

Stanford University Chemical Hygiene Plan

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1.0 PURPOSE, SCOPE, and RESPONSIBILITIES

1.1 Purpose

The purpose of Stanford University's Chemical Hygiene Plan (CHP) is to establish a written program that provides for and supports the procedures, equipment, personal protective equipment, and work practices for protecting laboratory personnel from potential health hazards of using hazardous chemicals in the laboratory.

Additionally, the CHP is designed to comply with the regulations of California's Occupational Safety and Health Administration (Cal/OSHA) *Occupational Exposure to Hazardous Chemicals in Laboratories*, Title 8 - California Code of Regulations, Section 5191: <http://www.dir.ca.gov/title8/5191.html>.

1.2 Scope

Stanford University's CHP applies to all Stanford University laboratory personnel who handle and may be exposed to hazardous chemicals in research laboratories at Stanford University. This includes labs that use small quantities of off-the-shelf hazardous chemicals in their research.

1.3 Exclusions

This CHP does not cover work with radioactive materials or biological agents. Procedures for work with these materials are addressed via the University's [Radiation Safety Manual](#) and [Biosafety Manual](#), respectively.

1.4 Responsibilities

A. Duties of Principal Investigator / Laboratory Supervisor

The Principal Investigator (PI) / Laboratory Supervisor has responsibility for the health and safety of laboratory personnel doing work in his/her laboratory. The PI / Laboratory Supervisor may delegate safety duties, but is ultimately responsible for all delegated safety duties.

The PI / Laboratory Supervisor's responsibilities are enumerated below with links to additional information on fulfilling those responsibilities:

1. [Identifying hazardous conditions](#) or operations in the lab, determining safe procedures and controls, implementing and enforcing [standard operating procedures](#), and requiring and advising on risk assessments prior to work.
2. Establishing [standard operating procedures](#) (general and protocol-specific) and performing literature searches relevant to safety and health that is appropriate for the work. Reviewing and approving of lab-specific SOPs.
3. Providing [prior approval](#) for the use of Restricted Chemicals in the PI / Laboratory Supervisor's laboratory.
4. [Consulting with laboratory personnel](#) on their use of higher-risk chemicals, such as Particularly Hazardous Substances or highly reactive chemicals, or conducting higher-risk experimental procedures, so that special safety precautions may be taken.
5. Maintaining the online laboratory [chemical inventory](#) for the laboratory.
6. Providing laboratory personnel under his/her supervision with access to the [CHP](#) and any individual [Laboratory Safety Plan](#).

7. [Training](#) laboratory personnel to work safely with hazardous chemicals and operations and maintain records of training provided locally. This includes informing laboratory personnel of the location and availability of Hazard Information described in [Section 10.1](#).
8. [Maintaining in functional working order](#) appropriate work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers), with emphasis on controls for Particularly Hazardous Substances.
9. Complying with the requirements of [Stanford University's Personal Protective Equipment Program](#).
10. Conducting periodic laboratory inspections and maintaining records of inspections, in [BioRAFT](#) or [equivalent](#).
11. [Prompt reporting](#) of laboratory accidents and injuries to Risk Management and Environmental Health & Safety (EH&S).
12. Investigating laboratory accidents and incidents, in collaboration with EH&S, as appropriate.
13. Making available required [medical surveillance](#) or medical consultation/examination for laboratory personnel.
14. [Informing](#) facilities personnel, other non-laboratory personnel, and any outside contractors of potential lab-related hazards when they are required to work in the laboratory environment. Identified potential hazards should be minimized to provide a safe environment for repairs and renovations.
15. If minors in the laboratory are participating in the University-sponsored function of laboratory research, complying with the requirements set forth in the document [Health & Safety Requirements for Minors in Laboratories at Stanford University](#). Review University Human Resources [Policy for Protection of Minors](#) and the Office of Science Outreach [information what you need to host an intern](#).

Toolkit. Stanford University's ***Laboratory Chemical Safety Toolkit*** has been developed to aid the PI / Laboratory Supervisors and laboratory personnel in fulfilling their responsibilities and promote a safe and regulatory-compliant laboratory environment. Links to relevant sections of the Toolkit are provided within the CHP to provide additional detailed information on a related topic. The Toolkit is available at <http://chemtoolkit.stanford.edu>.

Option of Laboratory-Specific Safety Plan. In order to help fulfill these responsibilities, PI / Laboratory Supervisors have the option of creating a specific safety plan that is tailored to the operations conducted in their laboratory (individual Laboratory Safety Plan). EH&S is available for consultation on the development of individual Laboratory Safety Plans.

PI/Laboratory Supervisors may assign the aforementioned duties to individual lab members for assistance. Refer to the [Assignment of Laboratory Safety Tasks](#) document.

B. Duties of All Laboratory Personnel

The responsibilities of laboratory personnel who work with hazardous chemicals in research laboratories are enumerated below with links that provide additional information on fulfilling those responsibilities:

1. Following the [CHP](#) and any individual [Laboratory Safety Plan](#).

2. Following oral and written [laboratory safety](#) rules, regulations, and [standard operating procedures](#) required for the tasks assigned.
3. [Keeping the work areas safe](#) and uncluttered.
4. [Reviewing and understanding the hazards](#) of materials and [processes](#) in their laboratory research prior to conducting work.
5. Utilizing [appropriate measures](#) to control identified hazards, including consistent and proper use of [engineering controls](#), [personal protective equipment](#), and administrative controls.
6. Understanding the capabilities and limitations of [personal protective equipment](#) issued to them.
7. Gaining [prior approval](#) from the PI / Laboratory Supervisor for the use of [Restricted Chemicals](#).
8. [Consulting with PI / Laboratory Supervisors](#) before using certain higher risk chemicals, such as [Particularly Hazardous Substances](#) or highly reactive chemicals, or conducting certain higher risk experimental procedures. The risk level of experimental procedures can be evaluated using the [SU Laboratory Risk Assessment Tool](#). Procedures with “high” and “unacceptable” risk ratings may not proceed without consultation with the PI/Laboratory Supervisor and EH&S.
9. Promptly [reporting](#) accidents and unsafe conditions to the PI / Laboratory Supervisor.
10. Completing all required health, safety, and environmental [training](#).
11. Participating in the [medical surveillance](#) program, when required.
12. Informing the PI / Laboratory Supervisor of any work modifications ordered by a physician as a result of [medical surveillance](#), an occupational injury, or exposure.

C. Added Duties of Laboratory Personnel Working Autonomously

In addition to the above responsibilities, laboratory personnel working autonomously or performing independent research are also responsible for:

1. Providing the PI / Laboratory Supervisor with a written scope of work for their proposed research.
2. Notifying and consulting with the PI / Laboratory Supervisor, in advance, if they intend to deviate from their written scope or scale of work.
3. [Preparing SOPs](#) and/or [Risk Assessments](#) and performing literature searches relevant to safety and health that are appropriate for their work.
4. Providing appropriate oversight, [training](#) and safety information to laboratory personnel they supervise or direct.

D. Duties of Environmental Health and Safety and CHO

Stanford EH&S's Lab Safety Program (LSP), which includes the University Chemical Hygiene Officer (CHO), is responsible for administering and overseeing institutional implementation of this Plan. The LSP provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous chemicals. Specifically, the CHO is responsible for:

1. Assisting PI / Laboratory Supervisors in the selection of appropriate safety control requirements, which include laboratory practices, personal protective equipment, engineering controls, and training.
2. Performing hazard assessments, upon request.
3. Maintaining area and personal exposure-monitoring records.

