TABLE OF CONTENTS

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 conducting work in his/her laboratory. The PI/Laboratory Supervisor may delegate the safety duties for which he/she is responsible, but must make sure that any delegated safety duties are carried out**.**

The PI/Laboratory Supervisor's responsibilities include:

1. Identifying hazardous conditions or operations in the lab, determining safe procedures and controls, and implementing and enforcing standard safety procedures.
2. Establishing standard safety operating procedures (general and protocol-specific) and performing literature searches relevant to safety and health that is appropriate for the work.
3. Providing prior-approval for the use of Restricted Chemicals in the PI/Laboratory Supervisor's laboratory.
4. Consulting on use of higher risk chemicals, such Particularly Hazardous Chemicals or highly reactive chemicals or conducting higher risk experimental procedures so that special safety precautions may be taken.
5. Maintaining the on-line 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 he/she supervises 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. Maintaining in functional working order appropriate personal protective equipment (e.g., gloves, goggles).
10. Conducting periodic laboratory inspections and maintaining records of inspections.
11. Prompt reporting of laboratory accidents and injuries to Risk Management and Environmental Health & Safety (EH&S).
12. Making available required medical surveillance or medical consultation/ examination for laboratory personnel.
13. Informing facilities personnel, other non-laboratory 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.

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.

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.

B. Duties of All Laboratory Personnel

All laboratory personnel who work with hazardous chemicals in research laboratories are responsible for:

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 Chemicals or highly reactive chemicals, or conducting certain higher risk experimental procedures.
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:

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

D. Duties of Environmental Health and Safety and CHO

Stanford's EH&S Occupational Health & Safety (OH&S) Program, which includes the University Chemical Hygiene Officer (CHO), is responsible for administering and overseeing institutional implementation of this Plan. The OH&S Group 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 hazards assessments, upon request.
3. Maintaining area and personal exposure-monitoring records.
4. Reviewing and providing advice on Laboratory SOPs, 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/ Unstability (incl. explosivity), and
- Toxicity (incl. irritation, sensitization, carcinogenicity, reproductive toxicity)

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

Below is brief discussion of these major classes of hazardous chemicals.

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 100 °F and combustible liquids having a flash point between 100-200 °F. 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 destruction of tissue through chemical action at the point 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/ Unstable Materials

Highly reactive or 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 highly reactive chemicals are peroxides, water-reactives, and pyrophorics.

- See the document, ***General Standard Operating Procedure for Working with Highly Reactive/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. 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 permitting, contact EH&S for such 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 high acute toxicity (also known as "highly toxic") 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. 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. NOTE: "Select carcinogens", as previously mentioned, also include those chemicals that are considered suspect carcinogens.

- See the document, ***General Standard Operating Procedure for Working with Carcinogens***.

B. Reproductive Toxins

Reproductive toxins include substances that cause chromosomal damage (mutations) or lethal or malformation effects on fetuses (teratogensis). 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 Toxic Chemicals

Chemicals with a high level of acute toxicity have the ability to cause harmful local and systemic effects after a single exposure. Many of these chemicals may also be characterized as a toxic gas, CDC Select Agent Toxin, corrosive, irritant or sensitizer.

- See the document, ***General Standard Operating Procedure for Working with Highly Toxic Chemicals***.

2.6 Sensitizers

A sensitizer is a substance that causes 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 chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin 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 property 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 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. Engineered nanoparticles may be bought via commercial vendors or generated via experimental procedures by researchers in the laboratory. Examples of engineered nanomaterials include: carbon buckeyballs or fullerenes; carbon nanotubes; metal oxide nanoparticles (e.g., titanium dioxide); quantum dots, among many others.

The health effects of exposures 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 other.

- See the document, ***SU's General Principles for Working Safely with Engineering Nanomaterials*** for guidance.

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 are recommended whenever using hazardous chemicals that:

- Have high acute toxicity, or which are carcinogens, or reproductive toxins except where there is very low risk of exposures (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 the document, ***Safe Fume Hood*** for information on safe use of fume hoods.

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 (i.e., glove box, sealed chamber).
- Micro scaling the size of the experiment to reduce the amount of chemical usage.

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 the document, ***Selecting Personal Protective Equipment*** for selection and use of PPE.

