Amherst College

Chemical Hygiene Plan

Prepared: 03/18/16, Revised: 06/17/2020

Table of Contents

Purpose:

This Chemical Hygiene Plan (CHP) is intended to provide the necessary work practice policies, general procedures and information to all laboratory users such that a safe work environment exists. This plan is specifically concerned with use, handling, and disposal of potentially hazardous chemicals and processes found in the laboratories.

Scope:

All areas where chemical use meets the definition of laboratory use and scale as defined in 29 CFR 1910.1450(b), including but not limited to academic laboratories, hazardous material storage spaces, photographic darkrooms, and hazardous waste Satellite Accumulation Areas (SAA) located in laboratories.

Definitions and Abbreviations:

Action Level: means a concentration designated in 29 CFR 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

BMPs: Best Management Practices

CHO: Chemical Hygiene Officer-the position required by Laboratory Standard to administer the provisions of the chemical hygiene plan

CHP: Chemical Hygiene Plan-this document

EHS: Environmental, Health and Safety

GFCI outlet: Ground Fault Circuit Interrupter outlet-an outlet that is designed to measure the amount of current flowing through it and to automatically trip if there is an imbalance.

GHS: Globally Harmonized System-A means of hazard communication developed by the United Nations and employed in full or in part in many nations as the standard mechanism for communicating hazards of hazardous materials or chemicals.

Hazard: An inherent property of a material, chemical, other object, process or situation that can cause harm to a person or property

Hazard Category: Part of the GHS classification system- means the nature of the physical or health hazards

Hazard Class: Part of the GHS classification system- means the division of criteria within each hazard class

Hazard Communication Standard: The regulations found in 29 CFR 1910.1200 and its appendices

Hazardous Materials or Chemicals: Any chemical or material which possesses a health or physical hazard, or which is a simple asphyxiant, as classified according to the Hazard Communication Standard.

Hazard Statements: Part of the GHS labeling requirements-a statement assigned to a hazard class and category that describes the nature of the hazards of a material or chemical, including, where appropriate, the degree of hazard.

Health Hazard: Hazardous properties as defined by membership in any of the following categories as defined in the Hazard Communication Standard: acute toxicity (any route of exposure), skin corrosion or irritation, serious eye damage or irritation, respiratory or skin sensitization, germ cell mutagenicity, carcinogenicity, reproductive toxicity, specific target organ toxicity (single or repeated exposure), aspiration hazard.

Laboratory: Any place where a laboratory scale use of hazardous materials or chemicals occurs outside of a production or quality assurance setting.

Laboratory Standard: The regulations found in 29 CFR 1910.1450 and its appendices

Laboratory Scale: means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.

Laboratory Use: means handling or use of hazardous chemical or materials in which all of the following conditions are met: (i) Chemical manipulations are carried out on a "laboratory scale;" (ii) Multiple chemical procedures or chemicals are used; (iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and (iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

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

MSDS: Material Safety Data Sheets-older versions of SDSs which are not required to comply with the 16 section format of the newer SDSs

NRC: The National Research Council-a branch of the National Academies of Science, Engineering and Medicine that functions as an advisory committee on matters affecting these disciplines.

OSHA: Occupational Safety and Health Administration-the national regulatory agency with oversight of the Laboratory Standard

PEL: Permissible Exposure Limit-The maximum amount or concentration of a hazardous material or chemical that an individual can be exposed to as a TWA (usually over eight hours) as defined by OSHA.

Physical Hazard: Hazardous properties as defined by membership in any of the following categories as defined by the Hazard Communication Standard: explosives, flammable (gases, liquids, solids, aerosols), oxidizing (solid, liquids, gases), gases under pressure, self-reactive and self-heating chemicals, pyrophoric liquids and solids, in contact with water liberates flammable gas, organic peroxides, corrosive to metals

PI: Principal Investigator-The faculty member responsible for a laboratory or studio.

Pictograms: Part of the GHS labeling requirements- a composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

PPE: Personal Protective Equipment-apparel worn as the last line of defense to mitigate risk

Precautionary Statements: Part of the GHS labeling requirements- means a phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous material or chemical or the improper storage or handling of the same.

Primary Container: The container in which a hazardous material or chemical is supplied by the manufacturer which directly contains the chemical (i.e., this does not included shipping containers or packaging that does not directly contain the material or chemical).

Protective Laboratory Practices and Equipment: means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the institution can show to be effective, in minimizing the potential for exposure to hazardous chemicals.

Risk: The probability that a hazard may cause harm to a person or property

SAA: Satellite Accumulation Area-the location within each laboratory or studio space where hazardous waste is accumulated.

SDS: Safety Data Sheets-Documents that are required to be supplied by chemical manufacturers, distributors and importers which detail the hazards of hazardous materials or chemicals in a standardized 16 section format as detailed in the Hazard Communication Standard (29 CFR 1910.1200)

Signal Words: Part of the GHS labeling requirements- means a word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used in GHS are "danger" and "warning." "Danger" is used for the more severe hazards, while "warning" is used for the less severe.

SOGs or SOPs: Standard Operating Guidelines or Procedures

STEL: Short term exposure limit-The maximum amount or concentration of a hazardous chemical or material that a person may be exposed to over a 15 minute period as a TWA as defined by OSHA.

TLV: Threshold limit value- of a chemical or material is a level to which it is believed an individual can be exposed day after day for a working lifetime without adverse effects.

TWA: Time weighted average-the average exposure to a chemical or material over a specified length of time.

Working Container: A container into which a hazardous material or chemical is transferred.

Introduction:

This Plan is prepared to comply with the U.S. Occupational Safety and Health Administration (OSHA) standard, 29 CFR 1910.1450 “Occupational exposure to hazardous chemicals in laboratories" (i.e., the Laboratory Standard) and the recommendations of the National Research Council (NRC). This Plan also includes requirements for training, medical consultation and examinations, hazard identification, personal protective equipment, including respirator use and record keeping.

Responsibilities:

College President:

The President has given oversight responsibility for Campus health and safety compliance to the Dean of Faculty, the Treasurer and the Chief of Campus Operations

Dean of Faculty and Chief Financial and Administrative Officer:

The Dean of Faculty and Chief Financial and Administrative Officer have directed compliance responsibility to administrative and academic departments, faculty and staff.

Chief of Campus Operations:

The Chief of Campus Operations has the direct responsibility for chemical hygiene within the College and provides continuing support for efforts to improve the Campus safety and health.

Environmental Health and Safety (EHS):

The Environmental Health and Safety Director (or designee) shall exercise the authority to identify and minimize dangers to all laboratory workers, the community and the environment. EHS has the authority to suspend operations which do not conform to the health and safety practices required by the Chemical Hygiene Plan. The duties of the EHS Director (or designee) include:

1. Review and approve the design, installation, operation, acquisition and maintenance of all building, fire and laboratory health and safety equipment where chemicals are stored or handled in accordance with regulatory requirements and best management practices (BMPs).

2. Provide technical expertise to the laboratory community with regard to health, safety and environmental issues.

3. Ensure that Departments develop and implement appropriate standard operating guidelines(SOGs) for the labeling, handling and storage of all hazardous materials and waste.

4. Ensure that all persons engaged in the use of hazardous materials are properly trained prior to working in laboratories and other related areas.

5. Review and approve personal protective equipment, and implement a medical assessment program when applicable and necessary.

6. Conduct inspections of laboratories and associated areas with the Chemical Hygiene Officer (CHO) and departmental safety officers, and provide appropriate resources for Principal Investigators to conduct their own periodic inspections.

7. Coordinate Department health and safety training sessions (either in person, online or other methods). These sessions shall include, but are not limited to, topics such as hazard communication, relevant elements of the Chemical Hygiene Plan, hazardous waste identification and management, emergency procedures and department specific procedures.

8. Implementation of proper safeguards and engineering controls to best protect persons using chemicals, laboratory equipment, laboratories and other related areas and materials.

9. Investigate all reports of laboratory accidents, near misses and chemical leaks, odors and spills, and other areas of concern to prevent re-occurrence.

Chemical Hygiene Officer (CHO):

The Chemical Hygiene Officer (CHO) has the same authority and responsibilities assigned to the EHS Director. In addition, the CHO will:

1. Maintain an accurate inventory of all College laboratories and associated storage areas.

2. Ensure that Safety Data Sheets (SDS) are maintained for all hazardous materials in College laboratories and associated areas.

3. Provide technical expertise for the laboratory community for development of SOGs for experimental setups and techniques, appropriate chemical handling, waste disposal, cleanup and decontamination procedures.

4. Review the CHP annually, and update when needed.

Department Chairs:

The Department Chair (or their designee, such as the Department Safety Officer) is responsible for chemical safety in the department and should understand the goals of the Chemical Hygiene Plan. The Department Chair shall establish a culture of safety within their departments, and ensure that members of their departments:

1. Fill out chemical inventory update sheets for submission to the CHO.

2. Forward all SDSs that are received to the CHO, and ensure that paper backup copies are maintained within their department. The location of these SDSs will be included in the department's hazardous material and safety training.

3. Inspect chemicals routinely for unusable or expired items.

4. Ensure that hazardous material and safety training of all laboratory workers occurs, and that the training is appropriate to the level and specificity of the work being performed.