4. Reviewing and providing advice on Laboratory SOPs and Risk Assessments, upon request.
5. Providing technical consultation and investigation, as appropriate, for laboratory accidents and injuries.
6. Helping to determine medical surveillance requirements for laboratory personnel.
7. Coordinating with Stanford University's Occupational Health Center (SUOHC) when laboratory personnel request to review their medical records.
8. Reviewing plans for installation of engineering controls and new laboratory construction/renovation, as requested.
9. Reviewing and evaluating the effectiveness of the Chemical Hygiene Plan at least annually and updating it as appropriate.

Other units within EH&S support the CHP by providing management, oversight, or assistance in chemical compliance, hazardous waste management, chemical inventory, and hazardous materials spill/release response.

2.0 GENERAL CLASSES OF HAZARDOUS CHEMICALS

Chemicals have inherent physical, chemical, and toxicological properties that require laboratory personnel to have a good understanding of the related health and safety hazards. The main types of chemical hazards that lab personnel should be aware of are:

- Flammability
- Corrosivity
- Reactivity/Instability (incl. explosivity)
- Toxicity (incl. irritation, sensitization, carcinogenicity, reproductive toxicity)

Additionally, compressed gases and cryogenic liquids are often-used laboratory materials that present unique hazards.

Below is a brief discussion of these major classes of hazardous chemicals. Refer to [Appendix A](#) for specific definitions of each hazard class.

2.1 Flammable and Combustible Liquids

Flammable and combustible liquids are classified according to their flash point, with flammable liquids having a flash point of less than 199.4 °F (93 °C) and combustible liquids having a flash point at or above 199.4 °F (93 °C). Both flammable and combustible liquids are considered fire hazards.

- See the document [General Standard Operating Procedure for Working with Flammable and Combustible Liquids](#).

2.2 Corrosive Materials

Corrosive materials cause irreversible destruction of living tissue through chemical action at the site of contact. As corrosive chemicals can be liquids, solids, or gases, corrosive effects can affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include sodium hydroxide, hydrochloric acid, and phenol.

- See the document [General Standard Operating Procedure for Working with Corrosive Materials](#).

2.3 Highly Reactive and Unstable Materials

Highly reactive and unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Examples of such substances are [explosives](#), [peroxides](#), [water-reactives](#), [self-reactives](#), and [pyrophorics](#).

- See the document [General Standard Operating Procedure for Working with Highly Reactive and Unstable Materials](#).

2.4 Compressed Gases, Cryogenic Liquids, and Toxic Gases

Compressed gases and cryogenic liquids are similar in that they can create pressure hazards and can also create health hazardous and/or flammable atmospheres. One special property of compressed gases and cryogenic liquids is that they undergo substantial volume expansion when released to air, potentially depleting workplace oxygen content to hazardous levels.

- See the document [General Standard Operating Procedure for Working with Compressed Gases](#).
- See the document [General Standard Operating Procedure for Working with Cryogenic Liquids](#).

Toxic gases pose additional potential acute health hazards to laboratory personnel and the public, and as such, are considered Stanford University “Restricted Chemicals” that require prior approval by the PI / Laboratory Supervisor. The [Santa Clara County Toxic Gas Ordinance](#) regulates the use, handling, distribution and dispensing of toxic gases. In addition, it contains specific provisions mandating facility permitting, engineering controls, protective equipment, storage requirements, emergency response plans, warning systems and employee training based on the type and quantity of toxic gas used. As usage of toxic gases may require special permits, contact EH&S for further guidance.

- For specific requirements on toxic gases, refer to [SU's Toxic Gas Page](#).

2.5 Cal/OSHA “Particularly Hazardous Substances”

Select carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity are considered to be high-risk materials and are treated by Cal/OSHA as [Particularly Hazardous Substances](#). Additional provisions for working with Particularly Hazardous Substances are described in [Section 3.4](#).

A. Select Carcinogens

Carcinogens are chemicals or physical agents that cause cancer or tumor development, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and may cause no immediate harmful effects. See Appendix A for the Cal/OSHA definition of a [Select Carcinogen](#).

- See the document [General Standard Operating Procedure for Working with Carcinogens](#).

B. Reproductive Toxins

A chemical which affects reproductive capabilities. Possible effects include chromosomal damage (mutations), effects on fetuses (teratogenesis), adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Many reproductive toxins cause damage after repeated low-level exposures. Effects become evident after long latency periods.

- See the document [General Standard Operating Procedure for Working with Reproductive Toxins](#).

C. Highly Acutely Toxic Substances

Categorized based on their LC₅₀ or LD₅₀ values, substances with a **high degree of acute toxicity** have the ability to cause adverse effects after a single exposure/dose or multiple exposures/doses within a 24 hour period. Many of these chemicals may also be characterized as toxic gases, [Select Agent Toxins](#), corrosives, irritants, or sensitizers.

- See the document [General Standard Operating Procedure for Working with Highly Toxic Chemicals](#).

2.6 Sensitizers

A sensitizer is a substance that can cause exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers used in laboratories include formaldehyde, many phenol derivatives, and latex proteins (commonly found in latex lab gloves).

- See the document [General Standard Operating Procedure for Working with Sensitizers](#).

2.7 Irritants

Irritants are substances that cause reversible effects (e.g., swelling or inflammation) on skin or eyes at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin and eye contact with all laboratory chemicals should be avoided.

- See the document [General Standard Operating Procedure for Working with Irritants](#).

2.8 Restricted Chemicals

If not properly considered, managed, and overseen, the use of certain chemicals can result in conditions of higher risk for laboratory personnel and to facilities. The approval of the PI or Laboratory Supervisor is required when certain [Restricted Chemicals](#) that carry a higher risk due to their inherent hazardous properties are used in Stanford laboratories. Laboratory personnel may not use Restricted Chemicals in any Stanford laboratory without obtaining the prior written approval of the PI or his/her delegate. See [Section 5.0](#) for more information.

2.9 Nanomaterials

A nanoparticle is a collection of tens to thousands of atoms approximately 1 to 100 nanometers in diameter. Nanoparticles that are naturally occurring (e.g., volcanic ash, forest fires) or are the incidental byproducts of combustion processes (e.g., welding, diesel engines) are usually physically and chemically heterogeneous and often termed ultrafine particles. Engineered nanoparticles are intentionally produced and designed with very specific properties related to shape, size, surface

properties and chemistry. These properties are reflected in aerosols, colloids, or powders containing these nanomaterials. Engineered nanoparticles may be bought via commercial vendors or generated via experimental procedures by researchers in the laboratory. Examples of engineered nanomaterials include: carbon buckyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); and quantum dots, among many others.

The health effects of exposure to nanomaterials are not fully understood at this time. Until more definitive findings are made regarding the potential health risks of handling nanomaterials, researchers planning to work with nanomaterials must implement a combination of engineering controls, work practices, and personal protective equipment to minimize potential exposures to themselves and others.

- See the document [SU's General Principles for Working Safely with Engineered Nanomaterials](#) for guidance.