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; and
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 he/she directs 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 to creating laboratory-specific SOPs.

5.0 PRIOR APPROVAL AND SPECIAL PRECAUTIONS

5.1 Restricted Chemicals Requiring Prior Approval

Laboratory personnel shall seek and the PI/Laboratory Supervisor (or his/her delegate) must provide prior approval of any chemical usage involving the following Restricted Chemicals:

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

5.2 Methods for Granting Prior Approval

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

a. PI/Laboratory Supervisor completes 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 provides other written approval e.g. via e-mail 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 following higher risk chemicals 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.
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, considering:
     - 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 Disability Act (ADA).]
     - Time the work is to be conducted (during normal business hours (i.e., 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:

- Establishment of a designated area
- Use of containment devices such as fume hoods or glove boxes
- Procedures for safe removal of contaminated waste
- 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 hood, especially those chemicals:

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

For any concern involving hazardous chemicals usage, including the above scenarios, EH&S- Occupational Health & Safety Program can provide chemical exposure

assessment to help verify adequate controls. For more information contact EH&S at 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/Record Keeping

Monitoring results are provided to laboratory personnel per the time requirements of the relevant regulation or within 15 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.

B. Select Agent Toxins

In addition to the requirements detailed above, for select agent toxins (in exempt quantities), the laboratory must provide one additional layer of physical security (i.e., toxin secured within locked freezer, or secured within a permanently fixed lock box) per the document, SU Requirements for Possession of Exempt Quantities of CDC Select Agent Toxins.

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. 25503.5 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 unnecessarily 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 exempt quantity levels are not exceeded by promptly updating Chemtracker after every container of CDC toxin is acquired, depleted, or inactivated. For more information, refer to the document, SU Requirements for Possession of Exempt Quantities of National Select Agent Registry 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 Inspection Requirements

Laboratories must be inspected as indicated per the guidance provided in the document, ***Lab Inspections***. Completed 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 by the type of inspection.

8.2 Performance Verification of Engineering Controls and Safety Equipment

To help 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 & Safety Equipment***.

9.0 HAZARDOUS WASTE MANAGEMENT

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

- Refer to document, ***Chemical Waste Disposal*** for guidance on general waste management practices, segregation of waste, accumulation and storage of waste, labeling of waste, and request 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, and
  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 information used 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, under the "Graphic" links. If a PEL is not established for a specific contaminant, contact EH&S for guidance.

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

- Material 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 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, and 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 (EHS-2200)
- Laboratory Ergonomics (call EH&S at 723-0448)

For on-line classes, register in STARS via the Axess Portal at http://axess.stanford.edu using the training tab. For live classes, call 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.

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 Section 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:

- Cover page with hazard symbols representing the different types of hazards within the lab.
- SU's Emergency contact form (or SOM Emergency contact form for the School of Medicine)
- Chemical storage map.
- The Lab's chemical inventory printout (provided annually by EH&S).

11.2 Types of Emergency Scenarios

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

- For guidance on proper response to various emergencies, review documents below:
  - Health Threatening Emergencies– fire, explosion, serious injury/exposure
  - Non-health Threatening Emergencies - no health threats, but spill is too large to be cleaned up by lab personnel
  - Small Spills - cleaned up by lab personnel

11.3 Incident Reporting

Laboratory personnel are to report all occupational injuries or illness to laboratory supervisor as soon as practical. The Principal Investigator/laboratory supervisor and laboratory personnel must submit the required paper work to Risk Management. Laboratory personnel are encouraged to report "near misses" as they are considered a precursor to actual 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 document, ***Medical Surveillance***.

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. 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:

- Identify 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: The airborne chemical concentration that triggers air monitoring and the implementation of additional control measures. The action level is always lower than the corresponding Cal/OSHA permissible exposure limit (PEL) and is designed to protect personnel from overexposure. At SU, the more conservative of either the Cal/OSHA-defined action level (generally one-half the PEL) or one-half the ACGIH Threshold Limit Value is used as the action level.

Carcinogen: See "Select Carcinogen"

Compressed gas: (Per Cal/OSHA 8 CCR 5191)

1. A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70° F (21.1°C); or
2. A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130° F (54.4°C) regardless of the pressure at 70° F (21.1° C); or
3. A liquid having a vapor pressure exceeding 40 psi at 100° F (37.8° C) as determined by ASTM D-323-72.