5. Ensure that training of all laboratory personnel is documented.

6. Purchase and appropriately use safety equipment when necessary.

7. Notify the CHO when laboratories or satellite waste areas are to be closed/commissioned, or when chemicals are to be moved from one area to another.

8. Develop and implement appropriate procedures and policies for the handling and disposal of hazardous materials used in laboratories.

9. Enforcement of disciplinary actions when appropriate to assure compliance with all applicable local, state and federal regulations, and Amherst College policies and procedures.

Principal Investigators (PIs) and Laboratory Supervisors:

Principal Investigators (PIs) and Laboratory Supervisors have the primary responsibility for chemical hygiene in research or teaching labs for which they are in control. They shall establish a culture of safety within their areas, and shall ensure that the requirements listed in the Department Chairs section are met in their areas. Additionally, they shall ensure that:

1. The procedures and requirements of the Chemical Hygiene Plan are implemented in their areas, including laboratory and hazard specific training.

2. Laboratory areas are inspected on a regular basis. A laboratory inspection checklist template is included as an appendix (Appendix 1) to this document.

3. Laboratory safety incidents and near misses are reported to the CHO. Other concerns are reported promptly to the appropriate departments (campus police, facilities, etc.).

4. Laboratory specific training outside of the scope of the training provided by the CHO and/or EHS shall be the responsibility of the laboratory PI. SOGs (SOPs) should be shared with the CHO and/or EHS.

All Laboratory Personnel, Users, Guest and Visitors:

1. Abide by all of the procedures and policies of the Chemical Hygiene Plan and any Department or laboratory specific policies.

2. Report any unsafe conditions, including, but not limited to, faulty fume hoods or emergency/safety equipment, chemical, electrical or other safety concerns to the laboratory supervisor or PI, the CHO and/or the EHS office.

3. Report any accidents or near misses to the PI or laboratory supervisor, the CHO and/or the EHS office.

Culture of Safety:

Amherst College is committed to fostering a culture of safety for all faculty, staff and students. In accordance with the College's mission to produce exceptional graduates capable of affecting positive change with actions guided by means of critical thought and personal responsibility, so safety in laboratory areas must start with the thinking individual. Each individual in the laboratory must be constantly aware of their surroundings and engaging in ongoing risk assessments and experiment planning. While it is important to abide by policies and rules meant to mitigate known risks, it is of even greater importance to be able to assess risks on a situational basis. Safety considerations should be part of all experimental designs from the very start, and should be continually addressed throughout the research process. PIs should engage in discussion of safety considerations with their laboratory personnel, and encourage discussion amongst their personnel of particular topics when appropriate. Department chairs should provide necessary and appropriate support for PIs to encourage attention to important safety considerations particular to their departments. When each individual is committed to safety, a strong sense of community identity invested in safety will emerge and benefit all.

Hazard Identification and Labeling:

The first step in assessing risk is the recognition and communication of hazards. All chemical hazards must be identified by means of appropriate labeling in all laboratory areas.

Primary Containers:

Primary containers of hazardous materials (i.e., those supplied by the chemical manufacturer) which were purchased after December 1, 2015 should comply with the Globally Harmonized System (GHS) labeling requirements detailed in Appendix C of 29 CFR 1910.1200. Namely, each primary container label should contain the following information:

1. Product identifier (eg., generally the name of material)

2. Applicable GHS pictograms

3. Applicable GHS signal word

4. Applicable GHS hazard statements

5. Applicable GHS precautionary statements

6. Name, address and telephone number of manufacturer or other responsible party

Primary container labels of hazardous materials purchased prior to December 1, 2015 and after March 11, 1994 should minimally comply with the provisions of the 1994 Hazard Communication Standard, and should include:

1. Product Identifier (eg., generally the name of the chemical)

2. Hazards associated with the material, including target organ effects

3. Name and address of manufacturer or other responsible party

Working Containers:

When a chemical is transferred from a primary container to a working container, the working container should be minimally labelled with the:

1. identity of the material (without chemical abbreviations or symbols). Abbreviations may only be used if the laboratory or storage area in which the material is to be stored has posted a key for all abbreviations used that is in plain view and easily accessible to emergency responders.

2. significant hazards of the material

The significant hazards may be communicated by means of the GHS system, the NFPA or HMIS systems, or by indicating the hazards with words on the label. Qualitative definitions of the GHS hazard classes may be found in Appendix 2 to this document; more rigorous, quantitative definitions can be found in 29 CFR 1910.1200 appendices A and B. Some typical physical and health hazards (and very qualitative definitions of these) that may appear on non-GHS labels include, but are not limited to the following:

Allergen: May cause allergic reactions

Carcinogen: May cause cancer

Combustible: Will support combustion (i.e., burn)

Corrosive: Destroys tissue or possesses a pH of 11.5 or greater, or 2 or less

Explosive: Releases heat, pressure or gas when exposed to elevated temperature, pressure or shock

Flammable: May ignite very easily at lower temperatures and/or concentrations

Irritant: Inflames tissue

Lachrymator: Vapors may cause eye irritation

Oxidizer: Initiates or promotes combustion in other materials

Pyrophoric: May ignite spontaneously on contact with air

Sensitizer: May cause allergic reactions after repeated exposures

Simple Asphyxiant: Displaces oxygen in an atmosphere to create an asphyxiation hazard

Target Organ Effects: Exposure via a specified route may cause damage to particular organs, tissues or other structures

Hepatoxin: May cause liver damage

Neurotoxin: May cause damage to the nervous system

Nephrotoxin: May cause damage to the kidneys

Teratogen: May cause abnormalities with embryonic or fetal development

Mutagen: May cause replication errors in DNA

Hematopoietic agent: May damage hemoglobin and cause oxygen deprivation

Toxic: May be harmful (in some cases, fatal) if exposure via a specified route occurs above a given level

Unstable or Reactive: Vigorously polymerizes, decomposes or self-reacts under conditions of shock or elevated pressure or temperature

Water-reactive: Chemically reacts with water to form a gas that is either flammable and/or a health hazard

Health and physical hazards may also be summarized on labels by means of the NFPA diamond (as described in NFPA 704) or the HMIS bar label (as described by the American Coatings Association). Individuals working in laboratory or laboratory support areas must be trained on the elements of the GHS system and any other hazard communication systems they are likely to encounter during the course of their work.

Safety Data Sheets (SDSs)

All hazardous materials that are sent to the College after December 1, 2015 must have an available GHS compliant Safety Data Sheet (SDS) that is in the format described in 29 CFR 1910.1200 Appendix D. This may be provided as a paper or electronic copy, or it may be available online through the manufacturer/supplier's website. The College maintains an electronic database of all SDSs for hazardous materials in laboratory areas received after December 1, 2013. The SDS database (MSDS Online) may be accessed from the Environmental, Health and Safety homepage. The first time a new hazardous material is to be used by lab personnel, the SDS (along with other resources describing health and physical hazards, chemical and physical properties, etc.) should be thoroughly reviewed and understood by laboratory personnel who will be using the material. See the Procurement section of this document for additional requirements for SDSs.

Hazard Mitigation:

It is important to recognize all hazards, and mitigate all resulting risks in so far as possible. Hazard labeling is an important tool for communicating the hazards of individual chemicals, but does little to alert lab personnel to synergistic effects (i.e., what happens when you have multiple chemicals in a mixture) which could present greater health and physical hazards than the initial constituents.

Risk assessments are useful tools for uncovering hidden hazards and risks, and should be conducted for all new procedures before the procedure is initiated. Risk assessments seek to identify all hazards associated with a planned procedure, and remove or mitigate the risks created by those hazards, or otherwise change the procedure, to simultaneously accomplish the goals of the experiment, and ensure the health and safety of the researchers performing the experiment. Conducting a risk assessment can be daunting, even for individuals with years of laboratory experience, because there can be many types of hazards, not all of which are immediately obvious. There are also many different ways to conduct a risk assessment, and certain approaches are better for some situations than others. Therefore, a prescriptive, "check list" type of approach is not necessarily desirable. The key feature of any good risk assessment is that it uncovers as many sources of potential hazards as possible, thereby effectively eliminating unrecognized hazards. Good risk assessments should also prioritize hazards and risks based on severity and probability of occurrence, and should most definitely eliminate all risks and hazards that are simultaneously high severity and high probability of occurrence. Contingency plans should be in place and communicated to all relevant parties in the event that something does go wrong.

Risk assessments should follow the principles of **RAMP**:

1. ***Recognize*** all hazards.

2. ***Assess*** the risks of those hazards.

3. ***Minimize*** the risks by mitigating hazards.

4. ***Prepare*** for emergencies.

Below is a very broad and general, but by no means all inclusive, series of questions that one might use to apply RAMP.

1. **What is the goal of the experiment you wish to perform?** This is important to keep in mind as you go through the process of assigning hazards and assessing risk. Obviously, any modifications made to a procedure will still have to achieve the goals of the experiment.

2. **Identify all equipment, chemicals, biological organisms and other materials associated with the planned procedure.** A list might be helpful.