2.10 Select Agent Toxins

Select Agent Toxins are certain toxins of biological origin which are subject to stringent regulatory requirements under [42 CFR 73](#) for their potential to pose a severe threat to public, animal, or plant health, or to animal or plant products. These toxins, along with specified biological agents (viruses, bacteria, fungi), fall under the oversight of the National Select Agents Registry (NSAR) Program which requires registration for possession, use, and transfer of the listed Select Agents. However, possession of small amounts of Select Agent Toxins as described below is exempt from registration with the NSAR Program. See EH&S's [Select Agent website](#) for additional information.

A. Possession of Permissible Amounts of Select Agent Toxins

The following Select Agent Toxins are not regulated if the amount under the control of a principal investigator does not exceed, at any time, the amounts indicated in the table below.

Select Agent Toxins / HHS Toxins [§73.3(d)(3)]	Amount
Abrin	1,000 mg
Botulinum neurotoxins* (see note below)	1 mg
Short, paralytic alpha conotoxins	100 mg
Diacetoxyscirpenol (DAS)	10,000 mg
Ricin	1,000 mg
Saxitoxin	500 mg
Staphylococcal Enterotoxins (Subtypes A, B, C, D, and E)	100 mg
T-2 toxin	10,000 mg
Tetrodotoxin	500 mg

*Botulinum neurotoxin use in a research setting is also regulated by Life Sciences Dual Use Research of Concern Oversight Policy. Please see the following link for more information: [Institutional Oversight of Life Sciences Dual Use Research of Concern](#). Contact EHS at 650-723-0448 and ask to speak to a Biosafety Specialist if you believe this may apply to your work.

Additionally, the following Select Agent Toxins are excluded:

- Any Select Agent Toxin that is in its naturally occurring environment provided it has not been intentionally introduced, cultivated, collected, or otherwise extracted from its natural source.
- Nonfunctional Select Agent Toxins.

Use of these Select Agent Toxins in permissible amounts requires strict adherence to Stanford University's requirements that address critical safety and compliance information including safe use, storage/security, and inventory management.

- Follow the document [Requirements for Possession of Permissible Amounts of Select Agent Toxins at Stanford University](#)
- Sections [7.1](#) and [7.2](#) of this Chemical Hygiene Plan address storage and inventory requirements, respectively.

B. Possession of Select Agent Toxins Above Permissible Amounts

Possession of Select Agent Toxins in amounts above permissible amounts requires prior approval from the Vice Provost and Dean of Research and registration with the National Select Agent Registry Program. Also note, that effective 12/4/12, botulinum neurotoxins are categorized as Tier 1 agents, which trigger additional regulatory requirements.

Failure to register with the NSAR Program is potentially punishable by up to five years in prison and/or large monetary fines. (*Public Health Security & Preparedness Response Act of 2002, Section 231(c), 18 USC 175(b), & Public Law (USA Patriot Act) 107-56 Sec. 817*).

Contact EH&S for assistance at 650-723-0448.

2.11 Newly Synthesized Chemicals

Some laboratories synthesize or develop new chemical substances during the course of their research. For the safe handling and management of a newly synthesized chemical, the researcher must label the substance with the IUPAC name or a clearly identifiable lab-designated name; a chemical structure may be included as well. Also label the substance with the material's hazardous properties (e.g., toxic, reactive, flammable, corrosive), determined to the best of the researcher's ability. If the composition of a new chemical substance or mixture is unknown, it must be assumed to be hazardous.

If the lab transfers newly synthesized chemicals to another user outside of the university or if any adverse health or environmental effects are observed by laboratory personnel working with newly synthesized chemicals, contact EH&S at 650-723-0448 for assistance.

3.0 MINIMIZING EXPOSURES TO HAZARDOUS CHEMICALS

For the general safety of laboratory personnel, all chemical usage must be conducted in adherence with the general safe laboratory practices below. The

methods used to specifically control chemical exposures are categorized as follows: Engineering Controls, Administrative Controls, and Personal Protective Equipment.

3.1 Engineering Controls

As general lab ventilation cannot be relied upon to protect personnel from localized exposures to hazardous levels of airborne chemicals, engineering controls such as laboratory fume hoods, glove boxes, and other local exhaust systems (e.g., drop down flexible ducts) are often necessary to provide additional exposure control. In general, laboratory fume hoods, or equivalent engineering controls, must be used whenever using hazardous chemicals that:

- Have a high degree of acute toxicity, are carcinogens, or are reproductive toxins, except where there is very low risk of exposure (e.g., use of minimal quantities in a closed system).
- Have a [permissible exposure limit](#) of less than 50 ppm (or 0.25 mg/m³ for particulate matter).
- Are appreciably volatile (e.g., solvents) or are easily dispersible in air (e.g., dust).
 - See section 9.1 of the [Laboratory Ventilation Management Program](#) for information on the proper use of laboratory ventilation and engineering controls such as chemical fume hoods.

If engineering controls cannot be used, contact EH&S for an assessment, including appropriateness of additional PPE, such as respirators.

Appropriate selection, use, and maintenance of engineering controls is described in the University's [Laboratory Ventilation Management Program \(LVMP\)](#).

A. Performance Verification of Engineering Controls and Safety Equipment

To assure that primary engineering controls and safety equipment provide proper and adequate performance, the University provides performance verification checks on a routine basis as identified in the document [Performance Verification of Engineering Controls and Safety Equipment](#). Performance standards for the testing and certification of engineering controls are available:

- [Commissioning of Exposure Control Devices](#)
- [Fume Hood Testing and Performance Standards](#)
- [Gas Cabinet Testing and Performance](#)
- [Biosafety Cabinet Testing and Performance Standards](#)

3.2 Administrative Controls

Administrative controls for minimizing exposures to hazardous chemicals include:

- Substituting in less hazardous chemicals (e.g., using proprietary detergents instead of chromic acid for cleaning glassware; or, using toluene instead of benzene for liquid-liquid extraction or chromatography).
- Isolating or enclosing an experiment within a closed system (e.g., glove box, sealed chamber).
- Micro-scaling the size of the experiment to reduce the amount of chemical usage.

- Scale up reactions in small steps and evaluate safety issues after each step to fully understand the reactive properties of the reactants and solvents, which may not have been evident at a smaller scale.
- Do not eat, drink, smoke, apply cosmetics, or store food in areas where chemicals are used or stored.
- Wash hands frequently and before eating.

3.3 Personal Protective Equipment

In addition to both engineering and administrative exposure controls, personal protective equipment (PPE) may be necessary to ensure an adequate margin of safety in case of incidental/accidental chemical release or contact.

➤ See [Stanford University's Personal Protective Equipment \(PPE\) Program](#) which contains information on:

- [PPE Quick Guide](#)
- [Laboratory PPE Assessment Tool](#)
- [PPE Training Guidance](#)

In general, the appropriate streetwear and PPE in laboratories with chemicals includes:

- Long pants, skirt, dress, or other clothing that covers the legs down to the top of the shoes.
- Hair that falls below the shoulder pulled back.
- Headgear or headwear (e.g., hats, scarves) made of natural fibers or flame-resistant fabrics.
- Lab coats (Flame resistant lab coats for work with pyrophorics, water reactive chemicals, flammable gases, or > 4L of flammable liquids).
- Safety eyewear such as safety glasses, goggles, or goggles plus a face shield when there is a risk of splash.
- Appropriate [chemical-resistant gloves](#).

The PI / Lab Supervisor is responsible for evaluating the hazards of their laboratory, assigning PPE, and training personnel in its use. Consult the PPE Assessment Tool for specific information.

