National Institutes of Health

Chemical Hygiene Plan

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Authored by the Division of Occupational Health and Safety (DOHS)
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
DOHS	Division of Occupational Health and 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
TAB	Technical Assistance Branch
TLV	Threshold Limit Value published by ACGIH
TWA	Time Weighted Average

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INTRODUCTION

The use of hazardous chemicals in the laboratory is a necessary part of modern biomedical research. To ensure the protection of laboratory personnel from the risks associated with the use of hazardous chemicals, 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, defined by OSHA as a facility where relatively small quantities of hazardous chemicals are used on a non-production basis. Traditionally, OSHA health standards have been established to help protect industrial and manufacturing workers who may be exposed to significant quantities of hazardous chemicals over a working lifetime. In contrast, the use of hazardous chemicals in research laboratories is generally limited to small quantities used on a short-term basis and in operations where the chemicals and procedures change frequently. The Laboratory Standard demonstrates that OSHA has recognized the need for a standard that focuses on the unique nature of laboratory work.

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, as defined by OSHA, must be "capable of protecting employees from health hazards associated with hazardous chemicals used in the laboratory."

The Laboratory Standard complements the provisions of the OSHA *Hazard Communication Standard* (29 CFR 1910.1200). In accordance with the *Hazard Communication Standard*, the National Institutes of Health (NIH) has established a written program, the *NIH Hazard Communication Program* for the use of hazardous chemicals outside of the laboratory. The NIH CHP is written specifically for the laboratory environment. Additionally, this laboratory 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.

I. PURPOSE

This plan outlines the information and services provided by the Division of Occupational Health and Safety (DOHS), Office of Research Services (ORS) and the Division of Environmental Protection (DEP), Office of Research Facilities Development and Operations (ORF) on the safe use, storage, and disposal of hazardous chemicals in the laboratory. This program is written to meet the specific safety and health requirements outlined in the Laboratory Standard.

II. SCOPE

This plan, designated in NIH Policy Manual Chapter 3034, complements the *NIH Hazard Communication Program*, which applies NIH-wide where hazardous chemicals are used. Specifically, the CHP applies to all laboratories and laboratory personnel of the NIH that use, store, or handle hazardous chemicals. This is inclusive of any laboratory located within an animal facility. A hazardous chemical is defined as 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 or highly 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. The definitions for the terms "laboratory" and "hazardous chemical" are listed in Appendix G (Glossary of Terms).

III. RESPONSIBILITIES

The **NIH Occupational Safety and Health Committee** (OSHC) is responsible for reviewing and evaluating the effectiveness of the CHP yearly and updating the plan as necessary.

The Chemical Hygiene Officer (CHO) when requested by a laboratory representative, is responsible for assisting with obtaining Safety Data Sheets (SDSs) for hazardous chemicals, working with laboratories to determine exposure possibilities, arranging for exposure monitoring, and implementing the CHP. The CHO assists the OSHC with updating the CHP annually.

The **Division of Occupational Health and Safety** (DOHS) oversees and develops programs focusing on laboratory safety and the proper handling of chemicals to ensure compliance with NIH Manual Chapter 3034 and the OSHA General Industry Standard (29 CFR 1910), which includes the Laboratory Standard. The DOHS branches assist with compliance. For instance, the Technical Assistance Branch (TAB) provides services such as respiratory fit, exposure monitoring, and air quality testing. For additional information regarding DOHS programs, contact your IC Safety Specialist, or visit the DOHS website.

In addition to assisting and overseeing adherence to OSHA regulations, the DOHS is responsible for communicating any pertinent updates to the CHP to stakeholders. Please notify DOHS if their procedure for notifying stakeholders of CHP updates should be changed.

The DOHS is responsible for conducting surveys of select laboratories, at least annually, to identify practices or procedures that may pose potential hazards to the health and safety of personnel.

The DOHS also provides 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 (including safety related ventilation equipment such as chemical fume hoods (CFHs), local exhaust ventilation systems (LEVs), biological safety cabinets (BSCs), and other containment systems).

The **DOHS Safety Operations and Support Branch** assists laboratory personnel in each Institute and Center (IC) in matters relating to chemical safety and exposure monitoring. Upon request, they review safety protocols for work involving hazardous chemicals to ensure that the proposed activities are conducted by trained personnel using the proper safety equipment and personal protective equipment (PPE).

The **DOHS Occupational Medical Service** (OMS) provides consultation and appropriate prophylactic or medical treatment in the case of exposure to hazardous substances. The OMS provides medical surveillance when chemical exposure monitoring data reveal an 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 **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, safety showers, 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, the maintenance personnel are responsible for conducting repairs to chemical fume hoods, safety showers, and general laboratory ventilation equipment. The maintenance personnel 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.

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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.

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. To demonstrate employee competency, training must be documented. A supervisor safety review checklist for the purpose of documenting training is provided in Appendix L.

Laboratory personnel are responsible for:

- Planning and conducting each operation in accordance with chemical hygiene procedures including the use of engineering controls, administrative controls, and PPE as appropriate;
- Developing and strictly adhering to sound personal chemical hygiene habits;
- Reporting incidents and possible chemical exposures promptly to their supervisor, and;
- Correctly segregating, packaging and labeling hazardous waste for disposal according to proper procedures listed in the NIH Waste Disposal Guide.

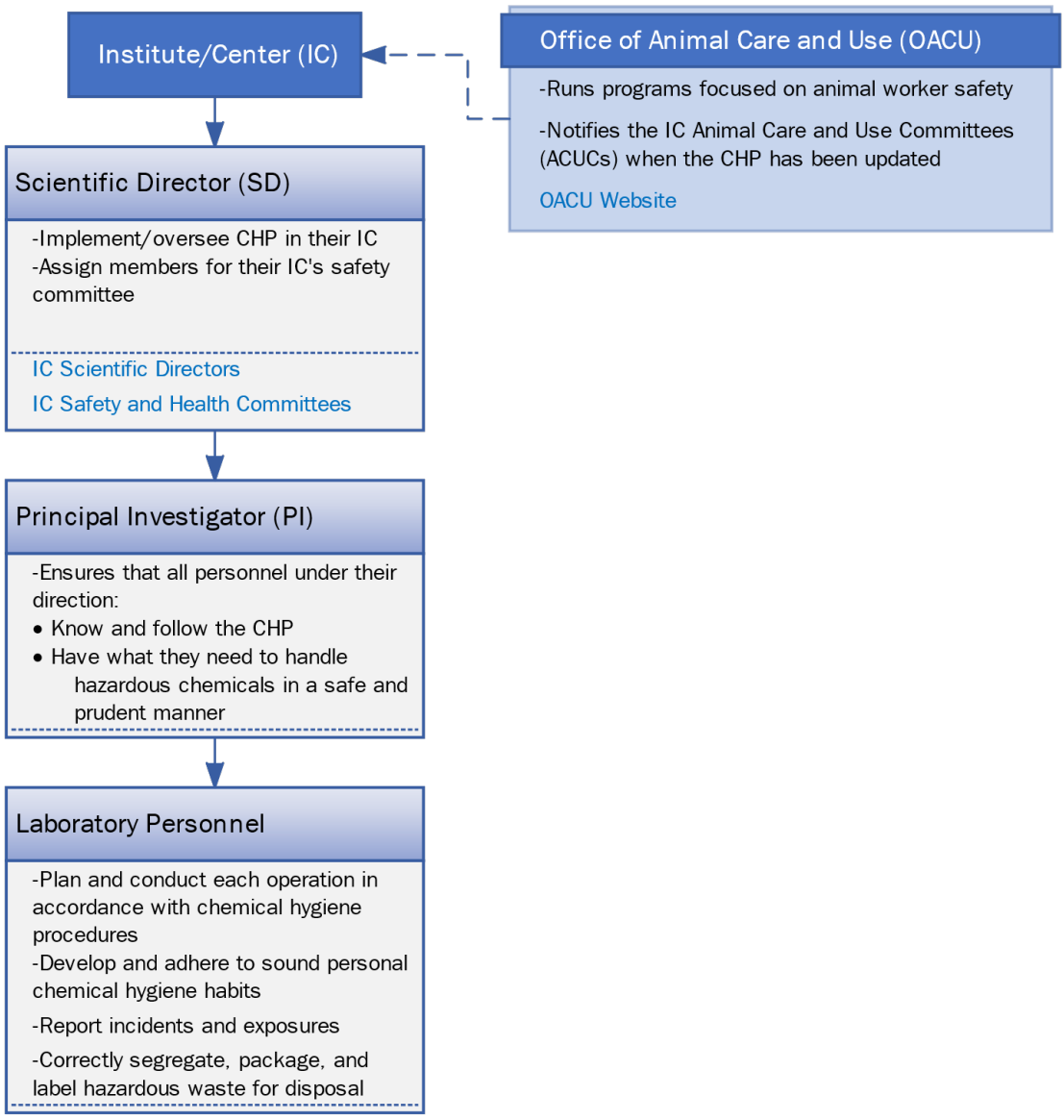

Figure 1. Overview of Responsibilities (IC level). This chart outlines the responsibilities related to the Chemical Hygiene Plan of the Office of Animal Care and Use, the Institute/Center, the Scientific Director, the Principle Investigator, and Laboratory Personnel.