3. **Attempt to identify any hazards associated with the use of any of the items on the list, or the circumstances of the procedure.** This is the really difficult part where things can be overlooked. It is a good idea to have multiple people review this area, particularly your PI. Their laboratory experience will enable them to recognize potential hazards that less experienced researchers might not be aware of. Here are some questions that might be helpful to guide you through this process.

a. **What apparatus is to be used, and what are the hazards?** For example, glassware containing a vacuum or higher than atmospheric pressure could implode or explode, respectively. Electronic instrumentation might present an electrical hazard if it is dismantled while plugged in or without

discharging capacitors. Hoses can pop off of reflux condensers due to changes in water pressure or unsecure connections.

b. **What chemicals are to be used?** Look at the SDSs for these materials, and some of the other sources of information listed previously for chemicals.

What are the health hazards of the material (*eg.*, toxic, carcinogen, corrosive, etc.) and what are its routes of entry (*eg.*, inhalation, skin absorption, etc.)?

What are the exposure limits to the materials?

What are the symptoms of exposure to the material (*eg.*, noticeable odor, headaches or nausea)?

Are any of the chemicals highly reactive (*eg.*, pyrophorics, shock sensitive materials, oxidizers, water-reactives, strongly incompatible with other materials, etc.)?

Do the materials degrade in storage to form something more hazardous (*eg.*, peroxide forming materials, etc.)?

c. **What biological organisms are to be used?**

Are any of the organisms considered to be infectious or transgenic?

What are the potential routes of exposure?

d. **Are radioactive materials involved?**

e. **Are sharps used?**

f. **Is there a potential for exposure to harmful levels of electromagnetic radiation (*eg.*, lasers, flash lamps, etc.)?**

g. **Are there temperature extremes involved (*eg.*, cryogenics or heat)?**

h. **Are there synergistic hazards, *i.e.*, hazards resulting from the presence and interaction of two or more items?**

For example, is there a potential to form any highly reactive or otherwise hazardous byproducts during a reaction?

i. **How do I dispose of the chemical and biological waste from each step? Can they be disposed of in the same container?**

4. **What is the level of severity of each hazard, and the probability that it will create a problem within the given procedure?** Any items which create a risk that is high severity and high probability

of occurrence must be removed or mitigated in the next step. Ideally, we would like all risk to be low severity and low probability of occurrence.

5. **Plan to remove or mitigate the hazards using substitutions of less hazardous items and procedures, engineering controls, administrative controls and personal protective equipment.** The list should always be applied in the order above with substitutions of less hazardous items or practices being tried first and personal protective equipment being the last line of defense against hazards. It will not always be possible to use all four options, but it is frequently possible to use more than one option to remove or reduce risk. Substitution might include changing the solvent of a reaction (eg., using water instead of a toxic organic solvent.) Engineering controls eliminate or greatly reduce the hazard through use of mechanical equipment or other technologies. An example is the chemical fume hood or biological safety cabinet. Administrative controls reduce individual exposure to hazards by limiting individual contact with the hazard through work practices. Examples include many general and standard operating procedures, like keeping the lab tidy to minimize hazards, not recapping needles prior to disposal and not eating or drinking in the lab. Use of personal protective equipment (PPE), like goggles, gloves and lab coats, is the last line of defense, and is generally used in conjunction with other methods. In all cases where regulatory exposure thresholds (eg., PELs, TLVs, STELs, etc.) exist for given materials, these must be observed.

6. **Ensure that your modified procedure still meets the goals of your experiment and eliminates all high risk, high probability situations.** For example, if you have changed materials or equipment, ensure that the new materials and equipment do not create new, unrecognized hazards. You should also have plans in place for emergencies, such as equipment failure, loss of power or a chemical spill.

Engineering Controls:

Engineering controls are pieces of equipment or other technologies that can be used to greatly reduce physical and health hazards. After substitutions of less hazardous items in a procedure (which is not always possible), engineering controls are the next line of defense. Examples common in a laboratory include, but are not limited to, blast shields, chemical fume hoods, the number of room air exchanges per hour, glove boxes, glove bags and snorkel exhausts. Note that biological safety cabinets (BSCs) are not appropriate for work with hazardous chemical materials unless the exhaust is hard ducted to the outside of the building. Amherst College currently only has BSCs in which the exhaust is recirculated to the laboratory, and therefore, hazardous chemicals must not be used in these units.

Chemical Fume Hoods:

Chemical fume hoods (or other engineering controls which isolate hazardous materials from the breathing zone of the user, as appropriate) shall be used for all laboratory procedures that create known or potential inhalation hazards. Note that the risk of inhalation is not determined strictly by the identity of the hazardous material that is in use, but also by the procedure that is employed for its use.

The following guidelines should be used to determine under what conditions and what type of engineering control must be used to protect laboratory personnel from inhalation hazards.

1. Appropriate methods should be used to ensure that exposures to all materials are below regulatory or recommended thresholds (i.e., PEL, STEL, TLV, etc.) when these exist.

2. A chemical fume hood or closed gas transfer system (exhausted to the outside of the building) must be used at all times for any hazardous material or mixture which exists as a gas and for which may be classified under GHS as any of the following:

    a. Acute Toxicity, Inhalation Categories 1, 2, or 3
    b. Specific Target Organ Effect (Single Exposure or Repeated) Categories 1 or 2 through inhalation route of exposure
    c. Sensitization-Respiratory Categories 1A and 1B
    d. Germ Cell Mutagenicity Categories 1A and 1B through an inhalation route of exposure
    e. Carcinogenicity Categories 1A and 1B through an inhalation route of exposure
    f. Toxic To Reproduction Categories 1A and 1B through an inhalation route of exposure

    Procedures which are likely to evolve a gas that can be thus classified must also be performed in chemical fume hoods.

3. A chemical fume hood, glove bag or glove box must be used for any hazardous material or mixture which exists as a solid or liquid and is used in such a way that generation of significant aerosols, mists, vapors, splashes or other airborne particulates is likely, and for which may be classified under GHS as any of the following:

    a. Acute Toxicity, Inhalation Categories 1, 2, or 3
    b. Specific Target Organ Toxicity Effect (Single Exposure or Repeated) Categories 1 or 2 through inhalation route exposure
    c. Sensitization-Respiratory Categories 1A and 1B
    d. Germ Cell Mutagenicity Categories 1A and 1B through an inhalation route of exposure
    e. Carcinogenicity Categories 1A and 1B through an inhalation route of exposure
    f. Toxic To Reproduction Categories 1A and 1B through an inhalation route of exposure

Chemical fume hoods should be tested annually to ensure proper functioning. They should be labeled with a sticker indicating the date the hood was tested, and green dot on the side indicating the maximum safe working height of the sash. Laboratory personnel must be trained on the proper use of chemical fume hoods, and any other engineering controls they will be required to use in performing their duties. Chemical fume hoods which do not appear to be functioning properly must not be used, and must be reported to the CHO or EHS immediately. All laboratory personnel working in the area should be notified if a fume hood is not functioning properly, and a sign indicating that the fume hood is not functioning should be placed on the sash of the fume hood.

Room Air Exchanges:

All laboratories which use hazardous materials must have a negative air pressure with respect to corridors and other non-lab areas. The appropriate number of room air exchanges per hour shall be determined by the mechanical code and the nature and level of risk of the work that is performed in the lab as determined by the Chemical Hygiene Officer and/or Environmental Health and Safety.

Blast Shields:

Blast shields must be used for work that poses a significant risk of explosion or implosion and is not carried out in a chemical fume hood, glove box or some other appropriate containment device. Such work is rare in a college laboratory, and must not be performed until after consultation with the Chemical Hygiene Officer.

Administrative Practices:

Administrative practices should be used to mitigate hazards that have not been adequately removed by substitutions or by the use of engineering controls. Administrative practices are policies or other practices that limit exposure of laboratory personnel to hazard materials. Examples include, but are not limited to, not eating in the laboratory, and using secondary containment for transporting chemicals. The College has many such policies and general practices. These are listed under the General Policies section of this document. Individual laboratories will also have standard operating procedures (SOPs) for laboratory specific items.

Personal Protective Equipment (PPE):

Personal protective equipment (PPE) is the last line of defense for hazard mitigation, and should only be relied on to mitigate hazards after substitution, engineering controls and administrative practices have been exhausted. PPE are articles that are worn to provide a barrier to specific areas of the body from hazardous materials. PPE must be selected such that it is appropriate for a given situation (eg., not all gloves will protect you from all things in all situations). Training on PPE selection, how to put on (i.e., don) and take off (i.e., doff), clean and care for PPE that is required to be worn by lab personnel will be provided by the P.I. or Chemical Hygiene Officer.

Eye and Face Protection:

Appropriate eye protection should be worn whenever there is a possibility that a hazardous material could enter the eye. Face protection should only be worn in addition to eye protection when necessary (eg., when there is a possibility for a sizable splash to the face, or for implosion or explosion), and not as a standalone item. Faceshields must be appropriate for the type of chemical being used.

Chemical Splash Goggles

Chemical splash goggles are meant to protect the eyes from splashes of liquid hazardous materials and from impact. These have a rubber seal that will make contact with your face. Some chemical splash goggles will also protect your eyes from vapors, however, many will not. Most chemical splash goggles have indirect vents that allow for air circulation so that they do not fog up. Only chemical splash goggles which do not have any vents are appropriate for protection from vapors. (Keep in mind that one should use engineering controls first to mitigate hazards. In the case of exposure to vapors, that is easily accomplished by use of a chemical fume hood.) Please note that direct venting goggles (eg., woodshop goggles) are not appropriate for protection from splashes of hazardous materials. Chemical splash goggles should minimally meet the testing requirements of the ANSI 2015 Z87.1 D3 designation. Check with the Chemical Hygiene Officer if you have questions regarding the suitability of particular products for particular applications.

