in a safe area) until directed otherwise by first responders. Notify supervisor.

f) Be prepared to provide the following information:
   i) Name and phone number of knowledgeable persons that can be contacted.
   ii) Name of chemical spilled, concentration and amount spilled, liquid or solid type spill.
   iii) Number of injured, if any (refer to procedures for chemical exposure below).
   iv) Location of spill

g) Do not reenter the room until the fire department or appropriate authorities determine that there is no immediate detriment to life or health.

3) Chemical exposure

a) For any suspected or verified chemical exposures or injuries, Call the NIH Division of Fire and Rescue Services (see above). Upon arrival, first responders will provide medical attention/transportation to any exposed/injured employees and assist with spill clean-up.

b) **Sharps injury** (needlestick or subcutaneous exposure): scrub the exposed area thoroughly for 15 minutes using warm water and soap.

c) **Skin exposure:** If possible, scrub the expose area thoroughly for 15 minutes using warm water and soap per SDS guidance, if applicable. If an exposure occurs in an area that cannot be washed using a sink, remove contaminated clothing per SDS guidance if applicable. Use the nearest safety shower for 15 minutes, or as stipulated by the chemical's SDS. Use a clean lab coat or spare clothing for cover-up.

d) **Eye exposure:** Begin using the eyewash immediately. Remove contact lenses as soon as practical, but do not delay irrigation while waiting for contact lens removal. Irrigate the eyes for 15 minutes (or as stipulated by the chemical's SDS), holding the eyelids open with thumb and index fingers, rolling the eyelids to permit thorough cleaning.

e) **Inhalation exposure:** Evacuate the contaminated area. Close the door to the area and post a sign. Prevent others from entering. Do not re- enter the space but stay in proximity.

4) Local Cleanup of Low-Level Hazard Spills

Do not attempt to clean up spills requiring respiratory protection. Call the Fire Department for assistance.

In the event of a low-level hazard spill (<100 mL of materials that are not PHS) that can be safely cleaned up by local personnel using readily available equipment (absorbent available in the Small Chemical Spill Kit) and laboratory PPE:

1. Notify personnel in the area and restrict access. Eliminate all sources of ignition.
2. Review the SDS for the spilled material or use your knowledge of the hazards of the material to determine the appropriate level of protection.
3. Personnel must wear a lab coat or smock, safety goggles, chemical appropriate type gloves and shoe covers as needed when cleaning up spills.
4. **Liquids:** Wipe up spilled liquids with absorbent pads. If using a neutralizing absorbent, cover the spill with the absorbent and allow to set for the prescribed contact time (usually 15 min.), and then scoop up and dispose of properly.
5. **Solids:** Gently cover with wetted paper towels or absorbent pads (unless chemical is water sensitive or reactive) to avoid raising dust and then wipe up.
6. Clean the spill area thoroughly with approved cleaning solution followed by clean water.
7. If spill is extensive within the containment, clean all interior surfaces after completion of the spill cleanup.
8. Double bag all waste in clear plastic bags (NSN-8105-01-195-8730) and attach a filled out chemical waste tag. For waste collection instructions consult the NIH Waste Disposal Guide; for chemical waste pick-up contact (301) 496-4710; for chemical waste assistance call (301) 496-7990.
9. **MANDATORY: You must report the spill to your IC Safety and Health Specialist.**

5) Injuries and Exposures:

a) Remove the injured/exposed individual from the area unless it is unsafe to do so because of the medical condition of the victim or the potential hazard to rescuers.

b) Administer first aid as appropriate (see 3, above).

c) As soon as possible (from a safe location), call the NIH Division of Fire and Rescue. Fill out information for your site as appropriate below. **Bethesda** (main campus):

911 on-campus;
9-911 off-campus,
301-496-9911 from a cell phone

Baltimore, MD

911 (cell phone)

Frederick, MD
911
Hamilton, MT
911
Research Triangle Park, NC
911 (landline)
919-541-2800 (cell phone)

d) Report the injury as soon as possible to your local OMS clinic. Fill out information for your site as appropriate below.
Bethesda (main campus): Building 10, Room 6C306; (301) 496-4411
Baltimore, MD: 251 Bayview Blvd., BRC 01B210, (667) 312-5843
Frederick, MD: 8200 Research Plaza, Room 1B116; (301) 631-7233
Hamilton, MT: 903 South 4th Street, Room 5202; (406) 375-9755
Research Triangle Park, NC: 111 T W Alexander Drive, Building 101, Room E111; (984) 287-4178

e) Bring copies of the SDSs for all chemicals the victim was exposed to, to the OMS clinic.

6) Lab-Specific Procedures
[This section is for any emergency procedures different from standard responses, or for additional emergency information due to the nature of materials or task. Include information on gas leaks, chemical spills, and personal exposure/medical emergency as appropriate.]

7) Building Maintenance Emergencies

a) **Emergencies** should be called into the Maintenance Operations 24 Hour Center at (301) 435-8000.

8) Biosafety Lab Level 3 or 4 (BSL-3/BSL-4) facility issues, should be called into the **Maintenance Operations 24 Hour Center** immediately, at **(301) 435-8000.**
(Requester should identify specific Building, Location, Biosafety Level, on- site contact and Facility Issue when speaking to an agent.)

9) Unusual Odors should be considered a life safety **emergency. Enter specifics for your site below.**
Bethesda (main campus): 911 on- campus;
9-911 off-campus;
301-496-9911 from a cell phone
Baltimore, MD
911 (cell phone)

Frederick, MD
911

Hamilton, MT
911
Research Triangle Park, NC
911 (landline)
919-541-2800 (cell phone)

10) Local Notifications
[Identify the area management staff that must be contacted and include their work and after-hours numbers. This must include the principal investigator and may include the lab safety manager, facilities manager, etc.]