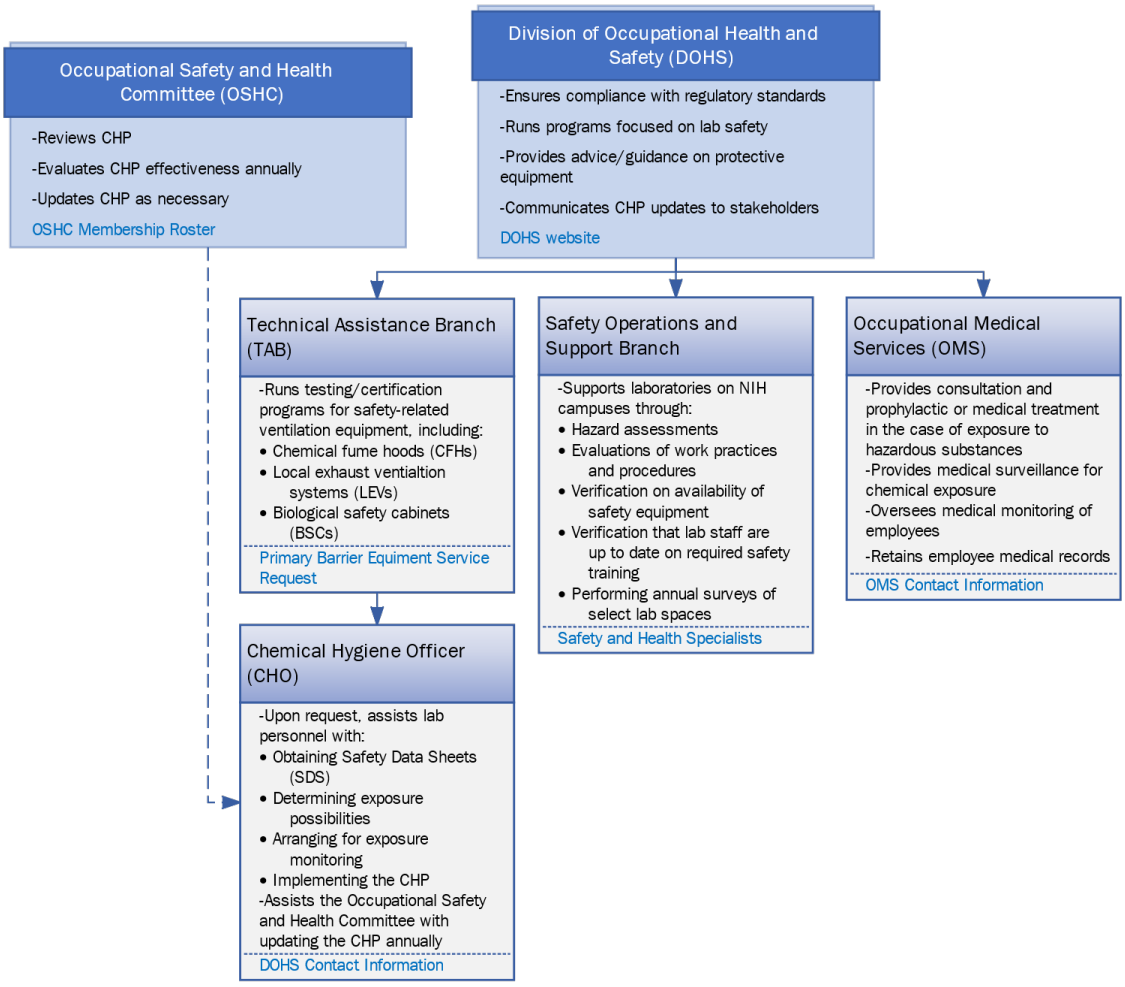

Figure 2. Overview of responsibilities (DOHS level). This chart outlines the responsibilities related to the Chemical Hygiene Plan of the Occupational Safety and Health Committee, the Division of Occupational Health and Safety (DOHS), the DOHS Technical Assistance Branch, the Chemical Hygiene Officer, the DOHS Safety Operations and Support Branch, and Occupational Medical Services.

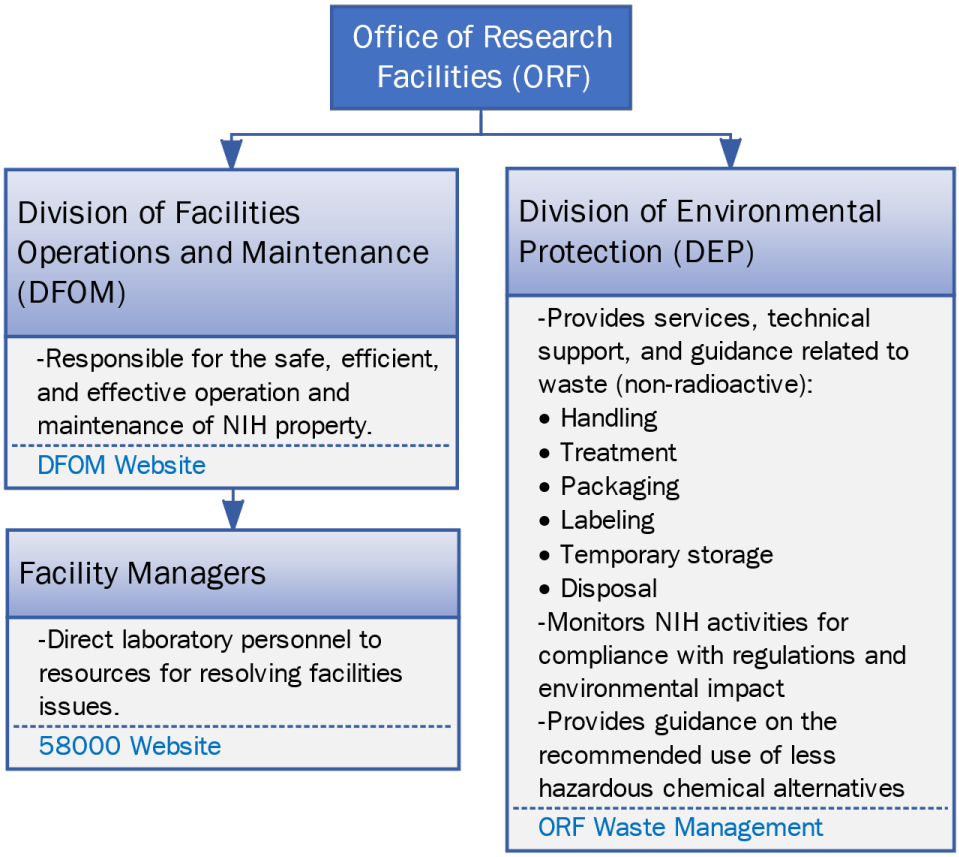

Figure 3. Overview of responsibilities (ORF level). This chart outlines the responsibilities related to the Chemical Hygiene Plan of the Office of Research Facilities (ORF), the ORF Division of Facilities Operations and Maintenance, and the ORF Division of Environmental Protection.

IV. TRAINING

Employees must be provided with training to ensure that they are apprised of hazards present in their work area, understand safety requirements, and PPE necessary to minimize their risk of an adverse exposure or contamination of the environment. This information must be provided 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 on 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.

DOHS 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 trainings offered by DOHS, visit the DOHS 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 must complete this course upon arrival at the NIH. The web-based training program is available online.

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 summer students and summer research associates.

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

V. LABELS AND SAFETY DATA SHEETS

Manufacturers are required to prepare and provide SDS for chemicals with hazardous properties. SDS for 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 a free collection of SDS to consult. Additional safety information should be reviewed before beginning work with a new material 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 DOHS is also available to assist workers with risk assessments.

Chemicals purchased from a manufacturer or distributed 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. Bottles or any container with missing information should have 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 container, the name of the chemical and any associated hazards must also be placed on each new container. If a chemical is stored within a secondary container, the secondary container must also be clearly labeled with the contents and hazards. See the Chemical Safety Guide for more information on GHS.

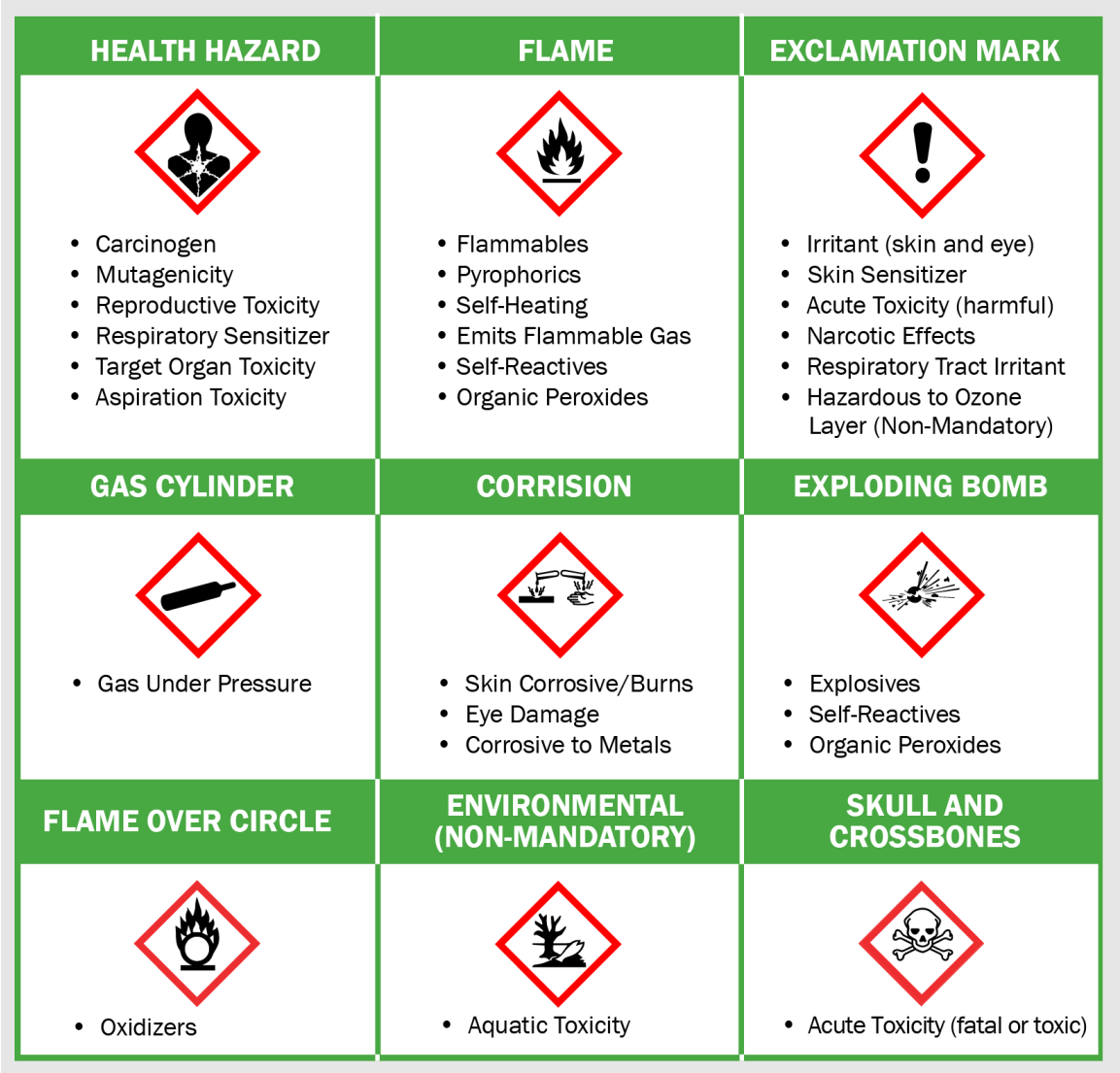

Figure 4. Universal pictograms for depicting chemical hazards. The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) requires the use of pictograms to alert users of the chemical hazards to which they may be exposed. The pictograms consist of a symbol which represents a distinct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

Any laboratory prepared solutions must be labeled with the chemical name (full name) and hazard warning(s). Containers, including secondary 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 trained on the hazards and appropriate protective measures. If a

chemical or byproduct's hazard status is unknown, it shall be assumed that the substance is hazardous. 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 on the hazards of the chemicals they work with. Chemical SDS may be used when determining the hazards of working with the chemical and when generating standard operating procedures (SOPs). A specific chemical hazard template is provided in Appendix N. This template can be used for describing the hazards of a given chemical and outlining controls, PPE, handling procedures, storage requirements, spill and accident procedures, emergency responses, waste collection, and disposal. In addition, it may be used as a form of training documentation. A SOP template is also provided in Appendix N. This template can be used for describing lab-specific procedures in which hazardous chemicals are used, and provides a 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.