3.4 Additional Provisions for Work Involving Particularly Hazardous Substances

Additional provisions for laboratory work with Particularly Hazardous Substances include:

1. Establishment of a designated area.
2. Use of containment devices such as fume hoods or glove boxes.
3. Procedures for safe removal of contaminated waste.
4. Decontamination procedures.

These provisions are further described in the Standard Operating Procedures for Carcinogens, Highly Toxic Chemicals, and Reproductive Hazards.

4.0 STANDARD OPERATING PROCEDURES (SOPs)

The PI / Laboratory Supervisor is responsible for providing written Standard Operating Procedures (SOPs) relevant to health and safety for laboratory activities involving

hazardous chemicals. Laboratory personnel working autonomously or performing independent research are responsible for developing SOPs appropriate for their own work. PI / Laboratory Supervisors and independent researchers may make use of the Laboratory Chemical Safety Toolkit provided in the CHP to develop SOPs.

Priority for SOP development should be given to any operation involving Restricted Chemicals, certain higher hazard chemicals such as Particularly Hazardous Substances and Highly Reactive Chemicals, and specified higher risk research procedures described in [Section 5.3](#). Refer to [Creating Standard Operating Procedures](#) for a template and guidance for creating laboratory-specific SOPs.

To aid development of lab-specific SOPs, researchers may use the [EHS-Curated Research Protocols and Standard Operating Procedures \(SOPs\) collection](#), which contains both EHS-authored General Use SOPs and researcher-authored laboratory specific SOPs.

In addition to General Use SOPs and laboratory-specific SOPs, the PI / Laboratory Supervisor may use the SU Risk Assessment Tool to plan a procedure. The [SU Risk Assessment Tool](#) allows the PI or designee to address the health and safety considerations of laboratory work with chemicals and may be used in place of an SOP.

5.0 PRIOR APPROVAL AND SPECIAL PRECAUTIONS

5.1 Restricted Chemicals Requiring Prior Approval

Laboratory personnel shall seek and the PI/Laboratory Supervisor must provide prior approval of any chemical usage involving the following [Restricted Chemicals](#):

- [Toxic gases](#) regulated by Santa Clara County (e.g., Carbon monoxide, Diazomethane, Hydrogen cyanide, Hydrogen fluoride (anhydrous), Nickel carbonyl)
- Dimethylmercury
- Chemicals classified as Department of Transportation (DOT) Division 1.1 explosives (e.g., picric acid, 2,4-dinitrophenylhydrazine (DNPH), ammonium perchlorate)
- [Tert-butyllithium](#)
- [Hydrofluoric acid](#)
- [Tetramethylammonium hydroxide](#)
- Procedures with “high” and “unacceptable” risk ratings on a self-conducted [Laboratory Risk Assessment](#)

5.2 Methods for Granting Prior Approval

The following options are available for PI / Laboratory Supervisors to grant prior approval:

- a. PI/Laboratory Supervisor completes the form [Documenting SOP Review and PI Approval](#).
- b. PI/Laboratory Supervisor signs and dates the laboratory personnel’s laboratory notebook and indicates approval for the process, procedure or activity,
- c. PI/Laboratory Supervisor signs and dates the Risk Rating section of the completed Laboratory Risk Assessment Tool, or

- d. PI/Laboratory Supervisor provides other written approval, e.g., via email or memo.

Such records of prior approval must be retained for at least one year.

5.3 Special Precautions for Other Higher Hazard Chemicals and Operations

A. Laboratory personnel should consult with PI/Laboratory Supervisors on the following higher-risk chemical usage and operations in their laboratories, so that special safety precautions can be taken where appropriate:

1. Work involving [Particularly Hazardous Substances](#) or highly reactive materials.
2. A procedural change that significantly increases the overall hazard of an existing procedure, such as introduction of a high hazard chemical in a procedure, or scale-up of an experimental procedure or operation. Careful consideration of scaled-up work is critical to plan for the effects caused by an increase in chemical concentration/quantity and differences in dissolution rate and heat transfer. See [Scale-Up Safety](#) for additional information.
3. Unattended operations that represent significant likelihood of fire, explosion, or exposure to personnel if a malfunction were to occur (such as a utility outage, runaway reaction, broken container, or chemical spill).
4. Working alone in the laboratory.
 - Each case should be evaluated on a case-by-case basis to determine if working alone will be permitted. Some tasks require PI approval including:
 - Work with certain hazardous materials:
 - Cryogenics (e.g., liquid nitrogen, liquid helium)
 - Pyrophoric and explosive materials
 - Highly reactive materials (e.g., strong oxidizers, acids, bases)
 - Hydrofluoric acid
 - Transferring large quantities of hazardous materials (i.e., >5L)
 - Procedures that may create hazardous conditions (e.g., oxygen deficiency), or adverse outcomes if not well-controlled (e.g., exothermic polymerization)
 - Work around high voltage
 - Machine shop activities
 - Confined space entry

For all other alone work, consider the following when establishing lab-specific protocols:

- Task and hazards involved in the work.
- Consequences resulting from a worst-case scenario.
- The possibility of an accident or incident that would prevent the laboratory personnel from calling for help.
- The laboratory personnel's training and experience.
- The laboratory personnel's physical conditions or handicaps [consult with local Human Resources Officer for guidance and compliance with Americans with Disabilities Act (ADA)].

- Time the work is to be conducted (during normal business hours, e.g., 7 am – 8 pm Monday through Friday) versus at night or on weekends/holidays.
- B.** In establishing special precautions for Particularly Hazardous Substances, consideration shall be given to the following, where appropriate:
1. Establishment of a designated area
 2. Use of containment devices such as fume hoods or glove boxes
 3. Procedures for safe removal of contaminated waste
 4. Decontamination procedures

6.0 CHEMICAL EXPOSURE ASSESSMENT

Consistent adherence to [general safe laboratory practices](#) in conjunction with appropriate use of exposure controls are expected to keep laboratory chemical exposures to a safe level. Exposure risk is more likely to increase when handling hazardous chemicals outside of a lab fume hood, particularly for certain substances, properties, and conditions, such as:

- Have a high degree of acute toxicity, are carcinogens, or are reproductive toxins, except where there is very low risk of exposure (e.g., use of minimal quantities in a closed system).
- Have a permissible exposure limit of less than 50 ppm (or 0.25 mg/m³ for particulate matter).
- Are appreciably volatile or are easily dispersible in air (e.g., fine powders).
- Are used in large volumes (e.g., greater than 1 liter).

For any concern involving hazardous chemicals usage, including the above scenarios, EH&S' Lab Safety Program can provide chemical exposure assessment to help verify adequate controls. For more information, contact EH&S at 650-723-0448.

6.1 Personal Exposure Monitoring

A. When

Personal monitoring is conducted by EH&S if there is reason to believe that exposure levels for a substance exceeds the [action level](#) (or in the absence of an action level, the permissible exposure limit). Examples where personal monitoring may be conducted include: (1) volatile chemicals are not used in a fume hood and/or (2) personnel develop signs or symptoms associated with possible hazardous chemical exposure.

B. Frequency

The initiation, frequency, and termination of personal monitoring are done in accordance with the relevant regulation.

C. Communication of Results / Recordkeeping

Monitoring results are provided to laboratory personnel per the time requirements of the relevant regulation or within 15 working days of EH&S's receipt of monitoring results. EH&S maintains copies of exposure monitoring per the regulatory requirement.