Chemical splash goggles should be worn in the laboratory whenever there is a possibility that a hazardous material could splash and get into your eye. They must be worn when working with a material for which exposure to the eyes is possible and that is classified under GHS as any of the following:

1. Serious Eye Damage Category 1
2. Germ Cell Mutagenicity Categories 1A and 1B through a dermal route of exposure
3. Carcinogenicity Categories 1A and 1B through a dermal route of exposure
4. Toxic to Reproduction Categories 1A and 1B through a dermal route of exposure
5. Specific Target Organ Toxicity Category 1, single or prolonged exposure through a dermal route

Safety Glasses

Safety glasses do not provide protection from liquid splashes. They are only meant to provide protection from impact. As such, they are not an appropriate substitute for chemical splash goggles. Safety glasses are appropriate for work with some tools and machinery, grinding material and other types of activities where solid projectiles without liquids are generated. Safety glasses must comply with the ANSI 2015 Z87.1 and have the Z87+ marking.

Face Shields

Face Shields are meant to provide incidental protection of the face and neck area from impact and splashes. They do not adequately block liquid splashes, nor are they robust protection from impact, and therefore, should only be worn in conjunction with adequate eye protection (i.e., chemical splash goggles if liquid splash or impact is likely, or safety glasses if only impact is likely).

Hand Protection:

Appropriate gloves should be worn when handling all hazardous materials. Gloves should be selected such that they provide adequate protection from the material that is being used. The

protection afforded by gloves for specific hazardous materials is generally controlled by the type of material from which the glove is made and its thickness, along with the application for which it will be used. Not all glove materials are compatible with all hazardous materials. For example, acetone can readily penetrate thin nitrile gloves, but latex can provide an effective, temporary barrier. The thickness of the glove also is important. The thicker the glove, the longer it will take for a hazardous material to break through (i.e., penetrate) the barrier. The type of contact resulting from particular applications is also of critical importance. For incidental contact with hazardous materials, it is usually acceptable to wear exam grade gloves made of an appropriate material. For prolonged and/or greater than incidental contact, thicker gloves may be necessary. Double-gloving may also be used to provide greater protection. Double-gloving can also be used to afford the protection of latex when necessary without the skin contact for individuals with latex sensitivities. SilverShield gloves are also a good choice for high hazard items or prolonged contact. Recommendations for appropriate choice of gloves are frequently listed in SDSs for given hazardous materials. Glove manufacturers also generally provide data from breakthrough tests with particular hazardous materials on their websites or by request. Consultation with the CHO can also be helpful in selecting appropriate gloves for given applications.

Gloves should ideally be worn whenever any hazardous materials are manipulated by hand. They must be worn whenever there is the possibility of hand contact with any materials that are classified under the GHS system as:

1. Acute toxicity-Dermal Categories 1, 2 or 3
2. Skin Corrosion Categories 1A, 1B or 1C
3. Sensitization-Skin Categories 1A or 1B
4. Germ Cell Mutagenicity Categories 1A or 1B through a dermal route of exposure
5. Carcinogenicity Categories 1A or 1B through a dermal route of exposure
6. Toxic to Reproduction Categories 1A or 1B through a dermal route of exposure
7. Specific Target Organ Toxicity Category 1, single or prolonged exposure through a dermal route of exposure
8. Irritation (skin)

Skin Protection:

In most cases, choice of appropriate clothing is sufficient to provide adequate skin protection in the laboratory. Laboratory attire should be selected such that:

1. As much skin as possible is covered on the body. Shorts and open toed shoes are not permitted in labs where hazardous materials are in use.
2. It is not loose fitting such that it creates a safety hazard by, for example, potentially causing spills or getting caught in equipment.
3. It is not overly form fitting such that it would trap chemicals spilled on it next to your skin.
4. It should be compatible with the chemicals used such that the integrity of the fabric is not compromised, or that it would otherwise create an additional hazard by adversely reacting with the chemical materials in use. Natural fabrics, such as cotton, are generally the best choice.

5. It should not be made of synthetic fabrics if open flames are in use. Cotton is generally the best choice for work with open flames.

Even with appropriate clothing choices, there are occasions where additional protection is a good idea and in some cases necessary. This largely depends on the types and quantities of hazardous materials in use, and the specific ways in which they are being used.

It is generally a good idea to wear a lab coat or apron when working with larger quantities of materials (i.e., liter scale or larger) and with items that pose significant health hazards that are used in such a way that it is likely to splash or otherwise get on you. Lab coats and aprons are available in a variety of materials, some of which are disposable. Reusable cotton and cotton-polystyrene blend lab coats are appropriate for most applications and generally provide the most comfort for users. Butyl rubber aprons are appropriate for work with strong acids or other highly corrosive materials, though they do not cover the arms. Lab coats and aprons which are disposable are generally made from spun polypropylene and other proprietary blends of polymeric fabrics (eg., Tyvek, Tychem). These must be chosen carefully to ensure they provide appropriate resistance to the hazardous materials they are used with. Disposable lab apparel is frequently targeted toward protection from biological materials, and therefore may not provide adequate protection from non-aqueous liquids or highly corrosive materials. Consultation with the CHO is recommended to discuss what and when lab apparel is appropriate and prior to selection of specific items.

Lab coats which are made from Nomex III, or otherwise meet the requirements of NFPA 2112 category 1, are required for use with materials classified by GHS as follows:

1. Pyrophoric Liquids Category 1
2. Pyrophoric Solids Category 1

Respiratory Protection:

Respiratory protection from hazardous materials in a lab is generally achieved by means of engineering controls (eg., chemical fume hoods). However, in certain situations, it may be necessary to rely on PPE such as negative pressure air purifying respirators or particle filtering face pieces to achieve exposure limits that are below regulatory thresholds. If there is reason to suspect that use of engineering controls is not sufficient to provide exposure levels below regulatory limits, exposure monitoring will be performed by either the CHO or EHS. If exposure levels are found to exceed the regulatory limits, the affected individuals will be medically evaluated, fit tested, trained and supplied with an appropriate respirator in accordance with the College's Respirator Policy. In situations where respirator use is not required, but lab personnel voluntary choose to wear respiratory protection, compliance with the full provisions of the College's Respirator Policy will be required for negative pressure air purifying respirators. Individuals are not permitted to select or purchase their own respiratory protection.

General Policies:

The College has established many general policies which are meant to mitigate common hazards encountered in many laboratories. Some of our policies pertain to when it is required to wear specific types of PPE, and these are listed above under the PPE section. Other general policies include, but are not limited to,:

1. **Food, beverages** and the application of cosmetics (including lip balm) are prohibited in the laboratory and associated areas where chemicals are stored at all times. Provisions may be made on a case by case basis with the CHO and/or EHS for a "clean" space within the lab where food and drink is allowed. These areas must be approved by the CHO and/or EHS.

2. **Mouth pipetting** and tasting of laboratory chemicals is prohibited.

3. **Laboratory clothing** must be appropriate for the level of hazards in the lab. Open-toed shoes and shorts are not permitted in labs that use hazardous materials.

4. **Long hair** should be tied back. Dangling **jewelry** or other items that could create a potential for a hazardous situation should not be worn or should be restrained.

5. **Working alone in Research Laboratories:** If you are not a PI, working alone in the laboratory is prohibited unless specific permission is obtained from your PI. If you have a need to work alone in a research lab, all lab personnel (including PIs), must notify the Amherst College Police Department (x2291 from any campus line or 413-542-2291) of where you will be working and for how long. If other people are working in labs on the same floor, you may use a buddy system in lieu of contacting the Amherst College Police Department. In either case, make sure you are familiar with all exit routes in the event of an emergency.

6. **Working alone in Teaching Laboratories:** Students working in teaching laboratories without a member of faculty or staff is prohibited. A member of the faculty or staff must be present at all times

7. **Housekeeping**-Laboratories should be kept as orderly as possible at all times to minimize hazards that could potentially result in injury and regulatory scrutiny during inspections.

8. **All laboratory equipment, such as glassware, should be inspected prior to use** to identify conditions which could produce failure. Sheathing should be used to contain shrapnel from items which could implode or explode (such as dewars) when appropriate and possible.

9. **Unattended reactions** or operations involving hazardous materials must be labeled with the identity of the hazardous materials present, the words "Let Run" and the contact information (name and phone number) of the responsible person.

10. **Designated Area**-Any substance which is classified under the GHS as:

    a. Acute Toxicity Category 1 through any route of exposure
    b. Carcinogenicity Category 1 through any route of exposure
    c. Germ Cell Mutagenicity Category 1 through any route of exposure
    d. Toxic To Reproduction Category 1 through any route of exposure

e. Specific Target Organ Toxicity Category 1, Single or Prolonged Exposure

should be used only in a designated area of the lab that is clearly defined and marked as such. For some labs, this might be the entire lab space. All personnel working in the lab space should be aware of the area, the potential hazards and emergency procedures. Designated areas should be decontaminated in so far as possible upon completion of work with highly hazardous materials. Cleanup can be made easier by use of plastic backed bench paper, Pigmat (chemically absorbent padding), or other types of disposal coverings. Refer these items to the Chemical Hygiene Officer for disposal once the work is complete.