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.

The following measures shall be taken to reduce the risk of an incident during transport:

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

- Compressed gas cylinders must always be strapped in a cylinder cart with the valve protected by a cap; and

- 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, storage rooms, shared equipment areas, cold rooms and other areas lacking the appropriate facilities and a proper means of ventilation.

Chemical exposures are minimized using engineering, administrative and work practice controls, 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 an especially hazardous risk. See Appendix F for guidance on selection of PPE.

Elimination/Substitution Controls:

- Do not use hazardous chemicals if it can be avoided; and
- Substitute a less hazardous chemical that can provide the desired results.

Engineering Controls:

- Chemical Fume Hoods (CFHs) and other Local Exhaust Ventilation (LEV) options such as down draft tables and slot hoods are the primary engineering methods of controlling inhalation exposures to hazardous chemicals in the laboratory. CFHs provide ventilation to carry away airborne contaminants 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 CFHs and LEVs used at the NIH must meet the NIH design specification. ICs may purchase CFHs only through ORF. DOHS review of any renovation affecting ventilation is required, per the NIH Design Requirements Manual (DRM). Note that ductless fume hoods are not permitted at NIH;
- Any alteration affecting CFHs and LEVs or associated ductwork must be approved by DOHS prior to the system's modification. Note that meeting design specifications 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 DOHS and ORF to ensure safe operation of all ventilation equipment. Contact the ORF DFOM for facility-related inquiries;
- Ductless CFHs are not permitted to be used in NIH laboratories. Captured organic vapors begin to desorb from the charcoal filters shortly after adsorption occurs. Some degree of breakthrough or capture failure occurs during introduction of vapor into the hood;

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- Conduct all work within the CFH at a distance of at least six inches behind the face opening and position the vertical sliding sash no higher than the height specified on the certification sticker. Avoid blocking the airfoil, baffles, and rear ventilation slot. Support large items on platforms or shelving with legs that raise the item(s) above the ventilation slot to minimize airflow disruption across the work surface;

- Minimize foot traffic around the CFH during use, since passing in front of the hood during operation disrupts the airflow and may pull contaminants out of the hood. Do not use the CFH for storage. By following these steps, the hood provides adequate containment for most chemical operations;

- CFHs equipped with alarms will alarm when the speed and volume of air moving through the hood falls outside set parameters. It is prudent to verify CFH function 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 or if the "tissue test" fails, mark the unit as "Do Not Use," and submit a work request to ORF to repair the dampers or exhaust fan. Contact DOHS to recertify the CFH prior to reuse, or if there is question about the function of the CFH; and

- 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 and prions. As their names suggest, BSCs are not interchangeable with CFHs, 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, please consult the Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition Appendix A for further guidance on biosafety cabinet characteristics, which compares classes of BSCs with notes on nonvolatile and volatile chemical use.

Administrative Controls:

- Keep and consume food, beverages, cosmetics, and medication outside the laboratory;

- Keep all doors to the laboratory closed. Open laboratory doors can adversely affect CFH performance and appropriate air flow through the building;

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

- 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 DOHS 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;

- 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";

- Contact DOHS (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.

Work Practice Controls:

- Read the SDS and become familiar with the chemical characteristics, hazards and exposure limits before using a chemical;

- Keep work area clean and uncluttered, with chemicals labeled and stored (see Appendix D) based on chemical compatibility;

- 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 gasses, combustible, flammable or toxic materials and are designed for use with aqueous solutions only. There are special designed vacuum systems available for use with hazardous chemicals;

- 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 appropriate for wear in any laboratory, especially when handling particularly hazardous substances (PHSs). Laboratory coats must not be worn outside the laboratory;

- Wear the appropriate gloves and eye/face protection whenever handling hazardous chemicals. These items must not be worn outside the laboratory;
- Remove gloves carefully and thoroughly wash hands and forearms upon completion of work and before leaving the laboratory;
- Use a certified CFH when opening, transferring, or handling volatile hazardous chemicals;
- Never pipette by mouth;
- Transport laboratory chemicals using bottle carriers and suitable carts;
- Follow the established procedures for the decontamination and safe movement of scientific and medical equipment;
- In the event of a hazardous chemical spill, immediately call 911 (landline) or (301) 496-9911 (cell phone) and follow additional procedures listed in Appendix H;
- Minimize all chemical exposures and avoid underestimating the risk. Avoid unnecessary exposure to chemicals by any route of exposure;
- When diluting a concentrated acid or base, always add the acid to the water;
- Handle glassware properly and carefully. Do not use damaged glassware. 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;
- 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;
- 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 the substances in the event of failure of an engineering control such as a fume hood or utility service;

- Do not underestimate risks. Assume that any mixture will be more hazardous than its most hazardous component and that all substances of unknown toxicity are toxic; and

- When working with flammable chemicals, use a maximum working stock of 500 mL, or the minimum allowed working stock for instrumentations.

Contact the 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 DOHS.

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

VIII. CHEMICAL STEWARDSHIP

The prudent selection, purchase and use of chemicals in the laboratory and the cost associated with the proper disposal of chemical wastes are inextricably linked. According to the American Chemical Society, the cost associated with chemical disposal is an average of 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:

- Order chemicals in the least amount needed to perform the work; and

- 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 wastes. 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.

IX. PERSONAL PROTECTIVE EQUIPMENT

Appropriate PPE is essential for worker protection and is used in combination with safe work practices and physical containment devices such as CFHs. PPE alone does not provide adequate 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 a 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.

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.

Reference Appendix J for Dr. Michael Gottesman's May 2015 memorandum, titled "Laboratory Safety Responsibilities" regarding PPE expectations.

Gloves: Disposable gloves are one of the most commonly used types of PPE in the laboratory. The proper use of disposable gloves provides protection to the wearer by providing a barrier to potential hazards. Gloves also provide product protection by protecting experimental materials from enzymes or DNA on the glove wearer's hands. Select the correct glove for the task (see Appendix F). Certain gloves do not afford appropriate chemical protection and no single 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; and

- Gloves must not be worn in common-use areas and outside laboratory rooms, outside animal holding rooms or outside 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.

Consideration for size and comfort is important for the use of both disposable and reusable gloves. Proper size will ensure proper dexterity and maintain glove integrity while sufficient comfort will encourage continued use by the wearer.

Protective Garments: 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.

Eye and Face Protection: Prescription safety glasses provide protection for the eyes from flying objects and are available through the OMS. 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 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 must not be used, purchased and/or used without prior approval by the DOHS. 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 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:

- Substitution of chemicals presenting 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.

The NIH abides by the OSHA Respiratory Protection Standard. The DOHS 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. Visit the DOHS webpage on Respiratory Protection for more information or to read the Respiratory Protection Program document.

X. WORKING WITH PARTICULARLY HAZARDOUS SUBSTANCES

The PI is responsible for ensuring that appropriate precautions are taken when working with hazardous chemicals and that appropriate training is provided before working with these materials. When planning for the use of any hazardous chemical in the laboratory, the PI must determine if that hazardous chemical is also a PHS. Such determination shall

consider the employee exposure potential, volume of chemical used, ability to identify health effects from employee exposure, and practical use of exposure control methods.

Criteria to classify a chemical as PHS include:

- Can cause severe, acute or lethal effects upon exposure by any route in quantities of 50 µg/kg or less;
- Are highly unstable or, when combined with other compounds in the procedure, are explosive;
- May undergo chemical or physical changes during routine use and generate by-products that may overcome standard control measures or may penetrate available PPE to cause severe, acute or lethal injuries;
- Have been determined by the DOHS to present a unique hazard or are used in an operation that requires approval above the level of the laboratory supervisor;
- Carcinogens;
- Reproductive toxins; or
- Listed as a PHS in Appendix B.

To determine if a specific chemical should be classified as a PHS, the Particularly Hazardous Substance Identification flow chart in Appendix B may be followed. Additionally, further resources may be found on OSHA's Laboratories website.

When a chemical is classified as a PHS, the PI shall develop a specific written Standard Operating Procedure (SOP) (which includes a Laboratory Hazard Analysis) and train potentially exposed workers prior to beginning work. This SOP should include:

- A description of the substance(s) to be used, including the potential physical and health effects;
- A step-by-step review of the work to be performed;
- A list of the available engineering controls, work practices to be utilized, and PPE;
- Designated areas for chemical use;

- Provisions for proper labeling, storage and waste disposal;
- Decontamination procedures; and
- Accident/spill procedures to include emergency contact information.

Note: When a PHS will be used for the first time, the PI must also notify their safety specialist of its use. The PI, with the assistance of the safety specialist and the CHO, will perform a specific chemical hazard analysis. The PI will develop a lab-specific SOP based on this hazard analysis. A specific chemical hazard analysis template and a lab-specific SOP template can be found in Appendix N. 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 hydrogen fluoride, MPTP, phenol, and hydrogen cyanide.