7.0 CHEMICAL LABELING, STORAGE, AND INVENTORY

Hazardous chemicals must be stored, labeled, and inventoried properly to avoid confusion or mistaken identity of a chemical, to provide separation of incompatible materials, and to provide information for emergency response personnel.

7.1 Labeling and Storage

A. All Hazardous Chemicals

Hazardous chemicals must be stored and labeled properly.

- See the document [Chemical Storage, Labeling, and Inventory](#) for detailed requirements and guidance for labeling & storage of hazardous chemicals.

When transporting chemicals between rooms or buildings, use a handheld bottle carrier that protects the bottle from damage and acts as secondary containment.

B. Select Agent Toxins

In addition to the requirements detailed above, for Select Agent Toxins (in permissible amounts), the laboratory must provide one additional layer of physical security (i.e., Select Agent Toxin secured within locked freezer, or secured within a permanently fixed lock box) per the document [Requirements for Possession of Permissible Amounts of Select Agent Toxins at Stanford University](#).

C. Controlled Substances

In addition to the requirements detailed in Section A above, Controlled Substances must be stored in a securely locked, substantially constructed cabinet, located where access is limited to those individuals with controlled substances authorization. Refer to [SU's Controlled Substances & Precursor Chemicals Program](#) for additional information.

7.2 Chemical Inventory

A. All Hazardous Chemicals

A chemical inventory must be maintained for all chemicals stored in the laboratory as required by the [California Health and Safety Code - Sec. 25506](#). This is done via the web-based [ChemTracker application](#). Each laboratory must update their chemical inventory at a minimum of every 12 months.

Additional benefits for maintaining an up-to-date inventory include:

- Ability to identify unneeded materials that can be culled from laboratory storage, reducing overall chemical laboratory risks.
- Can better rely on the inventory to find needed materials, possibly avoiding unnecessary redundant purchases.
- Reduce compliance risks pertaining to the County's hazardous materials storage and reporting requirements.
- Aid in identification of the relative hazards of the chemicals in the inventory.

B. Select Agent Toxins

PI / Laboratory Supervisors working with Select Agent Toxins must ensure that permissible amounts are not exceeded by promptly updating Chemtracker after every container of Select Agent Toxin is acquired, depleted, or inactivated. For more information, refer to the document [Requirements for Possession of Permissible Amounts of Select Agent Toxins at Stanford University](#).

C. Controlled Substances

PI / Laboratory Supervisors enrolled under the institutional [DEA Controlled Substance Program](#) must also maintain a continuous usage log using [SU's Controlled Substance Usage Log](#).

8.0 LABORATORY INSPECTIONS

Laboratory inspections are an essential function to identify and address potential health and safety deficiencies and to fulfill regulatory compliance requirements.

8.1 Laboratory Self-Inspection Requirements

Laboratories must be self-inspected as indicated per the guidance provided in the document [Lab Inspections](#). Completed self-inspection checklists and the actions taken to correct identified unsafe conditions must be maintained by the PI / Laboratory Supervisor or their designee for the length of time specified for each type of inspection.

8.2 EH&S Laboratory Quality Assurance Visits

Using a risk-based approach, EH&S conducts visits of laboratories to assist labs in assessing their implementation and compliance with core health and safety issues, including but not limited to: storage, use, and disposal of higher hazard chemicals; correct management of controlled substances; and select agent toxins.

9.0 HAZARDOUS WASTE MANAGEMENT

Management of hazardous waste is both a critical compliance and health & safety responsibility of the lab.

- Refer to the [Chemical Waste Disposal](#) website for guidance on general waste management practices, segregation of waste, accumulation and storage of waste, labeling of waste, and requesting removal of waste.
- For compliance with the training and information requirements for hazardous waste regulations, all laboratory personnel are required to know the following:
 1. The hazards of the waste chemicals in the lab.
 2. How to properly contain and store the waste in the lab.
 3. What to do in an emergency involving the lab waste.

10.0 CHEMICAL HAZARD INFORMATION AND TRAINING

To apprise laboratory personnel of the hazards of chemicals present in their work area, information and training must be made available.

10.1 Hazard Information

PI / Laboratory Supervisors must inform laboratory personnel of the location and availability of the following information:

- A. ["Occupational Exposure to Hazardous Chemicals in Laboratories." California Code of Regulations Title 8, Section 5191.](#)

Cal/OSHA is a governmental agency that protects worker health and safety in the State of California. This regulation was promulgated to protect laboratory personnel engaged in the laboratory use of hazardous chemicals. [NOTE: Custodial and maintenance staff who service the laboratory fall under Cal/OSHA's Hazard Communication Standard, Code of Regulations Title 8, Section 5194.]

B. Stanford University's Chemical Hygiene Plan.

The above-referenced Cal/OSHA regulation requires employers to have a written Chemical Hygiene Plan. This Plan fulfills this regulatory requirement and is a resource for planning experiments and laboratory operations.

C. ["Permissible Exposure Limits \(PEL\) for Chemical Contaminants", California Code of Regulations, Title 8, Section 5155.](#)

Cal/OSHA establishes regulatory exposure limits for many airborne contaminants; the actual values are in Table AC-1. If a PEL has not been established for a specific contaminant, contact EH&S for guidance.

D. Reference materials on the hazards, signs & symptoms of exposure, safe handling, and storage & disposal of hazardous chemicals at the various website links:

- [Safety Data Sheets](#)
- [Stanford University's Chemical Safety Database](#)
- [National Library of Medicine, National Institutes of Health](#)

10.2 Work Directed by PI / Laboratory Supervisor

For work directed by a PI / Laboratory Supervisor, PI / Laboratory Supervisors must provide laboratory personnel with information and training at the time of initial assignment to the laboratory, and prior to assignments involving new exposure situations, work with [Particularly Hazardous Substances](#), or other hazardous operations.

A. Types of Training

Laboratory personnel must receive general and laboratory-specific training as follows:

1. General Training

PI / Laboratory Supervisors must provide laboratory personnel with orientation to and training on the CHP. This is accomplished via the following training, which laboratory personnel must take (available on-line or in class):

- General Safety & Emergency Preparedness (EHS-4200)
- Chemical Safety for Laboratories (EHS-1900)

Laboratory personnel must take other trainings, as appropriate. For example:

- Computer Workstation Ergonomics (EHS-3400)
- Compressed Gas Safety (EHS-2200)
- Laboratory Ergonomics (EHS-4800)

For online classes, register in STARS via the Axxess Portal at <http://axess.stanford.edu> using the training tab (STARS). For live classes, call 650-723-0448.

2. Laboratory-Specific Training

Laboratory-specific training is to be provided by the PI/Laboratory Supervisor or his/her designee, addressing the specific chemical hazards present and emergency procedures specific to the laboratory. Also, any lab-owned equipment may require specialized training to prevent equipment damage. This can be achieved via a combination of the following:

- a. Review of any individual Laboratory Safety Plan.
- b. Review of local/building safety information.
- c. Review of Standard Operating Procedure(s) involving hazardous chemicals.
- d. Other laboratory-specific training on particular safety procedures or hazards encountered in the laboratory environment.

A template for creating a lab-specific training program can be found in the document [How To Develop Lab-Specific Training](#).

B. Recordkeeping of Safety Training

All health and safety training records are to be maintained by the PI / Laboratory Supervisor or designee for at least one year.

- For documenting SOP review by laboratory personnel, see the form [Documenting SOP Review and PI Approval](#).