10. **Covered Containers**-Containers of all liquid or solid materials must be covered (*i.e.*, capped, covered with parafilm or a watchglass, have a reflux condenser, etc.) when not in use. Prepared materials or reactions which evolve gases should have loose fitting covers, or some other form of pressure outlet, and be in a fume hood until gas evolution has ceased. Gas trapping techniques should be used for significant quantities of hazardous gases when possible (*eg.*, bubbling HCl through a sodium hydroxide solution). Venting directions for gas evolving materials (*eg.*, fuming nitric acid) purchased through manufacturers must be strictly obeyed.

11. **Gloves** cannot be worn outside of the laboratory. The only exception to this will be if gloved individuals are accompanied by at least one ungloved person who has the responsibility of opening doors and performing any other tasks for which hands would be required outside of the laboratory.

12. **Exposures and Near Misses**-All exposures to and spills of hazardous materials, and near miss or actual incidents must be reported promptly to the CHO and/or EHS.

13. **Secondary containers** must be used for the transport of hazardous materials between rooms (*eg.*, bottle carriers).

14. **Material Integrity**-Never return unused materials to the stock bottle once dispensed. Trace contamination can lead to potentially disastrous reactions.

15. **Consumer foodstuffs or equipment** (*e.g.*, sugar, aspirin, microwaves, refrigerators) used in a laboratory must be labeled “For laboratory use only, not for human consumption” or “Chemical Use Only”, as appropriate.

16. **Emergency Equipment Access**-Access to eyewashes, safety showers, exits, fire extinguishers and fuse boxes must not be obstructed. An area of three feet clearance is required around each.

17. **Electrical equipment** with frayed cords or exposed wires must not be used. GFCI outlets should be tested monthly by Facilities. Report broken or defective equipment tot eh PI, CHO, EHS or Facilities Department as appropriate.

18. **Belt pumps** must have a guard covering the belt.

19. **Laboratory Safety Information Cards**-Each laboratory must have an up to date door card indicating the PI and after hours contact information, the hazards and the types of emergency equipment found in the laboratory.

20. **Gas Cylinders**-Compressed gas cylinders may only be transported with the cap in place and by using a cart with a chain (or heavy-duty fabric belt) to keep the cylinder in place.

    a. Gas cylinders must be firmly affixed to walls with a chain or strap, or directly attached to an approved gas cylinder cart, during storage and use.
    b. Gas cylinders which are not in use (*i.e.*, do not have a regulator attached) must have the cap in place.
    c. Must be properly labelled, with gas identification facing forward.
    d. Must be compatibly stored (eg. Flammable and oxidizer or flammable and corrosive).

21. **Sharps**-The use of sharps (needles, razor blades, cannulae) is discouraged. If sharps must be used, the following must be done. Sharps must be disposed of in appropriate, puncture resistant receptacles designed for this purpose in compliance with 105CMR480. Needles must not be bent, broken, sheared, recapped, removed from disposable syringes, or otherwise manipulated by hand prior to disposal. Reusable sharps must be stored with all sharp edges covered (*eg.* in block of Styrofoam, or similar material). Contaminated reusable sharps must be decontaminated (chemically or thermally, as appropriate) prior to storage.

22. **Hazardous Waste**-All chemical waste must be disposed of properly in compliance with 310CMR30. Consult with the CHO if you are unsure how to handle disposal of particular waste streams. More details about hazardous waste disposal are covered later in this document.

23. **Broken Glass**-Dustpans and brooms (or other mechanical devices) must be used to clean up broken glass. Do not use your hands.

24. **Shipments of all hazardous materials** from the College must be approved, or shipped in some cases, by the CHO. This includes, but is not limited to, all aerosols, lithium ion batteries or devices which contain them, and paints, and some chemical samples. Consult the CHO before shipping anything that you suspect might be hazardous or contain a hazardous component.

Chemical Procurement, Storage, Security and Disposal:

Appropriate procedures for the procurement, storage, security and disposal of hazardous materials are of critical importance to the health and safety of lab personnel and regulatory compliance. Each department and PI are responsible for developing procedures within the guidelines listed below

that will best suit the needs of the department or lab, and meet the goal of achieving a healthy and safe environment for all. All procedures should be reviewed and approved by the CHO.

Procurement and Inventory:

Each department is responsible for devising and implementing a mechanism for chemical procurement. Chemicals should be purchased as needed, and should not be stored for long periods of time. Manufacturer guidelines for length and type of storage, when provided, must be followed. When small quantities of materials are needed, these may usually be borrowed from other laboratories on campus with the permission of the laboratory PI. The chemical inventory system may be used to locate items of interest. New work with highly hazardous materials should be discussed with the CHO before the work is commenced to ensure that proper control measures are in place.

When a new hazardous material is received in a laboratory, it must be barcoded and information including the identity, manufacturer information and barcode number must be entered on to the chemical inventory sheet that is provided to each laboratory. These sheets must be submitted to the CHO on a weekly basis. The CHO will then enter the information into the online chemical inventory system (Vertere), and will make sure that the SDS is available on the SDS database (MSDS online). Hard copies of SDSs should be maintained in each department's designated storage area. Copies should be forwarded to the EH&S office.

Access to the online chemical inventory system is provided by the CHO. The CHO or designee performs annual audits of chemical storage spaces to ensure accuracy with the online system.

Storage:

Appropriate storage of hazardous materials in laboratories and stockrooms is of primary importance for both safety and regulatory compliance. Many chemicals are incompatible with one another, and should therefore not be stored together. Other items, like flammable or combustible materials, present explosive, fire and health risks if not stored appropriately. Chemical segregation can be a complicated process if laboratories have a large quantity of chemicals and limited space. If you find that you do not have enough room to safely store your materials, contact the CHO to discuss storage options. The following are some general guidelines for storage. Please consult the Chemical Hygiene Officer for specific items. An example storage scheme for common laboratory chemicals can be found in Appendix 3 of this document.

1. **Maintain the smallest stocks of chemicals in the lab that is practical**. Unnecessary chemical storage takes up valuable space, can lead to regulatory issues of non-compliance for "waste-like" chemicals, increases the risk of an incident, and is expensive from both a purchasing and disposal standpoint. It is often possible to "borrow" small quantities of material from other labs when necessary.

2. **Minimize the storage of materials on benches and in fume hoods** (unless the fume hood is specifically used only for storage).

3. **Labels**-All materials must be stored with labels facing forward such that the label of the container can be read without moving the container.

4. **Flammable materials** not in use must be stored in an approved flammable materials cabinet, safety cans, a refrigerator or freezer rated for storage of flammable materials, or a room with appropriate ventilation and fire suppression systems in place. Refrigerators and freezers which are not appropriate for flammable material storage must have a sign saying "No Flammables Allowed". Refrigerators and freezers which are used for flammable material storage must be compliant with the requirements of NFPA 45 and 70.

5. **Acids and bases** must be separated.

6. **Oxidizers** must be stored separately from all other materials.

7. **Corrosive and toxic materials** may not be stored above the benchtop level.

8. **Liquid materials** should have secondary containment (i.e., a lipped shelf or bin) and only compatible materials may be stored in the same secondary container.

9. **Water reactive materials** must be stored in desicators, an inert atmosphere, or be otherwise protected from moisture (*eg.*, sodium in mineral oil).

9. **Peroxide forming materials** (eg., ethers, compounds with tertiary, allylic and benzylic hydrogen, and any other compound which can easily form free radicals) should be labeled as such, and should be tested for peroxides regularly if opened. Expiration dates provided by manufacturers must be obeyed unless the material gives a negative peroxide test. See Appendix 4 of this document for a list of common peroxide forming materials.

10. **Volatile, toxic materials** must be stored in well ventilated areas.

Please note that these guidelines are for general storage. The extent to which the chemicals in your laboratory need to be segregated depends on the quantity and type of materials in your laboratory. In general, if two chemicals react with each other, then they should not be stored together. The CHO is available to assist in this process.

Security:

Chemical security is an issue that is becoming increasingly important for laboratories and associated areas. The extent of security that is necessary largely depends on the nature and quantity of chemicals present in a laboratory or storage area. The following are guidelines that should be employed by all laboratory and storage spaces. Additional requirements may be necessary for specific areas with specific items.

1. **Locked**-Laboratories and storage areas should be locked when unoccupied.

2. **Restricted Access and Visitors**- Access to laboratory and storage areas should be restricted. Visitors must be accompanied by a trained member of the lab, or an individual responsible for the storage area.

3. **Highly Reactive and Toxic Materials, Controlled Substances**-Special attention should be given to highly toxic and reactive compounds, controlled substances as listed in 21 CFR 1308, and anything identified by the Department of Homeland Security as a Chemical of Interest as listed in 6 CFR 27 Appendix A. These compounds may need to be stored separately from other items and locked up. Storage of such items should be discussed with the CHO to ensure compliance with appropriate regulations.

Disposal:

Hazardous waste must be disposed of in accordance with appropriate state and federal regulations, and Amherst College policies and procedures. Each area that generates hazardous waste must have a Satellite Accumulation Area (SAA) for that waste. Every member of a laboratory that generates hazardous waste will receive training covering identifying, labeling, handling and storing hazardous waste on a laboratory scale. This training is required at least annually. Laboratory generators of hazardous waste must follow the requirements below.