An example of a Laboratory Hazard Analysis form can be found in Appendix K. Specific Chemical Hazard and SOP templates can be found in Appendix N.

XI. PRECAUTIONS REQUIRED FOR WORKING WITH PARTICULARLY HAZARDOUS SUBSTANCES

PHSs include select carcinogens, reproductive toxins and chemicals that have a high degree of acute toxicity. Substance-specific information is contained in each chemical's SDS and is also available through your IC Safety Specialist (301-496-3353). Appendix B contains a reference list of suggested PHSs, and those for which OSHA has specific standards. Please note that this list is not comprehensive but represents chemicals of concern that may be found in laboratories.

The Technical Assistance Branch (TAB) of DOHS has established surveillance programs that monitor for exposure to certain chemicals such as formaldehyde, ethylene oxide, xylene and others. Additionally, OMS has medical surveillance programs that may impact be required when using some hazardous chemicals. For more information contact your IC Safety Specialist.

In 2001, the "Mad as a Hatter?" campaign for a mercury-free NIH was launched. NIH Policy Manual Chapter 3033 exists to govern the "Procurement, Use, and Disposal of Mercury and Its Compounds."

Safe Work Practices with PHSs include but are not limited to the following:

- 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 PHSs. Contact your IC Safety Specialist for assistance;

- Consult the regulations, TAB/DOHS or OMS to determine if medical surveillance may be warranted if toxicologically significant quantities of PHSs are used on a routine or frequent basis;

- Contact the DEP at 301-496-7990 for assistance with specialized waste disposal;

- Keep PHSs in a secondary container to help prevent breaks and spills. The secondary container should be opened only inside a CFH;

- Attach a suitable hazard warning label to the secondary container to alert others of the chemical contained therein and the need for special precautions, for example: "Warning - Cancer Hazard" or "Danger - Highly Toxic;"

- 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;

- Wear appropriate PPE including gloves, eye/face protection, and other protective apparel or equipment as needed. Examples include impervious gowns, aprons or gauntlets. See Appendix F for guidance on selection of appropriate PPE;

- Remove all protective apparel and thoroughly wash exposed skin (*e.g.* face, forearms, etc.) upon completion of work and before leaving the laboratory; and

- For general decontamination procedures (not to be confused with sterilization), see Appendix I.

XII. MEDICAL CONSULTATION AND MEDICAL EXAMINATION

Employees who work with hazardous chemicals shall be provided 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 a hazardous exposure.

Reproductive hazards are substances or agents that may affect the reproductive health of women or men or the ability to have healthy children. OMS may be consulted by all staff of reproductive capability (i.e., women, men, 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 a reproductive hazard(s).

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 DOHS (301-496-2960). See Appendix M for the template used during annual program evaluation and improvement.

Records for documenting laboratory safety training are maintained by the DOHS. Individuals may request their training records online or by contacting the DOHS Training Officer (301-496-3353). PIs are responsible for documenting and maintaining training records for laboratory-specific safety training. The TAB/DOHS maintains appropriate area monitoring records and OMS maintains employee medical and exposure records.

APPENDIX A
General References

American National Standard for "Occupational Health and Safety Management Systems" ANSI/AIHA Z10-2005.

American National Standard for Occupational and Educational Eye and Face Protection Devices. ANSI/ISEA Z87.1-2010.

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Code of Federal Regulations, 29 CFR 1910.1450. Occupational exposure to hazardous chemicals in laboratories. Available at: https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450

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NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals. Quincy, MA: National Fire Protection Association, 2019. Available at: NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals

NFPA 55 Compressed Gases and Cryogenic Fluids Code. Quincy, MA: National Fire Protection Association, 2023. Available at: NFPA 55: Compressed Gases and Cryogenic Fluids Code

NFPA 400 Hazardous Materials Code. Quincy, MA: National Fire Protection Association, 2022. Available at: NFPA 400: Hazardous Materials Code

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NIH Policy Manual Chapter 1340 (2016) , NIH Occupational Safety and Health Management. Available at: https://oma1.od.nih.gov/manualchapters/management/1340/

NIH Policy Manual, Chapter 26101-42-F: Shipping Policies and Procedures. Available at: https://policymanual.nih.gov/26101-42-f

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APPENDIX B
Guidance for Identifying Particularly Hazardous Substances

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 possible spillage. This information should be documented, and employees trained appropriately.

Guidance set forth in this Appendix is intended to assist researchers in safely handling chemicals 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 Particularly Hazardous Substances. For many substances in the aforementioned 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 if the use of a chemical or drug warrants classification as a PHS. Contact TAB/DOHS 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 TAB/DOHS, 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.

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

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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.

Delayed Toxicity

The effects of exposure occur after a time lapse. Carcinogenic effects of exposure may have long latency periods, often 20 to 30 years after the initial exposure, before tumors are observed in humans.

Hypersensitivity

Chemical allergens can cause an adverse, antibody-mediated reaction that can result in sensitization to a chemical. As with environmental allergens such as pollen and animal dander, not everyone's immune system will become sensitized to any particular chemical. For those who develop a chemical allergy, sensitization usually evolves over time, after which even a low dose exposure to the chemical results in an allergic reaction. The reaction itself requires prior exposure and can range in severity from minor skin disturbances such as inflammation, itching, and redness, to life-threatening anaphylaxis.

Although any compound possesses the potential to elicit an allergic response in some subpopulation of workers, there are some chemicals that induce sensitization more commonly than others. Some common allergens include toluene diisocyanate, beryllium, methyl methacrylate, formaldehyde, dinitrochlorobenzene and powdered vinyl and latex gloves.

Reproductive Toxins

Reproductive toxins are agents that affect reproductive capabilities including chromosomal damage (mutations) and produce effects on developing fetuses (teratogenesis). 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 laboratory or shop activity involving reproductive toxins.

Carcinogens

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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 comply with the specific OSHA standards governing their use. OSHA has established standards that are above those required by 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 DOHS for a review to assure that your work practices and engineering controls are sufficient to keep your exposures below the OSHA specified limits. A listing of the chemical standards is available online.

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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Particularly Hazardous Substance Identification

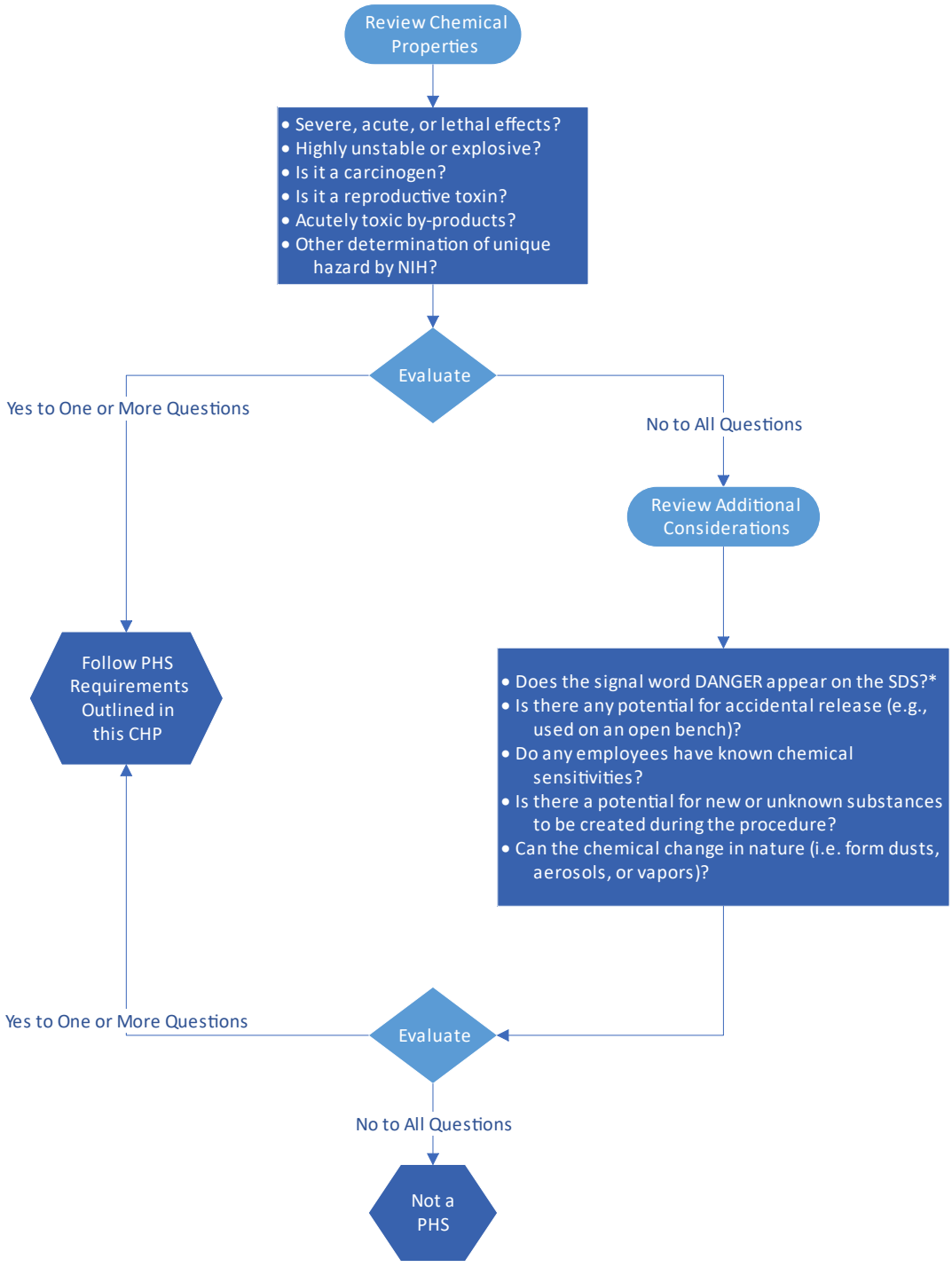

Figure 5. Decision tree for identifying particularly hazardous substances (PHS).

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PHS Requirements:

- PIs are responsible for identifying PHSs used in the work area. Review sources such as SDSs for specific compounds; and

- An assessment of the hazards and controls in place is necessary to limit employee exposures 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.