10.3 Work Conducted Autonomously or Independently

- PI/Laboratory Supervisors shall provide access to the CHP and any individual Laboratory Safety Plan, if one is developed, to persons working autonomously or performing independent research before they undertake work in Stanford University laboratories.
- Persons working autonomously are responsible for ensuring that they have any other training that is appropriate to the work they conduct in Stanford University laboratories and shall fulfill all the responsibilities set forth in Sections [1.4.B](#) and [1.4.C](#), including providing appropriate oversight, training, and safety information to any laboratory personnel they supervise or direct.

11.0 EMERGENCY RESPONSE - SPILLS AND EXPOSURES

All incidents involving hazardous chemical spills and exposures require prompt action by the responders and the victims in order to control chemical exposures to personnel and to minimize impacts to the environment and property.

11.1 Stanford University Life Safety Boxes

- A.** Life Safety Boxes, located outside of each laboratory, provide lab-specific chemical hazard information to emergency response personnel.
- B.** Hazard labels on the front of the Life Safety Boxes represent the different types of hazards that may be present within the lab.

C. Information in the Life Safety Boxes include:

1. Cover page with hazard symbols representing the different types of hazards within the lab (provided annually by EH&S).
2. [SU's emergency contact form](#) (or [SOM emergency contact form](#) for the School of Medicine) (provided and updated annually by lab).
3. [Chemical storage map](#) (provided and updated annually by lab).

11.2 Types of Emergency Scenarios

In the laboratory, chemical-related accidents require local emergency response that may involve requesting assistance, local clean up, and incident reporting/follow-up.

For guidance on proper response to various emergencies, review documents below:

A. Health Threatening Emergencies - fire, explosion, serious injury/exposure

In the event of an imminent or actual health-threatening emergency (threatening local or public health, safety, or welfare; or the environment outside the immediate area):

1. CALL 911 (or 9-911 from campus landlines) for the Fire Department.
2. Alert people in the vicinity, activate local alarm systems.
3. Evacuate the area.
4. REMAIN NEARBY TO ADVISE EMERGENCY RESPONDERS.
5. Once personal safety is established, call EH&S at 650-725-9999 and proceed with local notifications, below.

If Personnel Exposed:

1. Remove exposed / contaminated individual(s) from area, unless unsafe to do so because of (a) medical condition of victim(s), or (b) potential hazard to rescuer(s).
2. In all instances, immediately notify SU Emergency 911 (or 9-911 from campus landlines) if immediate medical attention is required.
3. Notify EH&S to report the potential exposure by calling 650-725-9999.
4. Administer First Aid as appropriate.
5. Flush contamination from eyes/skin using the nearest emergency eyewash / shower for a minimum of 15 minutes. Remove any contaminated clothing.
6. Take copy of SDS(s) of chemical(s) to hospital with victim.

B. Non-health Threatening Emergencies - no health threats, but spill is too large to be cleaned up by lab personnel.

In the event of a spill or release, which may or has impacted the environment (storm drain, soil, air outside the building), or spill or release that cannot be cleaned up by local personnel:

1. Notify Stanford Responders: Call 650-725-9999 (24 hours/day, 7 days/week).
2. Provide local notifications to your supervisor.

C. Small Spills - cleaned up by lab personnel

In the event of a minor spill or release that can be cleaned up by local personnel using readily available equipment (absorbent, available from EH&S in Small Spill Kit):

1. Notify personnel in the area and restrict access. Eliminate all sources of ignition.
2. Review the SDS for the spilled material, or use your knowledge of the hazards of the material to determine the appropriate level of protection.
3. Wear gloves and protective eyewear. Clean up using absorbent pads. Put the contaminated absorbent pads in a labeled hazardous waste container.
4. If greater than 30 ml, or if it will take longer than 15 minutes for you to clean-up, immediately call EH&S at 650-725-9999 to report the spill, and notify your supervisor.
5. Submit online [waste pickup request](#) to EH&S.

11.3 Incident Reporting

Laboratory personnel are to report all occupational injuries or illnesses to laboratory supervisor as soon as practical. The Principal Investigator/Laboratory Supervisor and laboratory personnel must submit the [required paperwork](#) to Risk Management. Laboratory personnel are encouraged to report "[near-misses](#)" as they are considered a precursor to more serious incidents.

11.4 Follow-up

The Principal Investigator / Laboratory Supervisor is to conduct (or coordinate) an investigation of all incidents and "near misses." The goal of the investigation is to identify and address any deficiencies that may have contributed to the incident.

12.0 MEDICAL CONSULTATION, EXAMINATION, AND SURVEILLANCE

Medical consultation, examination, and surveillance are provided as follows:

12.1 When Provided

Employee laboratory personnel who work with hazardous chemicals will be provided the opportunity to receive medical attention/consultation when:

- a. Symptoms or signs of exposure to a hazardous chemical develop.
- b. Exposure monitoring reveals an overexposure.
- c. A spill, leak, explosion, or other occurrence results in a hazardous exposure (potential overexposure).
- d. A regulatory standard triggers medical surveillance. Refer to the EH&S [Medical Surveillance](#) website for more information on these requirements.

12.2 Health Care Providers

Medical examinations will be conducted by licensed providers and will be provided at a reasonable time and place at no cost to the employee. Medical consultations and examinations for employees are provided via the Stanford University Occupational Health Center (SUOHC).

SUOHC will document and provide as appropriate the following:

- Examination and test results.

- Any medical condition that may place employee at increased risk from work place hazardous chemicals.
- Statement that employee has been informed of the results.
- The written report shall not reveal any specific findings of diagnoses unrelated to occupational exposure.

Employees are responsible for informing the PI / Laboratory Supervisor of any work modifications ordered by the clinician as a result of exposure.

12.3 Information Provided to Physician

EH&S's Industrial Hygienist will provide the following information to the physician:

- Identity of hazardous chemicals.
- Conditions of exposure, including exposure data, if available.
- Signs and symptoms of exposure.

12.4 Recordkeeping of Medical Records / Access to Medical Records

Medical records will be maintained by the SUOHC for the duration of the employee's employment plus 30 years.

Employees must have access to medical records within 15 days of request to EH&S, per [Cal/OSHA 8 CCR 3204, Access to Employee Records](#).

APPENDIX A: Definitions

Action level: (Per 8 CCR 5191)

A concentration designated for a specific substance, calculated as an eight-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance. The action level is always lower than the corresponding Cal/OSHA [permissible exposure limit](#) (PEL) and is designed to protect personnel from overexposure.

Acute toxicity: (Per 29 CFR 1910.1200 App A.1)

Acutely toxic substances cause adverse effects by any of the following exposure methods:

1. Oral or dermal administration of a single dose of a substance.
2. Multiple oral or dermal doses within a 24-hour period
3. An inhalation exposure of 4 hours.

By the criteria listed below, substances are placed in one of four toxicity categories according to their experimentally derived [LD₅₀ or LC₅₀](#) values.