1. **Hazardous Waste Identification**-All waste that meets the definitions of hazardous waste listed in 30 CMR 310 or 40 CFR 261 must be labeled, handled and stored as hazardous waste.

2. **Hazardous Waste Labels**-All hazardous waste must be stored in appropriately labeled and closed containers in the laboratory's SAA. Labels shall include the following:

a. the words "hazardous waste"
b. the hazardous waste's characteristics (ignitable, corrosive, reactive, toxic)
c. the College's EPA identification number
d. the contents of the container (be specific and identify each constituent)
e. the name of the generator

Labels are available from the CHO. **Do not use your own labels.**

3. **Secondary Containment**-Containers of hazardous waste in an SAA must be in appropriate secondary containment.

4. **Compatibility**-Containers must be selected such that they are compatible with contents. Containers holding incompatible wastes must be stored in separate secondary containers.

5. **Incompatible waste** should not be added to the same container.

6. **Closed Containers**-Containers must be kept closed unless contents are being added.

7. **Full containers** must be removed from the SAA within three days of the fill date. Full containers should be referred to the CHO or departmental safety officer. Only when containers are full and dated are SAAs allowed to have more than one waste stream per container.

8. **Inspection**-Containers and storage areas must be inspected on a weekly basis.

Emergency Equipment:

In the event of a spill, fire, exposure or other type of likely emergency, procedures and equipment must be in place in the laboratory for response. The nature of likely emergencies will be different for different laboratories, depending on the exact hazards present and the type of procedures employed. The following details equipment and emergency procedures which are likely to be used in a majority of laboratories. All individuals working in a laboratory should be trained on the location and use of emergency equipment that they will be expected to use in an emergency situation. Specialized equipment and procedures should be in place for atypical hazards. Consultation with the CHO and/or Environmental Health and Safety is recommended for these situations.

Spill Containment:

Spill containment items must be available in all areas where a spill of a hazardous material is likely. The exact nature and number of items necessary for a particular lab depend on the type and quantity of hazardous materials used in the lab. Not all spills can be adequately dealt with by laboratory personnel. Only incidental spills (less than 100 mL) of non-acutely hazardous chemicals should be cleaned up by laboratory personnel, and only if it is safe to do so. Spills of more than 100 mL or of acutely hazardous chemicals, should be referred to the campus police (x2111) as indicated in the emergency procedures section.

Absorbent padding, including paper towels, pigmat and spill pillows, is generally appropriate for most liquid spills. Spills of elemental mercury require the use of a specialized containment kit, and labs which use elemental mercury, including mercury thermometers, must have such kit on hand. Laboratories which use hydrofluoric acid, or other concentrated liquid sources of fluoride ion, are also required to have a specialized spill containment kit on hand. Extremely concentrated acids and bases may require a specialized type of pigmat if the quantity of the spill is sufficient, or they can be neutralized prior to absorbing. Appropriate containment strategies and materials can be recommended by the CHO for specialized situations.

All materials from a spill cleanup must be disposed of properly. Generally, these items should be placed in a waste container in the laboratories SAA, however, it is best to consult the CHO on proper disposal.

Eye Washes and Safety Showers:

Eye washes are used to irrigate the eyes in the event of a hazardous material exposure. These are generally activated by depressing a lever or squeezing a handle. Safety showers are used to irrigate the body in the event of a hazardous material exposure. These are generally activated by pulling on a handle. Each individual should be familiar with and trained on the location and use of the eye wash station and safety shower in his or her work areas. Affected areas should be flushed for a minimum of 20 minutes as specified in the emergency response procedures that follow.

Eye washes should be flushed weekly to prevent the buildup of sediment which could obstruct flow or cause damage to the eyes when the unit is used. It is each department's responsibility to ensure that individual eyewashes are tested and documented. Safety showers are flushed and tested twice annually by the Facilities Department. If the tag on a shower indicates that it has not been tested within the last six months, contact the Facilities Department (x2254).

First Aid Kits:

First Aid kits should be available in all laboratory spaces. It is each lab's responsibility to ensure that the First Aid kit is appropriately stocked. If more than a Bandaid is required from a First Aid kit for an incident, campus police should be notified (x2111).

Fire Extinguishers:

Fire Extinguishers are located by each exit point from the building. The type of extinguisher present in the lab should be appropriate to the types of materials that are in use in the lab as determined by Environmental Health and Safety in conjunction with the CHO. Fire extinguishers must only be used by individuals who have been appropriately trained, after the building fire alarm has been activated and if it is safe to attempt to extinguish the fire. Otherwise, the evacuation procedure for fires must be followed.

Specific Treatments:

Work with specific hazardous materials may warrant specialized emergency equipment, such as the specialized spill control kits discussed above. Specialized treatments for exposures may also be necessary. For example, work with hydrofluoric acid, or other potent sources of fluoride ion, requires the presence of a treatment kit that includes calcium gluconate gel. Training for all individuals involved in such work is required for specialized clean up and exposure response procedures.

Emergency Procedures:

The following emergency procedures have been developed for all laboratories. Additional emergency procedures may be required for specific laboratories depending on the nature and quantity of hazardous materials and equipment that is used.

General Emergency Procedures:

Report all emergencies to the Amherst College Police Department (413)542-2111

Fire Alarm-All faculty, staff and students are required to leave the building through the closest exit door, and should report to their designated area for reasons of accountability. This area should be away from the building (at least 50 feet) and should not block access for the responding emergency agencies.

Fire and/or Smoke- If you discover a fire or smoke condition;

Close the door the contain the fire
Alert people in the area
Pull the fire alarm and call (413)542-2111
Extinguish the fire if small, you are comfortable and you have been trained to use extinquishers.
-If not, evacuate the building.

Leaks, Odors and Spills

-Call (413)542-2111
-Provide the dispatcher with the following information
-Building, room and/or area
-Name of the chemical or odor, if known
-Name of the PI
-Where you will meet the CHO, EHS and/or Police

Small Hazardous Spill (Less than 100 mL):

If less than 100 mL of a hazardous material is spilled, the following should be done.

1. Alert all lab personnel to the spill, and evacuate the immediate area (and lab) if necessary.

2. If it is safe to do so, and you are comfortable doing so, contain (and neutralize, if appropriate and necessary) the spill.

   a. Use pigmat, spill pillows, other absorbent materials (including paper towels for very small spills) as appropriate.

b. Before applying absorbent materials, acids and bases should be neutralized. If you spill an acid, neutralize by using a weak solid-state base, such as sodium bicarbonate. If the material spilled is a base, use a week citric acid for neutralization. You may also use absorbent material that is specifically designed for strong acids and bases in lieu of neutralizing.
c. Dispose of absorbent material in a container for solid hazardous waste in the SAA.
d. For spills which could leave a residue, wipe up the area with wet paper towels (or other absorbent material, as appropriate) to remove the residue. Discard this cleanup material to the solid hazardous waste container in the SAA.

3. If it is not safe to clean up the spill, or you are not comfortable cleaning up the spill, contact the campus police at x2111 from any campus line to report the incident and request help.

   a. Indicate the identity and quantity of material spilled, along with the location.
   b. If possible, provide the (M)SDS to the first responder.

Large Hazardous Spill (More than 100 mL):

If more than 100 mL of a hazardous material is spilled, or any quantity of an acutely hazardous material or an unknown chemical, the following should be done:

1. Alert all lab personnel in the immediate area and evacuate the lab, closing the door behind you.

2. Contact the campus police at x2111 from any campus line to report the incident and request help.

   a. Indicated the identity and quantity of material spilled, along with the location.
   b. If possible, provide the (M)SDS to the first responder.

Minor Hazardous Spills Affecting a Person:

If a hazardous material is spilled on a person in the lab, and all of the following apply:

a. The spill does not involve an acutely toxic material
b. The spill is to a readily accessible portion of the body (i.e., hand, forearm, etc.) such that the use of an eye wash or safety shower is not necessary
c. The spill is relatively minor in nature (i.e., exposure is minimal and is immediately addressed)

the following should be done.

1. Alert all lab personnel in the immediate area and evacuate the lab, if necessary.

2. Flush the affected area in a sink for at least 20 minutes.

3. Monitor the area for inflammation or other signs that medical attention might be necessary, such as a swelling of the eyes or throat that could indicate a systemic allergic reaction.

a. If such symptoms develop, immediately contact the campus police at x2111 from a campus line and request medical assistance.
b. Report the identity and quantity of the material involved.
c. Present the (M)SDS to the first responders, if possible.

4. If no symptoms requiring medical attention develop, report the incident to the CHO and/or Environmental Health and Safety, and file an incident report. The CHO and/or Environmental Health and Safety can aid you in this process.

Major Hazardous Spills Affecting a Person:

If a hazardous material is spilled on a person in the lab, and the conditions for a minor spill affecting a person are not met, the following should be done.

1. Alert all lab personnel in the immediate area and evacuate the lab, if necessary.

2. Have someone call x2111 from a campus line to report the incident to campus police and request medical help.

   a. Report the identity and quantity of material if possible.
   b. If possible, have someone get the (M)SDS to provide to the first responder.

3. If it is safe to help the victim, do so.

   a. Always ensure your own safety before helping others.
   b. Wear gloves, goggles, and a lab coat, or other PPE as appropriate.