OSHA requires that the following four categories of controls be considered for operations and activities involving PHSs:

- 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). Requirements may be found in the section entitled "Designated Areas." NOTE: When handling substances (in non-laboratory settings) that are regulated by OSHA substance specific standards (such as asbestos), "regulated areas" will be established in accordance with the applicable OSHA standard;

- Use containment devices (such as CFHs, downdraft tables, LEVs, gas cabinets, glove boxes 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 cloths) must be disposed of as hazardous waste.

The following controls are required for PHSs:

Training and Information

- Employees who either handle or who may be exposed to PHSs must complete "Laboratory Safety" training;

- All employees who may be exposed to PHSs must be trained in the specific hazards and controls of the materials being handled. Furthermore, employees working in designated areas are to be informed of the specific hazards and controls of the materials used. Area-specific training is a line management responsibility. The TAB/DOHS, is available to provide assistance;

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- Consult the section entitled “Labeling and Safety Data Sheets” for labeling requirements for primary and secondary containers; and

- The designated areas of PHS use must be posted with a warning sign depicting hazards and emergency contact information.

Substitution and Chemical Inventory Management

- Identify and use safer chemical alternatives if possible;

- If a safer chemical cannot be used, limit the amount that is purchased or borrow the necessary quantity from a colleague;

- When transferring a PHS to a colleague, or receiving a PHS from a colleague, make note in the laboratory chemical inventory;

- Conduct periodic cleanouts to prevent accumulating unneeded chemicals; and

- Procure and use the minimum amount of material required for the operation.

Ventilation

- Use LEVs such as a CFH or glove box when handling PHSs in a manner that may produce an airborne hazard (such as fumes, gases, vapors and mists). This includes transfer operations, preparation of mixtures, blending, sonication, spraying, heating and distilling. See Engineering Controls for more information.

Work Practices

- Transfer containers in bottle carriers;

- Do not eat, drink, smoke, chew gum or tobacco, store food, beverages and products of personal consumption such as health and beauty aids in work areas where PHSs are being used or stored;

- Use a mechanical aid or a pipette bulb for pipetting;

- Open bottles or carboys slowly and carefully and wear PPE to protect from splashes and vapors/gases;

- Wipe drips/residues from containers and work surfaces. To facilitate decontamination, use stainless steel or plastic trays, absorbent paper with a moisture-proof lining, or other impervious material;

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- 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 PHSs shall be prevented. The following PPE must be worn when handling these materials**:**

- At a minimum, safety glasses with side shields, laboratory coats (see the Guidance for the Selection of Laboratory Coats for more information; coveralls are acceptable in shop settings) and closed-toe shoes will be worn when handling these materials. These measures are considered to be minimum protection and must be upgraded if necessary;

- Additional PPE such as chemical 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 TAB/ DOHS (see Section IX);

- 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 are skin-absorbents (i.e., agents that readily pass through the skin), it is important to select gloves that are chemically resistant to the material. Consult the PPE section, which contains a list of skin-absorbent agents and provides detailed guidance for selecting chemically resistant gloves. An IC Safety Specialist may also be contacted for assistance in selecting appropriate gloves; and

- Gloves must be selected based on their chemical resistance to the material(s) being handled, their suitability for the procedures being conducted, and their resistance to wear, as well as temperature extremes. Improper selection may result in glove degradation, permeation of the chemical through the glove and ultimately, personal exposure to the chemical. This is a potentially serious situation. Consult "Gloves" in Appendix F for guidance on the selection, uses,

limitations and disposal of chemically resistant gloves. An IC Safety Specialist may also be contacted for assistance in selecting appropriate gloves.

Additional information on PPE may be found in Section IX.

Storage
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.

APPENDIX C
Employee Training and Information

Information that must be provided to employees:

- The contents of the 29 CFR 1910.1450 standard and its appendices;
- The location and availability of the NIH CHP;
- The PELs for OSHA-regulated substances and recommended exposure limits for other hazardous chemicals where there are no applicable OSHA standards;
- Signs and symptoms associated with exposures to hazardous chemicals used in the lab;
- 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;
- The appropriate PPE. Employees should be instructed on the proper wear, use, maintenance, and limitations; and
- Safety operating procedures developed for PHSs.

Employee training should be documented and shall include:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or order of hazardous chemicals when being released, etc.);
- The physical and health hazards of chemicals in the work areas;
- The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and PPE to be used;
- Applicable details of the NIH CHP; and
- Retraining identified as appropriate.

APPENDIX D
Proper Storage of Chemicals in the Lab

Storage Considerations

- Note that many areas, including office spaces, are not permissible for storage of laboratory chemicals, as a malfunction of the equipment or operator error could create a chemical, explosive, or asphyxiation hazard. Furthermore, for areas (including office spaces) with recirculating ventilation, a portion of the exhaust air is recirculated back into the building supply air. Any release in such a space would also be dispersed to other areas of the building via the HVAC system. When bringing in new or moving old laboratory chemical storage equipment, please contact DOHS to evaluate the area for its appropriateness;

- Flammable and combustible materials must be stored in an approved storage cabinet. Keep cabinet doors closed;

- Store acids in a dedicated acid cabinet. Nitric acid, sulfuric acid, perchloric acid and chromic acid are strong oxidizers. They may be stored in the same acid cabinet only if they are kept isolated from all other acids;

- Liquids should be stored in unbreakable or double-contained packaging, or the storage cabinet tray should have the capacity to hold the contents if the container breaks or leaks;

- CFHs shall not be used for storage as containers block proper air flow, reduce available workspace, and exacerbate hazards in case of fire or spill;

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

- Do not store hazardous chemicals in a cold room or other storage area with recirculating ventilation;

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

- Ensure all containers of hazardous chemicals are properly labeled with the identity of the hazardous chemical(s) and appropriate hazard warnings;

- Record the date of receipt on each chemical to assist with inventory management;

- Record the date of receipt and the date of opening on each peroxide former and dispose or test for peroxides as directed (see Appendix D, Table 2 for more information);

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- Solutions must be labeled and dated when prepared with a commonly known name of the hazard or mixture and any applicable hazard warnings;

- Segregate all incompatible chemicals for proper storage by hazard class. In other words, store like chemicals together and away from other groups of chemicals that might cause reactions if mixed;

- Only store chemicals alphabetically within each group of compatible chemicals;

- Hazardous chemicals should be stored no higher than 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;

- Only compressed gas cylinders that are in use 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;

- Keep all stored chemicals, especially flammable liquids, away from heat and direct sunlight;

- Periodically inspect stored chemicals to verify container integrity; and

- 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.

  Label information: chemical name, hazard warnings, date of transfer, preparers name, expiration date (if applicable)

Safety Hints:

- Do not purchase hazardous chemicals in quantities greater than can be used in 6 months or within the specified storage period;

- Ethers and other peroxide formers should be stored in the dark;

- Some materials are more stable when stored under an inert gas such as nitrogen. See the manufacturers information/SDS for guidance;

- Always check for the presence of peroxides before distilling any peroxide-former;

- Consult safety references (SDSs) before working with hazards which are new, using hazards in new processes, or if any are hazards are unfamiliar;

- If old containers of peroxide-forming chemicals are found, do not move them. Contact the DEP 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. Questions regarding what may be approved for drain disposal may be directed to the DEP at (301) 496-3537;

- Properly collect, tag and date waste. For guidance on filling out hazardous waste tags, please consult DEP's Hazardous Waste Search Table. Keep chemical waste containers closed/sealed. Use secondary containment under waste collection 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 incompatibility of stored chemicals;
    - Do not touch or handle the bottles in case they are shock sensitive. Contact your IC Safety Specialist, PI/supervisor. Pictures of the chemicals, location, and phone number should be provided to the chemical waste services contractor. Based on the information provided, Chemical Waste Services will determine if the fire department should be called. The contractor will send out a reactive specialist to assess the situation and determine the next steps for appropriate disposal. 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 situation, this should be expressed when reporting the situation. This includes crystallization forming around chemicals such as picric acid, diethyl ether, and organic peroxides;

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- Once you have notified the listed groups, isolate the area using tape, cones, signage, etc., to prevent the area from being disturbed. Your IC Safety Specialist can assist with this step if needed;
- 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): 301-346-6287

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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.