Exposure Route	Category 1	Category 2	Category 3	Category 4
Oral (mg/kg bodyweight)	≤ 5	> 5 and ≤ 50	> 50 and ≤ 300	> 300 and ≤ 2000
Dermal (mg/kg bodyweight)	≤ 50	> 50 and ≤ 200	> 200 and ≤ 1000	> 1000 and ≤ 2000
Inhalation – gases (ppm by volume)	≤ 100	> 100 and ≤ 500	> 500 and ≤ 2500	> 2500 and ≤ 20000
Inhalation – vapors (mg/L)	≤ 0.5	> 0.5 and ≤ 2.0	> 2.0 and ≤ 10.0	> 10.0 and ≤ 20.0
Inhalation - dusts and mists (mg/L)	≤ 0.05	> 0.05 and ≤ 0.5	> 0.5 and ≤ 1.0	> 1.0 and ≤ 5.0

Note: Substances in Categories 1 and 2 are considered to have a “high degree of acute toxicity.” These substances are also referred to as “Highly Acutely Toxic Substances.”

Asphyxiant: See [simple asphyxiant](#)

Aspiration hazard: (Per 29 CFR 1910.1200 App A.10)

A liquid or solid chemical that causes severe acute effects if it infiltrates into the trachea and lower respiratory tract. Possible effects include chemical pneumonia, pulmonary injury, or death.

Carcinogen: (Per 29 CFR 1910.1200 App A.6)

A substance or a mixture of substances which induce cancer or increase its incidence.

See also: [Select Carcinogen](#)

Combustible liquid: (Per Cal/OSHA 8 CCR 5194)

Any liquid having a flash point greater than 93°C (199.4°F).

Compressed gas: See [Gases under pressure](#)

Controlled Substances: Drugs and certain other chemicals, both narcotic and non-narcotic, which come under the jurisdiction of federal Drug Enforcement Administration (DEA) and state laws regulating their manufacture, sale, distribution, use, and disposal.

Corrosive: (Per 29 CFR 1910.1200 App A.2 and App A.3)

A substance causing irreversible destruction of living tissue by chemical action at the site of contact. Major classes of corrosive substances include strong acids and strong bases.

Corrosive substances may be classified as causing *skin corrosion*, *serious eye damage*, or both. Skin corrosives are further divided into 3 hazard categories (1A, 1B, and 1C; 1A being the most corrosive). The criteria for each category are available in [29 CFR 1910.1200 App A.2.2.1](#).

Cryogenic liquids: Materials with extremely low boiling points (i.e., less than -150 °F). Common examples of cryogenic liquids are liquid nitrogen, liquid helium, and liquid argon. One special property of both cryogenic liquids and dry ice (frozen carbon dioxide) is that they undergo substantial volume expansion when converted to the gas phase, which can potentially lead to an oxygen-deficient atmosphere in areas where ventilation is limited.

See also: [Refrigerated liquefied gas](#)

Explosive: (Per 29 CFR 1910.1200 App B.1)

A solid or liquid chemical which, by itself, can chemically react to produce gases at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic chemicals are included even when they do not evolve gases.

Flammable: (Per 29 CFR 1910.1200 App B.2, B.3, B.6, B.7)

A substance that falls into one of the following categories:

- *Flammable gas* means a gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi).
- *Flammable liquid* means a liquid having a flash point of not more than 93°C (199.4°F).
- *Flammable solid* means a solid which is a readily combustible solid, or which may cause or contribute to fire through friction. *Readily combustible solids* are powdered, granular, or pasty substances which can be easily ignited by brief contact with an ignition source, such as a burning match, and for which flame spreads rapidly.
- *Flammable aerosol* means an aerosol containing any flammable materials. An *aerosol* is defined as a non-refillable receptacle containing a gas compressed, liquefied, or dissolved under pressure, and fitted with a release device allowing the contents to be ejected either as suspended particles in a gas, or as a foam, paste, powder, liquid, or gas.

See also: [Combustible liquid](#)

Gases under pressure: (Per 29 CFR 1910.1200 App B.5)

Gases which are: stored at a pressure of 29 psi (gauge) or more, liquefied, or liquefied and refrigerated. They are divided into the following four categories:

- *Compressed gas:* A gas which, when under pressure, is entirely gaseous at a temperature of -50°C (-58°F), including all gases with a critical temperature ≤ 50°C (-58°F).

- *Liquefied gas*: A gas which, when under pressure, is partially liquid at temperatures above -50°C (-58°F).
- *Refrigerated liquefied gas*: A gas which is made partially liquid because of its low temperature.
- *Dissolved gas*: A gas which, when under pressure, is dissolved in a liquid phase solvent.

Germ cell mutagen: (Per 29 CFR 1910.1200 App A.5)

A substance that causes mutations in the germ cells of humans which can be transmitted to their offspring. Germ cell mutagens are further classified into 3 hazard categories (1A, 1B, and 2) based on the weight of evidence for their germ cell mutagenicity, with category 1A having the most conclusive evidence. The criteria for each category are available in [29 CFR 1910.1200 App A.5.2](#).

Hazardous chemical: Any chemical which is classified as a [health hazard](#) or [simple asphyxiant](#).

Health hazard: (Per Cal/OSHA 8 CCR 5191 and 8 CCR 5194)

A chemical classified as posing one or more of the following hazardous effects: [acute toxicity](#) (any route of exposure), skin [corrosion](#) or [irritation](#), [serious eye damage](#) or eye [irritation](#), respiratory or skin [sensitization](#), [germ cell mutagenicity](#), [carcinogenicity](#), [reproductive toxicity](#), [specific target organ toxicity](#) (single or repeated exposure), or [aspiration hazard](#).

Hepatotoxin: Substances that produce liver damage (e.g., nitrosamines, carbon tetrachloride).

Highly Toxic / Highly Acutely Toxic: See [Acute toxicity](#)

Incompatible: Materials that could cause dangerous reactions by direct contact with one another.

Irritant: (Per 21 CFR 1910.1200 App A)

- *Skin irritant*: A substance that causes reversible damage (such as swelling or inflammation) to the skin following an exposure.
- *Eye irritant*: A substance that causes changes in the eye following an exposure, which are fully reversible within 21 days of exposure.

Laboratory Personnel: Includes both employee and non-employee laboratory personnel who perform research activities, and covers individuals employed in the laboratory workplace who may be exposed to hazardous chemicals in the course of their assignments. Employees include faculty and staff and may include research associates, undergraduate and graduate students, and post-doctoral researchers, depending on their employment status. Non-employees include [visiting scholars](#) and may include research associates, undergraduate and graduate students, and postdoctoral researchers, depending on their employment status.

Laboratory Safety Plan: An individual plan prepared by a PI that covers the safety procedures pertinent to activities conducted in his/her laboratory.

Laboratory Supervisor: The individual in charge of the laboratory. It may be a Principal Investigator (PI), laboratory instructor, or laboratory manager.

LC₅₀/LD₅₀ (also referred to as “median lethal dose”): The dose required to kill half of a tested animal population. When the dose is expressed in units of mass (usually normalized to the mass of the animal tested), the abbreviation LD₅₀ is used. Similarly, the abbreviation LC₅₀ is used for doses expressed in units of concentration.

Microscaling (of process): Reducing the quantities of hazardous chemical used in a research operation to “microscale” quantities in order to reduce the risks to personnel and property and to minimize chemical waste streams. Microscale quantities range from 50-1000 milligrams and utilize glassware designed to hold less than 25 ml.

Nanoparticle: A collection of tens to thousands of atoms approximately 1 to 100 nanometers in diameter, which may either be naturally occurring or engineered. Examples include: carbon buckyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); and quantum dots, among many others.