4. If the spill is to the eyes, get the victim to the eyewash.

   a. Help the victim position his/her head over the eyewash
   b. Activate the eyewash and irrigate the eyes for at least 20 minutes.
   c. If the victim is unable to keep his/her eyes open, assist them.

5. If the spill is to the body, get the victim to the safety shower.

   a. Remove all affected clothing from the victim.
   b. Position the victim under the shower and activate the shower. Flush the affected area for at least 20 minutes. A sink may be used for readily accessible portions of the body (i.e., hand, forearm, etc.)

6. Remain with the victim until first responders arrive.

Electrical Shocks:

All electrical shocks must be reported to the PI, CHO and/or EHS and the Facilities Department to ensure prompt corrective action. If you receive a shock from a piece of equipment or a cord:

1. Do not touch the cord or equipment.

2. Place a sign on the unit that indicates "**Electric Shock-Do Not Touch**"

3. Contact the PI, the CHO/EHS, Facilities or the Amherst College Police Department

4. Electric shocks should also be reported to your primary care physician, unless emergency response personnel determine emergency care is warranted at the time of the incident.

Fires:

In the event of a fire in the laboratory, the following should be done.

1. **C**lose the door.

2. **A**lert everyone in the lab.

3. **P**ull the nearest fire alarm.

4. **E**vacuate the building via the nearest exit and assemble with your other lab members in a predefined location at least 50 ft. away from the building and which does not obstruct responding emergency agencies.

   a. Do not use the elevators to exit.
   b. P.I.s are responsible for designating their labs' meeting location.
   c. Remain in the meeting location until a head count can be taken.

5. The building may be reentered when the fire alarm has been silenced, and the fire marshall has declared that it is safe to do so.

6. Fire extinguisher may be used to fight a fire only if the following circumstances apply:

   a. Personnel are trained to use a fire extinguisher
   b. The fire alarm has been activated
   c. It is safe to extinguish the fire

Lab Design:

Laboratories must be designed in such a way that they create a safe working environment and adequately support the needs of the activities being performed in the space. Because the design of a laboratory is highly dependent on the activities taking place therein, it is impossible to create a set of absolute principles governing lab design. However, the following principles should always be used to guide laboratory design and layout.

1. **Ventillation**-The ventilation of the laboratory should be appropriate to provide proper respiratory protection to the individuals working in the laboratory and those around it.

   a. Laboratories must be negative in pressure with respect to surrounding non-lab spaces.
   b. The appropriate number of room air exchanges per hour shall be determined by the nature and level of risk of the work that is performed in the lab as determined by the CHO and/or Environmental Health and Safety.
   c. The placement of large pieces of equipment, or equipment that needs to be tied in to the exhaust system, can alter air flow dynamics of the lab, and must be discussed with the CHO and/or Environmental Health and Safety.

2. **Equipment** that requires modifications to building systems (gas, vacuum, and exhaust connections, electrical modifications, etc.) must be discussed with the CHO and/or Environmental Health and Safety.

3. **Chemical storage areas**, including all shelving, must be appropriate to the types of materials being stored in the space.

   a. Appropriate flammable storage (cabinets, safety cans, flammable rated refrigerators and freezers, etc.) must be available in labs that store flammable materials. Automatic fire suppression systems or heat activated fire alarms will be required, as specified by Environmental Health and Safety.
   b. Shelving should be compatible with the materials stored on it (eg., metal shelves are not compatible with corrosive materials).
   c. Space should be ample enough to provide storage of containers such that the labels can be easily read without moving containers.
   d. Other provisions of the storage section of this document must be followed.

4. **Engineering controls** (including but not limited to chemical fume hoods, biosafety cabinets, glove boxes, etc.) appropriate to the level of work being performed in the lab must be in place. Consult with the CHO and/or Environmental Health and Safety to determine appropriate measures.

5. **Exits and safety equipment**-Means of egress, access to electrical panels and safety equipment (including First Aid kits, fire extinguishers, eye washes and safety showers) must not be obstructed.

   a. Aisle ways must be at least 3 ft. wide.
   b. Items must not be stored in aisle ways.
   c. Eyewashes, safety showers, and fire extinguishers should be located next to exits whenever possible, and should be accessible within 10 seconds from any point in the lab.

6. **Emergency Contact Information**-Laboratories must have emergency contact information and hazard information available.

a. Each laboratory must have a door card indicating the contacts for the lab and hazards present within. A template is available on the Environmental Health and Safety website which must be used for this purpose. Door cards must be updated annually, or when hazards or contact information changes.
b. Special hazardous operations within the lab (eg., an unattended reaction) should also be appropriately labeled with hazards and contact information.

Training:

Training is required on an annual basis, or whenever conditions change such that refresher or updated training is necessary, for all laboratory personnel. It is the responsibility of the PI and individuals departments to ensure that the required training is completed. Contact the CHO or EHS for any assistance needed to complete the required training. Annual training will consist of:

1. Hazard Communication, including labeling and (M)SDSs
2. The Laboratory Standard (29 CFR 1910.1450) and contents of this Chemical Hygiene Plan
3. Waste identification and management, including hazardous waste
4. Standard and General Operating Procedures
5. Emergency Procedures
6. Risk Assessments
7. Chemical Storage and Handling
8. Information about the Chemical Inventory System and (M)SDS database
9. Hazmat Shipping Information

Written training is authored by the CHO, and quizzes will assess knowledge and provide proof of training. Records of training will be retained by the CHO, departmental safety officers or Environmental Health and Safety. In some cases, training may consist of a presentation provided by Environmental Health and Safety and/or the CHO where students are permitted to ask questions, and sign an attendance sheet as proof of training.

Hands on training, and training on laboratory specific items (i.e., specific SOGs for particular procedures or work with particular chemicals, symptoms of exposure to particular chemicals, use of emergency equipment, etc.) will be conducted by the laboratory PI. The CHO is available to assist with this training.

Exposure Monitoring and Evaluation:

Monitoring of airborne concentrations of hazardous materials is generally not necessary in a laboratory, particularly if engineering controls such as chemical fume hoods have been employed. If there is reason to believe that the OSHA action level or permissible exposure limits (PELs) are

being exceeded, or if requested by laboratory personnel, exposure monitoring will be conducted by Environmental Health and Safety, the CHO or an outside contractor, as appropriate.

An exposure evaluation will be performed, when necessary, to determine whether an exposure occurred that might have caused harm to one or more laboratory personnel and, if so, to identify the hazardous materials involved and causative factors.

Evidence of an overexposure, and therefore, the need for an exposure evaluation, will include situations where:

1. There is an uncontrolled release of a hazardous material in the lab
2. Exposure monitoring reveals exposure above acceptable levels
3. A known exposure to a hazardous material (i.e., a spill affecting a person)
4. There is other evidence of exposure, including but not limited to:

    a. odors
    b. health or mental effects (eg., skin, eye, mucosal membrane irritation, mental fogginess, neurological symptoms, etc.)
    c. damage to items stored in the space (eg., sever corrosion of metal or plastic items)

5. It is suspected by laboratory personnel

An exposure evaluation will consist of:

1. Interview of the person reporting the event and anyone else that was potentially exposed.
2. List of essential information of the event, including:

    a. Hazardous materials involved
    b. Other hazardous materials used and stored in the lab, if pertinent
    c. Symptoms describe by lab personnel, particularly within 72 hours of an incident
    d. SDSs for material involved
    e. Description of the event including the use of control measure and how they were used at the time of the event
    f. Results of any air monitoring in place at the time of the incident
    g. Results of subsequent air or surface sampling as appropriate

3. A review of the interview and essential information to determine adequacies of procedures and root cause of incident, if possible.
4. The decision on whether or not affected personnel should receive a preliminary medical evaluation.

Medical Evaluation and Consultation:

Lab personnel who work with hazardous materials are provided the opportunity to receive a medical consultation and examination whenever:

1. they develop signs and symptoms of exposure associated with hazardous materials they are using, or may be in contact with, in the laboratory.
2. exposure monitoring reveals concentrations of hazardous materials above acceptable levels
3. whenever an event takes place, such a spill or leak, which would result in a likely exposure to a hazardous material
4. a known exposure occurs

Such medical consultation shall be used to determine if a medical evaluation is required.

All medical examinations and consultations must be:

1. performed by or under the direct supervision of a licensed occupational physician. Every effort shall be made to refer employees to licensed physicians that have been trained to recognize signs and symptoms of hazardous material related exposure and disease.
2. provided at no cost to the individual
3. provided without loss of pay (if the person is an employee)
4. performed at a reasonable time and place for the individual. Every effort shall be made to schedule medical examinations and consultations during the individuals regularly scheduled work hours (if the person is an employee), provided there is no undue delay in medical attention.

The College will provide to the examining physician a copy of the exposure evaluation and any other pertinent information requested by the physician.

Human Resources must obtain a written opinion from the examining physician. The written opinion must include:

1. The results of all medical examinations and tests
2. Any medical condition the employee has that places him or her at risk as a result of future exposures to hazardous materials
3. A statement confirming that the employee has been advised of the results of the examinations and tests, including any medical conditions relevant to occupational or hazardous material exposures.
4. The written opinion must not reveal specific findings of diagnoses unrelated to occupational exposure.
5. Medical records will be kept by Human Resources for 40 years. Medical records are considered privileged information.