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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 • Sulphides • 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 container Store in a corrosive cabinet labeled “Acid” or on shelving using a secondary containment • Do not store under the sink • Do not store acids on metal shelving • Hydrofluoric acid 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 • Sulphides • Poisons/Toxins	• Heat • Gas Generation • Violent Reaction • DO NOT POUR WATER INTO ACID • Hydrofluoric acid can result in skin irritation and causes burn Respiratory distress • Use NIOSH approved gloves, eye protection, face shield & apron
Corrosive Bases-Organic/Caustic 	• Hydroxylamine • Tetramethylethylamine • Diamine • Triethylamine • Proplylenediamine • Cuprietylenediamine Solution • Dicyclohexylamine	• Store in separate cabinet, preferably with ventilation, corrosive cabinet or storage area with a spill tray, away from potential water sources (DO NOT store under 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 • Causes skin 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 Sulphide • Naphthalene • Camphor	• Keep in a dry, cool area away from oxidizers and corrosives • Follow specific safety procedures • Conduct work on small scale if possible • Keep amounts on-hand to a minimum • Keep away from other flammables	• Acids • Bases • Oxidizers • Poisons/Toxins	• Fire Hazard • Violent Reaction • Generates toxic fumes • Respiratory distress • Keep away from ignition & sparks • Ignites readily, 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) ie: Di-ethyl Ether, Tetrahydrofuran, Furan, Methyl Butanol, Methyl Acetylene, Heptanol, Dioxanes, Digyleme • 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 container (polyethylene) • Store volatile toxic materials with evaporation rate above 1.0 - (ether =1.0) in flammable cabinet • Store non-volatile liquid poisons in a refrigerator or cabinet; amounts less than 1 liter can be stored in a cabinet above bench level, ONLY if the cabinet has sliding doors (not swinging) • Sodium Azide, must be kept refrigerated	• Flammable liquids • Acids • Bases • Reactives • Oxidizers • Corrosives • Please consult Division of Environmental Protection (DEP) for assistance	• Generation of Toxic and Flammable Gas • Combustible • Heat • Fire Hazard • Explosion Hazard • Violent Reaction • Chloroform explosively reacts with chemically-reactive metals (e.g., Aluminum or Magnesium powder, Sodium, and Lithium), Strong Oxidizers, Strong Caustics (e.g., Alkalis), and decomposes in sunlight • Some toxins are mutagenic and carcinogenic. • Review your SDS before working with toxic material • Use NIOSH approved gloves, eye protection, face shield & apron
Explosives 	• Picric Acid (Dry) • Ammonium Nitrate • Nitro Urea • Trinitroaniline • Benzoyl Peroxide (Dry) • Trinitrobenzene • Trinitrobenzoic Acid • Trinitrotoluene • Urea Nitrate • Diazoisbutylnitrile • Sodium Azide (Solid)	• Store in a secure location away from other chemicals; store in an area away from friction or shock • Store Picric Acid in cool location or in a hazard rated fridge to prevent explosive crystallization • Storage regulations DO NOT apply to binary explosives until mixed. Consult Explosive Expert of DEP	• Please consult the SDS and the DEP • Explosives must be stored as "STAND ALONE". 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) and the Division of Environmental Protection (DEP)	• Explosion Hazard • Violent Reaction • Shock Sensitive • Combustion (Exothermic Reaction) • If an old or expired container of a peroxide-forming chemical or reactive is found, do not move it. Contact the DEP at 301-496-4710 for assistance in disposing of the container • Use proper PPE • Use NIOSH approved gloves, eye protection, face shield & apron
Water Reactive 	• Sodium Metals • Lithium Metals • Potassium Metals • Sodium Borohydride • Alkali Metal Hydrides • Cesium metal	• Store in a dry, cool area away from potential spray from fire sprinklers and other water sources (DO NOT store under the sink) • Label this area for water-reactive storage • Do not store with any other chemicals	• Aqueous solutions • Oxidizers • Please consult the Safety Data Sheet (SDS) and the Division of Environmental Protection (DEP)	• Heat Evolution • Violent Reaction when mix with water • Liberates hydrogen gas with water • Reacts violently with water • Use NIOSH approved gloves, eye protection, face shield & 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 DOHS to determine if a fail-safe valve and/or continuous monitoring for toxic gas may be required during use	• Flammable Compressed Gases • Oxidizing Compressed Gases • Please consult the specific SDS and DEP	• Release of Toxic Gas • Hydrogen Sulfide is a colorless, flammable, extremely hazardous gas with a “rotten egg” smell; • Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep, 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 • Benzadine • Methylene Chloride • Carbon Tetrachloride • Cadmium & Compounds • Arsenic & Compounds • Asbestos • Alfatoxins • Beryllium & Compounds	• Label all containers as "Cancer Suspect Agents" or the equivalent • Store according to the hazardous nature of the chemical, using appropriate security when necessary	• Please consult the specific SDS and DEP	• Please consult the specific SDS and DEP • Use NIOSH approved gloves, eye protection, face shield & 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 Cellusolve • 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 containers when storing with other chemicals	• See incompatibles for flammable liquids; • Do not store with acids, oxidizer, toxic and reactive chemicals; • Use secondary container 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 containing 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 containers when storing with other chemicals	• See incompatibles for corrosive acid, base and toxic items above; Use secondary container 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

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.

Table 2. Suggested Storage Time Limits for Common Peroxide Forming Compounds

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 and the date of opening to assist with inventory management. 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.

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

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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

Administrative controls for peroxide formers:

1. Write the date of receipt on all peroxide formers. Class A peroxide formers must be discarded within 3 months of receipt. Discard of Class B and C peroxide formers in accordance with the SDS;
2. Write the date of opening on all Class B and C peroxide formers. Every 6 months after the opening date, Class B and C peroxide formers must be inspected; and
3. During inspection of Class B and C 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.
    a. Crystallization or any solid precipitate, either around the cap or in solution
    b. Discoloration
    c. Stratification (oily layer or second liquid phase)
    d. Rusty or excessively old containers

Contact numbers:

- Bethesda campus: Chemical Waste Services: 301-496-4710
- Baltimore campus: The Environmental Manager assigned to BRC (currently LCDR James Pitt): 301-346-6287

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APPENDIX E
Cryogenic Liquids Safety

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

- Extreme cold (causes frostbite, burns, blisters, or eye damage);
- Asphyxiation (vaporization of cryogenic liquids can displace oxygen in rooms that are not adequately ventilated);
- Explosion (if pressure builds up in cryogenic liquids containers as the liquid boils off, the container may pressurize and explode);
- Fire (oxidizing and flammable cryogenic liquids 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 liquids:

- Always store cryogenic liquids in well-ventilated rooms. Cryogenic liquids need to release pressure as they boil off over time. Note that pressure will build until it is released by a relief valve. However, this release may cause oxygen to be displaced. Note that storage in cold rooms will not slow down the liquid to gas conversion. The storage of cryogenic liquids in cold rooms is not recommended;
    - When purchasing a cryogenic liquid for the first time, or when storing a cryogenic liquid in a new location, contact DOHS to perform a risk assessment of the area. DOHS may recommend the placement of oxygen monitoring devices in some cases, or other safety precautions. For more information on the oxygen monitoring program, please see 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. Note that 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 explosion. If there are any issues with the container, reach out to the vendor or contract entity;
- Always wear appropriate PPE which when handling cryogenic liquids. PPE which must be worn includes 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;
- Never leave the area unattended during the manual filling of cryogenic liquid in dewars.

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- Cryogenic liquids should be stored in the upright position. For 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 buildup on a pressure relief valve. When performing this task, appropriate PPE 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 DOHS website.

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 the entry of others; and

- Treat any cold burns immediately by flushing with tepid water or placing 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
    - DOHS may be contacted to review the incident and develop preventative actions;
        - DOHS phone number: 301-496-2960

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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;
- Disposable gloves provide barrier protection for small amounts of lab chemicals but need to be immediately replaced when they become contaminated and should never be reused;
- Latex deteriorates with petroleum products;
- Surgical latex gloves are thicker than latex exam gloves; and
- Always consult manufacturer's glove selection guidelines for specific hazards.

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Glove Selection Guide (unsupported)

GLOVE TYPE	USES	CAUTION
Disposable: vinyl, latex, nitrile	Dry Powders Aqueous Solutions	*Do **NOT** use for solvents and corrosives *Disposable gloves must be replaced immediately upon chemical contamination
Reusable: Neoprene (Black)	Corrosives, solvents and alcohols Resists oils and offers less fatigue	Must be properly rinsed and dried after each use
Reusable: Nitrile (Blue or Green)	Organic solvents (non-halogenated) Puncture and abrasion resistant	Must be properly rinsed and dried after each use
Reusable: Nomex or Zetex	Temperature extremes	*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;
- Eye protection must be appropriate for the type of hazard (e.g. chemical splash and vapors, impact hazards, lasers, ultraviolet light);
- Safety glasses/spectacles are designed to protect against impact hazards. Additional PPE, such as face shields, are to be used simultaneously when working with chemicals; and
- 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.

OSHA's Eye and Face Protection eTool can be used as an additional resource.

Laboratory Coat Selection Information

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

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 a CHP.

Chemical Hygiene Plan: A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace.

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

Corrosives: Materials that cause destruction on contact with living tissue. Precautions for corrosives focus mainly on preventing such contact. Acids with a pH<2 and bases with a pH>12 are especially dangerous. Eye protection that forms a complete seal around the eyes (goggles) and appropriate gloves must always be used when handling corrosive materials. A face shield over safety glasses, a rubber apron and rubber boots may also be appropriate. 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/embryotoxins), or other chemicals with significant acute or chronic toxicity are used/kept in the laboratory.

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Emergency: Any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of hazardous chemical into the workplace.

Explosive: A chemical that causes a 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 considered to 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 100ºF (37.8º

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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 or highly 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 of 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 and requires an emergency response. High-level hazard spills include spills that are larger than 100 mL of any material or spills of any volume of a PHS. Emergency responses must be initiated when any of the following criteria are met: the employee is uncomfortable; assistance from outside of the immediate release area is required; the spill is likely to result in an uncontrolled release of hazardous substances; or the response to a release poses a potential safety or health hazard to the responder.

Low-level hazard spill: Low-level hazard spills of non-volatile chemicals with which the employee is familiar and is trained and has the resources to clean up the spill. As a general guideline, spills that are less than 100 mL of non-PHS, are within a lab or contained area (such as a benchtop or inside the chemical fume hood) AND are low hazard (NOT chemicals which are toxic, corrosive, flammable or reactive) 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 considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

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: A class of compounds that have the ability to form shock-sensitive explosive peroxide crystals. Certain chemicals can turn into dangerous organic peroxides with prolonged storage and/or concentration. Therefore, it is extremely important that procedures be followed regarding the identification, handling, storage, and disposal of peroxide-forming chemicals. Peroxide-forming chemicals react with oxygen – even at low concentrations – to form peroxy compounds. The risk associated with peroxide formation increases if the peroxide crystallizes or becomes concentrated by evaporation or distillation. Factors that affect rate of peroxide formation include exposure to air, light, heat, moisture, and contamination from metals. Avoid the prolonged storage of all peroxide-forming chemicals. Especially dangerous are ether bottles that have evaporated to dryness. The following tables list compounds that are known to auto-oxidize to form peroxides and classes of chemicals that can form peroxides upon aging.

Physical hazard: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water reactive.

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 on contact with air. Avoid a flammable spill by storing breakable glass bottles inside a rubber or plastic bottle carrier. Use and store all pyrophorics in an inert atmosphere (e.g., stored under nitrogen or argon).

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 to for use (I.e., 10% bleach solution in a spray bottle). Some of these secondary containers require appropriate labeling.

Secondary Containment: a line of defense that prevents spills or leaks from hazardous chemicals from entering the surrounding area and preventing direct contact with personnel or facilities. Typically, secondary containment is tear and puncture resistant, impervious to moisture and leak-proof, and does not require 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 according 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

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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. Many laboratory accidents occur from the inadvertent formation of explosive or shock sensitive materials, such as peroxides, perchlorates and azides.

Target organ effects: Effects on specific body systems which may occur as a result 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.

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 hrs./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.