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

Corrosive: Substance causing irreversible destruction of living tissue by chemical action at the site of contact (dermal or respiratory). Major classes of corrosive substances include strong acids, strong bases, and dehydrating agents.

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

Explosive: (Per Cal/OSHA 8 CCR 5191) A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable: (Per Cal/OSHA 8 CCR 5191) A chemical that falls into one of the following categories:

(1) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(2) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air greater than 12 percent by volume, regardless of the lower explosive limit.

(3) "Liquid, flammable" means any liquid having a flashpoint below 100° F (37.8° C), except any mixture having components with flashpoints of 100° F (37.8° C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(4) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 29 CFR 1910.109(a), 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 one-tenth of an inch per second along its major axis.

Hazardous Chemical: (Per Cal/OSHA 8 CCR 5191) A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed laboratory personnel (includes carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoitic systems, and agents which damage the lungs, skin, eyes, or mucous membranes).

Hematopoietic toxicants: Substances that decrease hemoglobin function and deprive the body tissues of oxygen (e.g. carbon monoxide, cyanides).

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

Highly Toxic: (Per Cal/OSHA 8 CCR 5194, also referred as highly acute toxin) A chemical falling within any of the following categories:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each.
2. A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each.
3. A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

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

Irritant: (Per Cal/OSHA 8 CCR 5194) A substance, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. (dermal or respiratory).

NOTE: A wide variety of organic and inorganic compounds are irritants and consequently exposure to all laboratory chemicals should always be avoided.

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.

Micro scaling (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 glassware designed to take less than 25 ml.

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

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

Neurotoxin: Substances that produce 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 Cal/OSHA 8 CCR 5191) 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: (Per Cal/OSHA 8 CCR 5191) A chemical other than a blasting agent or explosive defined by Cal/OSHA, that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

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 (also defined as highly toxic).

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

Precursor Chemical: Precursor chemicals are chemicals used in the course of legitimate research that can potentially be used in the illicit production controlled substances such as methamphetamine, cocaine, heroin, and MDMA (ecstasy).

Pyrophoric: (Per Cal/OSHA 8 CCR 5194) A chemical that ignite spontaneously in air at a temperature of 130 F or below**.**

Reproductive Toxin: (Per Cal/OSHA 8 CCR 5191) A chemical that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). Under Proposition 65, the State of California maintains a list of known chemicals causing reproductive toxicity. *IMPORTANT: Lab personnel should recognize that many chemicals have not been thoroughly assessed for their reproductive toxicity. Prior to selecting/ using chemicals in the laboratory, researchers should determine their potential reproductive toxicity risks.*

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 Cal/OSHA 8 CCR 5194) A substance that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the substance. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock**.**

Select Agents: Bacteria, viruses, toxins, rickettsia, and fungi 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) that pose a potential threat to public health or welfare. NOTE: The safety practices and precautions provided by the Chemical Hygiene Plan are most applicable with the use of Select Agent toxins as opposed to infectious agents. List of these agents is available at: CDC Select Agents.

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 Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
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.

IMPORTANT: Lab personnel should recognize that many chemicals have not been thoroughly assessed for their carcinogenicity. Prior to selecting chemicals for use in laboratory procedures, researchers should be familiar with the specific classes of compounds and functional group types that have been correlated to carcinogenic activity.

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

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

Class I Material: Has a median Lethal Concentration (LC 50) 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 LC 50 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 LC 50 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.

Toxic Substance: (Per Cal/OSHA 8 CCR 5194) Substances that cause adverse effects to specific target organs (i.e., lungs, liver, skin), or the nervous or blood systems. These substances can result in acute and/or chronic effects at moderate levels. Per Cal/OSHA, a toxic substance must fall within one of the following categories:

(a) A substance that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A substance that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A substance that has a median lethal concentration (LC50) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one 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 list of Toxic Gases
http://www.stanford.edu/dept/EHS/prod/researchlab/lab/tgo/tgodata.html

Unstable (reactive): (Per Cal/OSHA 8 CCR 5191) 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.

Water-reactive: (Per Cal/OSHA 8 CCR 5191) A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.