7 WASTE DISPOSAL

[Describe the quantities of waste you anticipate generating and appropriate waste disposal procedures. Include any special handling or storage requirements for your waste. Please see the NIH Chemical Waste Guidance Procedure for questions and guidance.]

8 TRAINING REQUIREMENTS

General Training *(check all that apply):*

☐ Introduction to Lab Safety – On-Line Training

☐ NIH Laboratory Safety Training 101

☐ Working Safely with HIV and Other Bloodborne Pathogens (for Non- Hospital Personnel)

☐ Other: _____

[Depending on the hazardous materials and processes you will be working with in this SOP, additional safety training may be required by NIH]

Location Where General Records Maintained:

Laboratory-specific training *(check all that apply):*

☐ Review of SDS for chemicals involved in process/experiment

☐ Review of this SOP

☐ Hands-on training

☐ Other: _____

Location Where Specific Records Maintained:

9 PRIOR APPROVALS

You **must** seek prior approval from your principal investigator (PI) or lab supervisor if you plan to use **Particularly Hazardous Substances (PHS)**.

You should also consult your PI or lab supervisor if your experiments involve **high-risk chemicals** (e.g., chemicals with a high level of acute toxicity,

carcinogens, reproductive toxins, and highly reactive materials) **and operations,** as special safety precautions may need to be taken. For additional guidance, see the Chemical Hygiene Plan.

Your PI or lab supervisor's prior approval may be documented by his/her signature in the Approval Signature section of this document.

Prior Approval ***(check if applicable):***

☐ Prior approval from the PI or lab supervisor is required for this procedure.

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APPENDIX M
Contact Information

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The Contact Information is on the next page.

APPENDIX M
Contact Information

Bethesda (Main Campus)

- Chemical Hygiene Officer – Rani Jacob: 240-961-1137
- Chemical Waste Services – 301-496-7990 (Assistance) 301-496-4710 (Pick-Up)
- Division of Emergency Management – 301-496-1985
- Division of Environmental Protection – 301-496-3537
- Division of Radiation Services – 301-496-5774 (7am-5pm), 911 (after hours)
- DS On-Site – 301-496-2960
- Emergency Communications Center (24-hour): 301-496-5685
- Fire Department – 911 or 9-911
- Maintenance Operations Center (24-hour) – 301-435-8000
- Occupational Medicine Service: 301-496-4411
- Office of Research Management: 301-594-0999
- Police – 911 (Off Campus or On Campus Landline); 301-496-9911 (On Campus Cell Phone)
- Safety and Health Specialist(s): Safety and Health Specialists (nih.gov)
- Scientific Director: Scientific Director Membership Roster | NIH Office of Intramural Research

Baltimore

- Chemical Hygiene Officer – Rani Jacob: 240-961-1137
- Chemical Waste Services – James Pitt: 667-312-5762
- Division of Environmental Protection – James Pitt: 667-312-5762
- DS On-Site – Delores Dobson: 667-312-5401
- Division of Radiation Services – DRS
- Fire Department – 911
- OMS - 667-312-5843; nidaoms@mail.nih.gov
- ORF – Maurice Nottage: 677-312-5760
- Police – 911
- Safety and Health Specialist(s) – Rhonda Walther (NIA): 667-205-2216; Carrie Wertheim (NIDA): 667-312-5403; Delores Dobson (Safety Manager): 667-312- 5401
- Scientific Director – NIDA - Dr. Amy Newman; NIA - Dr. Luigi Ferrucci

IRF Frederick

- Chemical Hygiene Officer – Contact DEP
- Hazardous Waste Services – Contact DEP at 240-236-9575
- Division of Environmental Protection – Mark Marshall: 301-631-7238
- Division of Radiation Services – Dustin Gibbs (Area Health Physicist): 301-631- 7226

- Environmental compliance officer – Mark Marshall: 301-631-7238
- Fire Department – 911 or 9-911
- OMS – 301-631-7233. Contact Main Campus if onsite clinic is closed or after hours
- ORF – 301-435-8000
- Police – 911 or 9-911
- Safety and Health Specialist(s) – Terry Bray : 301-846-1451;
- Scientific Director – Dr. Connie Schmaljohn

Rocky Mountain Labs (RML)

- Chemical Hygiene Officer – Rani Jacob: 240-961-1137
- Hazardous Waste Services – Arron Bestor: 406-363-9304
- Emergency Response: 301-496-1985 Coordinator; Yancy Wroble: 406-802-6271
- HAZMAT group – 406-802-6271
- Maintenance Operations Center (24-hour) – 301-435-8000
- OMS – 406-375-9600; Angie Allen: 406-363-9496; Marcie Caldwell: 406-375- 9755
- Office of Research Management – Eric Hansen: 406-802-6208
- Police – NIH Police: (406) 363-9492, Hamilton Police: 406-363-2100
- Radiation Safety/Environmental Compliance Officer – 406-363-9304
- Safety and Health Specialist(s) – Shanda Sarchette: 406-363-9429
- Security control – 406-636-9400 or 911

NIDDK-Phoenix

- Radiation Safety/Environmental Compliance Officer – Shannon Parrington: 602- 200-5308 or 520-275-2271
- NIDDK-Phoenix Collateral Duty Safety Officer (CDSO) – Maureen Clark: 602- 200-6590
- Safety Committee Chair – Vicky Ossowski: 602-440-6590
- Safety Committee member – Karen Kavena: 602-200-5367
- Safety Committee member – Dacia Sorrell: 602-200-5313

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