APPENDIX H
Hazardous Material Spill Procedure

Laboratory emergencies require prompt action to prevent or reduce undesirable effects. Laboratory employees must be able to immediately take control of the situation, and 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 actions for specific hazards in the laboratory (such as skin contact with hydrofluoric acid) must be developed by the department and provided to the laboratory workers. 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 dusts may be hazardous to your health and the health of those around you.

Spill Control Equipment

The Division of Environmental Protection requires all labs have access to a spill kit. Each department must have appropriate spill control items available for each laboratory. Items may include commercial spill control products such as inert absorbents and absorbent pads, pillows and rolls, as well as collecting devices such as scoops, brooms, and dustpans. Other chemical-specific neutralizing or absorbing items such as sodium bicarbonate for acid spills, boric acid or citric acid for alkali spills, or activated charcoal for solvent spills should be considered in accordance with frequently used chemicals in the laboratory.

For high-level hazard spills (a spill that cannot be controlled):

- 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:

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- **Eyes:** Begin using the eyewash immediately per SDS guidance if applicable. 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; or

- **Skin:** Remove contaminated clothing per SDS guidance if applicable. 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, call 301-496-9911;

- Notify the supervisor if he or she is immediately available;

- Report to OMS, Building 10, Room 6C306 (301-496-4411) within one hour of an exposure (Monday-Friday 7:30 AM to 5:00 PM). If OMS is closed, promptly call the Clinical Center Operator at 301-496-1211 and ask them to page an 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 that are less than 100 mL of non-PHS, are within a lab or contained area (such as a benchtop or inside the chemical fume hood) AND are low-level hazard (NOT chemicals which are toxic, corrosive, flammable or reactive) are considered low-level hazard. However, DO NOT attempt to clean up a spill unless you have the training and resources to clean the spill with no risk to yourself or others. Attempt ONLY if it is a nonvolatile liquid with which you are familiar, and you have appropriate supplies on hand:

- Use one or more spill control products referenced above to clean spill (use inert absorbents (e.g. clay, sand, etc.) or absorbent pads to clean spill);

- Bag separately;

- Follow the NIH Waste Disposal Guide for instructions on disposal; and

- Call the Fire Department.

Some chemical spills must be cleaned up by the Fire Department. Please see the NIH Chemical Safety Guide for further guidance on spill cleanup.

Spill Control for Powders

Powders are positively charged and spread easily. 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;
- Secure the lab preventing access;
- Minimize ventilation;
- On the Bethesda campus call 911 (landline) or (301) 496-9911 (cell phone); and
- Avoid tracking through the hallways, you may spread contamination unknowingly.

Spill Control for Acids, Alkalis and Solvents

As a general guideline, spills of less than one liter of these materials are considered small. However, spills of particularly hazardous substances, regardless of the amount spilled, may require immediate Fire Department & DOHS notification and assistance. PHSs include select carcinogens, reproductive toxins and substances with a high degree of acute toxicity.

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 DOHS, 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 mercury policy that will replace mercury-containing equipment with “greener” products where possible.

Liquid mercury is a proven neurotoxin. It has been decided that mercury containing equipment will not be used at the NIH if at all 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.

For all Mercury Spills:

- Leave the area immediately;
- Close the doors;
- Prevent others from entering the area; and
- Call the Fire Department.

Biohazard Spills

- Quickly assess whether there are any injured persons 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 an 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 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 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 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.

APPENDIX I
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 DOHS, the Fire Department and/or the DEP for guidance on cleaning and disposal of contaminated objects;
- It is preferable to use soap and clean water when available; and
- Allow clothes and tools/equipment to air dry thoroughly before re-use.

Important Considerations

- Use gloves and eye protection.

Note: Do not immerse electrical or battery-operated tools/equipment in solutions. Clean exterior with a rag soaked with soap and water or disinfectant solution.

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APPENDIX J
Michael Gottesman Memo
"Laboratory Safety Responsibilities"

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Institutes of Health
Bethesda, Maryland 20892

www.nih.gov

Date: May 15, 2015

To: NIH Scientific Directors

From: Deputy Director for Intramural Research

Subject: Laboratory Safety Responsibilities

There is no more important issue to me than the safety of our NIH staff. I regularly discuss important laboratory safety issues, and I am writing to you now about the following concerns and expectations.

A. Laboratory Safety Training: I am reinforcing the importance of laboratory safety training. It is your responsibility to confirm that Lab/Branch Chiefs in your IC or their designees document that all laboratory personnel have taken the role-based mandatory laboratory safety training. A centralized safety training database is available for use by supervisors to document and track the online and classroom training taken by laboratory personnel.

B. IC Laboratory Safety Committees: As you know, your IC Safety and Health Committee (SHC) has authority to oversee and monitor the IC's safety operations. Your responsibilities are to: (1) assure that you have appointed a duly-constituted committee in your IC; (2) walk through all laboratory and intramural research spaces annually (accompanied by your SHC Chair and a representative from the Division of Occupational Health and Safety (DOHS)) to become familiar with the safety and health issues present and to direct appropriate corrective actions; and (3) ensure that the IC SHC surveys all IC space and provides a report to you annually.

C. Use of Personal Protective Equipment (PPE): It is NIH policy and a requirement that appropriate PPE be used by individuals working in a laboratory. At a minimum, this includes wearing long pants, closed-toe shoes and a lab coat while working in the laboratory and/or near hazardous substances. Wearing appropriate gloves for the hazardous substances being handled and the use of protective eyewear are also requirements.

D. Accurate Inventory of Potentially Hazardous Biological Materials: It is your responsibility to assure that each PI maintains an accurate inventory of stored potentially hazardous biological materials (human pathogens worked with at BSL-2 and above, human blood and body fluids and tissues, toxins and animal or plant pathogens) in the centralized database for this purpose.

Finally, as a reminder, only those lab personnel who are certified shippers are allowed to prepare shipments of hazardous materials. Shipper training [https://www.safetytraining.nih.gov/Main.aspx] is provided by DOHS. Additionally, all hazardous materials must be shipped through NIH Freight Forwarding [http://www.ors.od.nih.gov/sr/dohs/BioSafety/shipbio/Pages/shipping_biological_material.aspx].

Your support and enforcement of these requirements and policies are essential to ensure the safe conduct of science at the NIH.

Michael M. Gottesman, M.D.

cc: Dr. Alfred C. Johnson
Dr. Deborah E. Wilson

APPENDIX K
Laboratory Hazard Analysis

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The Laboratory Hazard Analysis form is on the next page.

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APPENDIX K
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 DOHS 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 L
Laboratory Personnel Safety Check List

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

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APPENDIX L
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.

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

2. Has the PI/Lab Supervisor discussed all hazardous components of the research? ☐
   a. Chemical ☐
   b. Biological ☐
   c. Physical ☐

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

4. 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? ☐

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

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

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

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

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

   a. Emergency Shower ☐
   b. Emergency Eyewash ☐
   c. Fire Alarm Pull Station ☐
   d. Fire Extinguisher ☐
   e. Spill Kit ☐
   f. Telephone (9-1-1) ☐

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

11. Have basic laboratory safety requirements been explained & reinforced? ☐

14. Has the employee/student signed up for the appropriate Laboratory Personnel Training? See https://www.safetytraining.nih.gov/. ☐

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

APPENDIX M
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 [Insert Calendar Year of Review]

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 N
Specific Chemical Hazard and Lab-specific SOP Templates

Specific Chemical Hazard Template

The purpose of this template is to be used to describe the hazards of a given chemical and to outline general procedures to be used when working with that chemical.

National Institutes of Health • Office of Research Services • Division of Occupational Health and Safety

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

Instructions for filling out your SOP

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

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

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- Section 12: Document training for all personnel who will handle this chemical. All personnel must sign to indicate they are aware of the hazards and of all general and lab-specific procedures which must be followed when using this chemical.

1	DESCRIPTION OF SPECIFIC CHEMICAL HAZARD INFO for *[chemical name]*

Obtain specific chemical hazard information from SDS

CHEMICAL NAME: *[chemical name]*
CAS number: *[XXX]*
Routes of exposure: *[XXX]*
How exposure might occur: *[XXX]*
Target organs: *[XXX]*
Signs/symptoms of exposure: *[XXX]*

Select Globally Harmonized System (GHS) - applicable Hazard Pictograms (see SDS Section 2 for pictograms and hazards selection; delete any non-applicable pictograms):

Explosive metals
Self-Reactive
Self-Heating
Organic Peroxide

Flammable
Pyrophoric
Emits Flammable Gas
Self-reactive Organic Peroxide

Oxidizer

Gas Under Pressure

Corrosive to Metals
Skin Corrosion
Skin Burns
Eye Damage

Acute Toxicity (fatal or toxic)

Irritant (skin and eye)
Skin Sensitizer
Acute Toxicity (harmful)
Narcotic effects
Respiratory Tract Irritant
Hazardous to Ozone Layer

Carcinogen
Mutagenicity
Reproductive Toxicity
Respiratory Sensitizer
Target Organ Toxicity
Aspiration Toxicity

Aquatic Toxicity

2	PROCESS

Describe or attach what is being done with *[chemical name]*, including specific laboratory procedures and quantities used.
[➡ Click here to enter text ⬅]

3	PLANNING AND PREPARATION

Hazardous chemical and specific SOP training will be provided to personnel working with *[chemical name]* and any other personnel authorized or required to be in the laboratory during work with the chemical.

Attach SDS for *[chemical name]* to this SOP.

Appropriate cleaning method(s) for *[chemical name]* will be determined and supplies for cleaning and spill cleanup of *[chemical name]* will be readily available.

4	ENVIRONMENTAL / VENTILATION CONTROLS

Work with *[chemical name]* will be performed in a *[Select ventilation control from dropdown]*.

[Describe any work outside of hood or exhausted containment and controls put in place to prevent exposure.] *[➡ Click here to enter text ⬅]*

5	PERSONAL PROTECTIVE EQUIPMENT

List the PPE that will be worn when working with *[chemical name]*: *[Customize list]*
Any gloves must be changed immediately if contaminated, torn, or punctured!

6	SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

HANDLING

Preparation

- All preparation of *[chemical name]* solutions will be performed over plastic-backed absorbent pads in a *[Select ventilation control from dropdown]*. Pads will be disposed of after completion of tasks or immediately upon contamination.
- Wear chemical appropriate gloves for all procedures involving preparation and handling of *[chemical name]*.
- Change gloves after each use, or immediately when torn, punctured, or contaminated.