Near-miss: (Per [American Chemical Society](#))

An event in which an injury or loss did not occur, but could have. The conditions of the event are often readily identified as precursors to an accident or loss. These events, which are sometimes referred to as a “near hit,” are indicators that the existing hazard controls, if any, may not be adequate and deserve more scrutiny.

Nephrotoxin: Substances causing damage to the kidneys (e.g., certain halogenated hydrocarbons).

Neurotoxin: Substances that exhibit their primary toxic effects on the nervous system (e.g., mercury, acrylamide, carbon disulfide).

Non-Laboratory personnel: Laboratory personnel such as administrative staff, plumbers, and Heating, Ventilation & Air Conditioning (HVAC) technicians entering research laboratories to perform maintenance, administrative, or other non-research laboratory tasks.

Organic peroxide: (Per 29 CFR 1910.1200 App B.15)

A liquid or solid organic chemical which contains the bivalent -O-O- structure, and as such is considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.

Oxidizer: (Per 29 CFR 1910.1200 App B.4, B.13, B.14)

- *Oxidizing gases* are gases which may cause or contribute to the combustion of other material more than air does, generally by providing oxygen.
- *Oxidizing solids and liquids* are substances which, while not necessarily combustible themselves, may cause or contribute to the combustion of other material, generally by yielding oxygen.

Oxidizing solids and liquids are each divided into three hazard categories (1, 2, and 3) based on their ability to accelerate combustion, with Category 1 being the strongest oxidizer. The criteria for each category are available in [29 CFR 1910.1200 App B.13.2 and B.14.2](#).

Particularly Hazardous Substances: (Per Cal/OSHA 8 CCR 5191)

These consist of [select carcinogens](#), [reproductive toxins](#), and substances that have a high degree of [acute toxicity](#).

Permissible exposure limit (PEL): Per Cal/OSHA, the maximum permitted 8-hour time-weighted average concentration of an airborne contaminant.

Physical hazard: (Per Cal/OSHA 8 CCR 5191)

A chemical that is classified as posing one of the following hazards: [explosive](#), [flammable](#), [combustible liquid](#), [oxidizer](#), [self-reactive](#), [pyrophoric](#), [self-heating](#), [organic peroxide](#), corrosive to metal, [gas under pressure](#), [in contact with water emits flammable gas](#), [water-reactive](#), or combustible dust.

Precursor Chemical: Chemicals used in the course of legitimate research that can potentially be used in the illicit production of [Controlled Substances](#) such as methamphetamine, cocaine, heroin, and MDMA (ecstasy).

Pyrophoric: (Per 8 CCR 5194 and 29 CFR 1910.1200 App B.9, B.10)

- *Pyrophoric gases* are gases that will ignite spontaneously in air at a temperature of 130 °F (54.4 °C) or below.
- *Pyrophoric solids and liquids* are chemicals which, even in small quantities, are liable to ignite within five minutes after coming into contact with air.

Reproductive Toxin: (Per Cal/OSHA 8 CCR 5191)

A chemical which affects reproductive capabilities. Possible effects include chromosomal damage (mutations), effects on fetuses (teratogenesis), adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring.

Under Proposition 65, the State of California maintains [a list of chemicals](#) known to cause reproductive toxicity. Fed/OSHA criteria for reproductive toxicity are available in [29 CFR 1910.1200 App A.7.2](#).

Restricted Chemicals: Use of the following chemicals requires prior approval by the PI:

- Toxic gases regulated by Santa Clara County (e.g., Diazomethane, Hydrogen cyanide, Hydrogen fluoride (anhydrous), Nickel carbonyl)
- Dimethylmercury

Sensitizer: (Per 29 CFR 1910.1200 App A.4)

- *Respiratory sensitizers* are substances that will lead to hypersensitivity of the airways following inhalation of the substance.
- *Skin sensitizers* are substances that will lead to an allergic response following skin contact.

Both respiratory and skin sensitizers are further classified into two categories (1A and 1B, 1A being the strongest sensitizers) based on the criteria in [29 CFR 1910.1200 App A.4.2.1 and A.4.2.2](#), respectively.

Select Agent Toxins: Certain toxins of biological origin identified by the United States Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC), the United States Department of Agriculture (USDA), and the Animal and Plant Health Inspection Service (APHIS) as posing a potential threat to public health or welfare. Selected biological organisms (bacteria, viruses, fungi) are also regulated as Select Agents.

NOTE: A list of Select Agents and Select Agent Toxins is available at the following link: [Select Agents and Toxins](#).

Select Carcinogen: (Per Cal/OSHA 8 CCR 5191)

A substance or agent that meets one of the following criteria:

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

Self-heating chemical: (Per 29 CFR 1910.1200 App B.11)

A solid or liquid chemical that is not a pyrophoric liquid or solid, which, by reaction with air and without outside supply of energy, is liable to self-heat. These chemicals differ from pyrophoric substances in that they will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

Self-reactive (also referred to as "unstable"): (Per 29 CFR 1910.1200 App B.8)

Thermally unstable liquid or solid chemicals which are liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). This definition excludes chemicals classified as explosives, organic peroxides, oxidizing liquids, or oxidizing solids.

Simple asphyxiant: (Per Cal/OSHA 8 CCR 5194)

A substance or mixture that displaces oxygen in the ambient atmosphere and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

Specific target organ toxicity (STOT): (Per 29 CFR 1910.1200 App A.8 and App A.9)

A *specific target organ toxicant* is a substance that has non-lethal toxic effects on specific organs or biological systems. This term includes all significant health effects that impair organ function and are not specifically covered by another hazard classification (e.g., acute toxicity, carcinogenicity, etc.). These toxicants are divided into two types by the number of exposures necessary for toxic effects to occur:

- *Single exposure (STOT-SE)*
- *Repeated exposure (STOT-RE)*

Both STOT-SE and STOT-RE are divided into two categories (1 and 2) by the weight of evidence for toxic effects in humans, with Category 1 having the most conclusive evidence. The criteria for each category are available in [29 CFR 1910.1200 App A.8.2 and A.9.2](#).

Substitution: When designing and planning a laboratory operation, using the least hazardous chemical possible to minimize risk to personnel and property.

Threshold limit value: As determined by the American Conference of Governmental Industrial Hygienists (ACGIH), a threshold limit value is the airborne concentration of a chemical substance under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects.

Toxic Gas: A material that is regulated under Santa Clara County's Toxic Gas Ordinance as:

- *Class I Material:* Has a median Lethal Concentration (LC₅₀) in air of 200 parts per million or less by volume of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for an hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.
- *Class II Material:* Has a LC₅₀ in air more than of 200 parts per million but not more than 3,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 30 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for an hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.
- *Class III Material:* Has a LC₅₀ in air more than of 3,000 parts per million but not more than 5,000 parts per million by volume of gas or vapor, or more than 30 milligrams per liter but not more than 50 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for an hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

See Stanford University's [Toxic Gas Table](#) for a list of Toxic Gases.

Toxic substance: See [acute toxicity](#) and [specific target organ toxicity](#)

Unstable: See [Self-reactive](#)

Water-reactive (also referred to as “Chemicals which, in contact with water, emit flammable gases”): (Per 29 CFR 1910.1200 App B.12)

Solid or liquid chemicals which, when exposed to water, can become spontaneously flammable or give off flammable gases in dangerous quantities. These chemicals are divided into three categories (1, 2, and 3) based on the strength of their reaction with water, with Category 1 being the most reactive. The criteria for each category are available in [29 CFR 1910.1200 App B.12.2](#).