Describe how [chemical name] will be prepared.
[➡ Click here to enter text ⬅]

Use

- A sharps container will be in the immediate vicinity for safe sharps disposal.
- The *[Select ventilation control from dropdown]* will be cleaned upon completion of tasks with *[chemical name]*.
- All potentially contaminated disposable items will be placed in a waste bag before disposal.
- Hands must be washed upon completion of tasks.

STORAGE

[chemical name] containers will be labeled and stored in a/an *[select storage container from dropdown]* in *[room #]*.

TRANSPORT

[chemical name] will be transported in labeled and sealed non-breakable secondary containers.

7 SPILL AND ACCIDENT PROCEDURES

Spill and Accident Procedures [*Specific cleaning and waste disposal procedures must be determined*.]

[chemical name] spills must be cleaned up immediately by properly trained and protected personnel who are not sensitive to *[chemical name]*. All other persons should leave the area. Spill response procedures must be developed based on the chemical and potential spill or release conditions. Clean up spills using contents of the spill kit. **Do not attempt to clean up any spill if not trained or comfortable performing the cleanup.**

High-level hazard spills are spills >100 mL of any material and spills of Particularly Hazardous Substances (PHS) of any volume.
If a high-level hazard spill occurs, do not attempt to clean up the spill. Evacuate the area and call the Fire Department for assistance in cleaning up these spills, or if ANY of the below criteria are met:

1. The employee is uncomfortable
2. Assistance from outside the release area is required
3. The incident is likely to result in an uncontrolled release of hazardous substances
4. Response to a release poses a potential safety or health hazard to the responder

Fill out information for contacting the Fire Department at your site as appropriate below:

Bethesda, MD
911 on-campus
9-911 off-campus
301-496-9911 (cell phone)

Baltimore, MD
911 (cell phone)
9-911 (landline)

Frederick, MD
911

Hamilton, MT
911

Research Triangle Park, NC
911 (landline)

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919-541-2800 (cell phone)

High-level hazard spill response:

1. 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.
2. Cover spill, if possible, to minimize vapors. If the spill is in a chemical fume hood or biosafety cabinet, close the sash before leaving.
3. 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 below in Section 8.
4. **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)**
5. Stay in close proximity to the site (in a safe area) until directed otherwise by first responders. Notify supervisor.
6. Be prepared to provide the following information:
   - Name and phone number of knowledgeable persons that can be contacted
   - Name of chemical spilled, concentration and amount spilled, liquid or solid type spill
   - Number of injured, if any (refer below to section 8).
   - Location of spill
7. Do not reenter the room until the fire department or appropriate authorities determine that there is no immediate detriment to life or health.

If a person is injured, exposed, or suspected of being exposed to *[chemical name]*, follow procedures below in section 8.

As a general guideline, low-level hazard spills are low-level hazard spills that are within a lab or contained area, such as a chemical fume hood, ducted biological safety cabinet, glove box, or other approved containment.

Low-level hazard spill response:

1. Contained spills that are <100 mL of materials that are not PHS, can typically be cleaned up by trained people who are not sensitive to *[chemical name]*. However, do not attempt to clean up spills requiring respiratory protection. Call the NIH Division of Fire and Rescue Services for assistance.
2. Notify personnel in the area and restrict access. Eliminate all sources of ignition.
3. Review the SDS for the spilled material or use your knowledge of the hazards of the material to determine the appropriate level of protection.
4. Personnel must wear a lab coat or smock, safety goggles, chemical appropriate type gloves and shoe covers as needed when cleaning up spills.
5. **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.

6. **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. 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**.**

Reporting Requirements:

- All spills must be reported.
- If cleaned up locally (low-level hazard spills only) and there were no suspected or verified exposures or injuries, contact your IC safety and health specialist.

If the spill cannot be cleaned up locally or if anyone was injured, exposed or suspected of being exposed, report to NIH Division of Fire and Rescue Services for your site (see above).

8 EXPOSURE PROCEDURES in CASE of EMERGENCY

- **Provide First Aid Immediately**
  - **For sharps injury** (needlestick or subcutaneous exposure), scrub exposed area thoroughly for 15 minutes using warm water and soap.
  - **For skin exposure,** if possible, scrub the exposed area thoroughly for 15 minutes using warm water. 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 SDS. Use a clean lab coat or spare clothing for cover-up.
  - **For 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.
  - **For inhalation exposure**, evacuate the contaminated area. Close the door to the area and post a Spill Alert sign to prevent others from entering. Do not re-enter the space, but stay in close proximity.

- **Get Help**
  - **MANDATORY: When in a safe place, call the NIH Division of Fire**

and Rescue Services. Give details of exposure, *i.e.*, chemical, dose, route of exposure, time since exposure. Have the SDS and this SOP available. Fill out information for your site as appropriate below:

Bethesda, MD
911 on-campus
9-911 off-campus
301-496-9911 (cell phone)

Baltimore, MD
911 (cell phone)
9-911 (landline)

Frederick, MD
911

Hamilton, MT
911

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

- Notify your supervisor as soon as possible for assistance.
- Follow all directions given by emergency responders when they arrive on scene.

- **Injury and/or Illness Reporting and OMS Care**
  - 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.
  - Call the NIH Division of Fire and Rescue (see above for contact information).
  - The injury should be immediately reported to your local OMS clinic (fill out information for your site as appropriate below):
    Bethesda, MD: Building 10, Room 6C306; (301) 496-4411
    Baltimore, MD: 251 Bayview Blvd., Suite 200; (443) 740-2309
    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
  - Bring to the copies of SDSs for all chemicals the victim was exposed to, to the OMS clinic.

9 WASTE COLLECTION AND DISPOSAL

Collection

- Waste containing *[chemical name]* is considered a **hazardous chemical waste**.
- Accumulate waste in a sturdy, chemically compatible container with a secure closure.

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- For contaminated debris (i.e., pipette tips, absorbent paper, disposable lab coats, chemically contaminated gloves), materials should be placed in a clear plastic bag (NSN-8105-01-195-8730):
  - Close the plastic bag with a filament tape or bag closure tie
  - Place bag in a plain carboard box or double bag the dry waste
  - Complete and attach a Chemical waste tag (NSN # 753000L075985).
- **All waste containers must be properly closed or sealed**

Particularly hazardous substances (PHSs) involved? *	Yes?	Blocks #10 & #11 are Mandatory
	No?	Blocks #10 & #11 are Optional

**PHSs include select carcinogens, reproductive toxins and chemicals that have a high degree of acute toxicity. See CHP Section X: Working with Particularly Hazardous Substances.*

10 Approval Required

All staff working with *[chemical name]* must be trained on this SOP prior to starting work. They must also be trained on the *[chemical name]* SDS, and it must be readily accessible in the laboratory. All training must be documented and maintained by the PI or their designee.

11 Designated area/Decontamination

All surfaces will be decontaminated with *approved cleaning solution* following the chemical SDS after removing the plastic backed pads.

All work with *[chemical name]* must be done in a designated laboratory, workspace, and *[Select ventilation control from dropdown]*. This work will be conducted in *[room #]*.

Name:	Title:
Signature:	Date:

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[Laboratory Name] I have read and understand the content of this SOP and the coinciding SDS **Documentation of Training** **Standard Operating Procedure for [chemical name]**		
Name	SOP Training Date	Signature
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	
Click here to enter name.	Click here to enter date.	

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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 a given chemical.

NIH National Institutes of Health • Office of Research Services • Division of Occupational Health and Safety

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, folate functionalization of polymeric micelles, etc.]**

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

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

2	DESCRIPTION OF PROCESS/ EXPERIMENT

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

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

3	SAFETY LITERATURE REVIEW & 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 DOHS (301) 496-2960.**

b. **Guidance on Personal Protective Equipment - To assist with your PPE selection, contact your health and safety specialists through DOHS (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)
9-911 (landline)

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 in close proximity to 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 close 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.

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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:

10. Notify personnel in the area and restrict access. Eliminate all sources of ignition.
11. Review the SDS for the spilled material or use your knowledge of the hazards of the material to determine the appropriate level of protection.
12. Personnel must wear a lab coat or smock, safety goggles, chemical appropriate type gloves and shoe covers as needed when cleaning up spills.
13. **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.
14. **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.
15. Clean the spill area thoroughly with approved cleaning solution followed by clean water.
16. If spill is extensive within the containment, clean all interior surfaces after completion of the spill cleanup.
17. 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.
18. **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)
9-911 (landline)

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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., Suite 200; (443) 740-2309
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)
9-911 (landline)
Frederick, MD
911

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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,

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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.

APPENDIX O
Contact Information

Bethesda (Main Campus)

- Chemical Hygiene Officer – John Veitch: 301-451-5823
- 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)
- DOHS 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 – John Veitch: 301-451-5823
- Chemical Waste Services – James Pitt: 443-740-2761
- Division of Environmental Protection – James Pitt: 443-740-2761
- DOHS On-Site – Delores Dobson: 443-740-2311
- Division of Radiation Services – James Pitt: 443-740-2761
- Fire Department: 911 or 9-911
- OMS: 443-740-2309; nidaoms@mail.nih.gov
- ORF – Ray Phelps: 443-740-2760
- Police: 911 or 9-911
- Safety and Health Specialist(s) – Rhonda Walther (NIA): 667-205-2216; Carrie Wertheim (NIDA): 443-740-2403; Delores Dobson (Safety Manager): 443-740-2311
- Scientific Director – NIDA - Dr. Amy Newman; NIA - Dr. Luigi Ferrucci

IRF Frederick

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

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- 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) – Kelly Flint: 301-631-7224; Krisztina Janosko: 301-631-7337
- Scientific Director – Dr. Connie Schmaljohn

Rocky Mountain Labs (RML)

- Chemical Hygiene Officer – John Veitch: 301-451-5823
- Hazardous Waste Services – Arron Bestor: 406-363-9304
- Division of Emergency Management: 301-496-1985
- Division of Environmental Protection – Barry Twardoski: 406-363-9216
- 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: 406-521-0541 or 406-375-7467
- Safety and Health Specialist(s) – Shanda Sarchette: 406-363-9429, Seth Cooley: 406-802-6398
- 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