Appendix 1: Laboratory Inspection Checklist Template*

Laboratory Information				
Laboratory Director/Principal Investigator: **Location:**				
	Yes	No	N/A	Comments
Training and Documentation				
Up-to-date inventory maintained for all hazardous materials?				
Chemical Safety Data Sheets (SDS) maintained and readily available at all times employees are present?				
Workplace hazard assessment and certification completed?				
Employees know the location of chemical inventory, SDS and related reference material?				
Employees received institutional safety training (typically provided by CHO/EHS) and supplemental laboratory specific safety training for the hazards present in the laboratory?				
Employees familiar with physical and health hazards of chemicals in work areas?				
Employees able to describe how to detect the presence or release of hazardous materials?				
Employees know how to protect themselves and others from the effects of hazardous materials?				
Employees familiar with Chemical Hygiene Plan (or equivalent)?				
Spill and Emergency Planning				
Employees familiar with the fire safety and building evacuation procedures including evacuation routes, nearest fire exits, fire alarm pull stations, and fire extinquishers?				
Emergency procedures and phone numbers clearly posted?				
First aid materials readily available?				
Are any “antidotes” or special first aid materials required and available (eg., Hydrofluoric acid requires a specialized kit)?				
Spill cleanup materials available and laboratory staff familiar with their use?				

Safety shower and eye wash accessible within 10 seconds and unobstructed (eg., no closed doors)?				
Safety shower tested and documented within past year?				
Eye wash tested, flushed and documented as least weekly?				
Fire alarm pull stations, strobes, speakers, and fire extinguishers unobstructed and visible?				
Exits clearly marked?				
Hazard Mitigation Techniques				
Procedures reviewed to include substitution of less hazardous materials where possible?				
Personnel wear shoes that fully cover feet and full length clothing to protect legs?				
Long hair confined? Jewelry, lanyards and other loose articles are confined or removed?				
Lab coats of appropriate material are available and worn when appropriate/necessary?				
Appropriate gloves available and worn when appropriate/necessary?				
Goggles, safety glasses, face shields, etc. are of appropriate type and worn when appropriate/necessary?				
Respirators available and used in the laboratory if necessary? If yes…				
Respirator training, fit test and medical evaluation completed for employees?				
Respirators cleaned, stored, and inspected regularly?				
Chemical Fume Hood available and used when necessary? If yes…				
Chemical fume hood free of clutter?				
Chemical fume hood inspected within last 12 months and working height indicated?				
Compatible chemicals and quantities used (eg., perchloric acid use requires a specialized fume hood).				
Biological Safety Cabinet available? If yes…				
Biological Safety Cabinet free of clutter and surfaces decontaminated?				
Biological safety cabinet certified within last 12 months?				

Mechanical pipetting used, no mouth suction?				
Chemical Safety				
Are chemicals used in this area? If yes…				
Appropriate labels are found on all hazardous chemical containers?				
Containers are in good condition (eg., labels intact, metal cans free of rust) and closed when not in use?				
Containers properly segregated by hazard class (eg., flammables away from oxidizers, acids separated from bases, incompatible acids separated, etc.)?				
Storage of chemicals above eye level is avoided when possible? Corrosive chemicals are not stored above eye level?				
Flammable liquids stored in OSHA/NFPA approved cabinets and safety containers?				
Flammable liquids requiring refrigeration stored in either explosion proof or flammable resistant refrigerators and freezers? Regular refrigerators and freezers labelled as no flammables allowed?				
Ignition sources avoided when using/storing flammables?				
Concentrated liquid corrosives stored in acid cabinets or other appropriate storage?				
Peroxide formers labeled and tested regularly?				
Picric acid sufficiently wet?				
Large containers (4L or greater) stored near the floor?				
Bottle carriers or carts utilized when transporting hazardous chemicals between work areas?				
Proper signs delineate designated areas where high hazard chemicals are used?				
Designated area properly cleaned and decontaminated?				
Biological Safety				
Are biological materials used in this area? If yes…				

Infectious biological materials are not stored in hallways in unlocked freezers or refrigerators?				
Biohazard signs are posted in labs handling infectious materials (BSL-2 and higher).				
Disinfectants are on hand for sanitizing bench tops and treating spills?				
Biological safety cabinet was certified in the last 12 months?				
Sink available for hand washing?				
BSL-2 areas locked when unattended?				
Laboratory procedure manual prepared and available for BSL-2 labs?				
Ionizing and Non-Ionizing Radiation Safety				
Are radioactive materials used in this area? If yes…				
Pure beta emitters (eg., P-32, P-33, S-35, C-14)?				
Gamma and x-ray emitters (eg., I-25, I-131, Cr-51, Na-22)? Volatile, gaseous radioisotopes (eg., I-125) or aerosol/dust generating laboratory operations (eg., vacuum flasks)?				
Sealed sources?				
Irradiators?				
X-ray generating equipment (Electron Microscope, X-ray diffraction, Diagnostic X-ray, Computed Tomography)?				
Is the proper shielding available for the radioactive material used				
Are appropriate meters available for radioactive material used and are meter(s) calibrated?				
Are radiation workers provided personal monitoring when required?				
Are all appropriate signs posted? (Radiation labels, Notice to Employees and Emergency Procedures)?				
Are all spaces and items which store, handle or use radioactive materials properly labeled with “Radioactive Material”, “Radiation Area” or other applicable hazard warning labels?				

Are radioactive materials secured/locked against unauthorized access from non-authorized users?				
In non-ionizing radiation used in the area? If yes…				
Laser-Classes (eg., 1, 2, 3R, 3B or 4)?				
Personal protective equipment (eg., eye protection) or shielding available specific to the type and class of laser used?				
Laser hazard warning signage posted?				
Compressed and Cryogenic Gas Safety				
Are compressed gas cylinders used in this area? If yes…				
Cylinders stored upright and properly secured at all times?				
Caps properly secured when cylinders are not in use?				
Regulators always used, proper regulators used for type of gas?				
Cylinders in good condition and clearly marked?				
Flammables stored separately from oxidizers, toxics in secure area, etc?				
Cylinders moved on appropriate carts with regulators removed and caps secured?				
Cylinders of toxic gases stored in ventilated enclousures?				
Cryogenic gas cylinder pressure relief valve in proper working order?				
Oxygen monitor available in areas with increased likelihood of oxygen deficient atmospheres?				
Equipment and Physical Hazards Safety				
Are equipment safety signs posted and in good condition?				
Are all guards and shields in place and secured?				
Are safe work practices (long hair tied back, no loose clothing, etc.) being adhered to by all equipment users?				
Is equipment in good repair with evidence of proper maintenance?				
Are electrical cords in good condition, out of travel paths, and free of any cracks or breaks in insulation?				

Is a lock-out, tag-out program in place if appropriate?				
Is proper PPE available and being used by equipment operators?				
Is a tagging system in place to prevent use of damaged equipment?				
Is access to the equipment restricted?				
Have all users been trained to operate equipment?				
Have there been any modifications to the equipment?				
Is equipment being used appropriately (i.e., not for task for which it is not designed)?				
General Laboratory Safety				
Smoking, eating and drinking is prohibited in the lab? No food storage in the lab?				
Lab is maintained secure; door is locked when no one is in the lab?				
Appropriate warning signs posted near lab entrance?				
Unobstructed aisles maintained at least 36 inches wide throughout?				
Lab benches and work areas free of clutter?				
Shelves and cabinets in good condition?				
Storage above eye level minimized?				
Refrigerators and freezers clearly labeled as not for food use?				
Waste Management				
Solid wastes are identified and discarded appropriately?				
Is universal waste generated in this area? If yes…				
Are dead batteries taken to a recycling container?				
Mercury containing lamps and unwanted electronics recycled? Equipment decontaminated prior to disposal as appropriate?				
Is hazardous waste generated in this area? If yes…				
Chemical inventory management/ordering system in place and checked before ordering new chemicals?				
Waste containers closed unless actively adding or removing waste?				

SAA located at or near point of generation?				
Maximum SAA storage capacity not exceeded (55 gallons for non-acutely hazardous waste; 1 kg or 1 quart for actutely hazardous waste)?				
Waste containers are in good condition (not leaking, rusted, bulging or damaged)?				
Each waste container is marked with the words “Hazardous Waste”?				
Each waste container is marked with full chemical names identifying the contents stored inside (no abbreviations or formulas)?				
Add least one characteristic hazard (i.e., ignitable, corrosive, reactive, toxic) is indicated on the label?				
Each waste container is in good condition and not leaking?				
Each waste container is in secondary containment which is in good condition?				
Only waste containers with compatible contents are stored in the same secondary containment?				
No two containers have the exact same contents?				
Area is inspected weekly and documented?				
Full waste containers are removed within three calendar days?				
Empty chemical containers are tripled rinsed and discarded with caps off?				
Is medical/biological waste (including sharps) generated in this area? If yes…				
Sharps are discarded into an appropriate puncture resistant container or stored appropriately?				
Sharps waste containers are red, red-orange or fluorescent orange in color?				
Sharps containers are not overfilled and are removed when filled?				
Are biological liquids appropriately treated before disposal (eg. chemically, thermally)?				

If biological waste is stored prior to treatment and disposal, is it stored appropriately in a properly labeled "bio-bin" with clear bag liner?				
Is the bio-bin kept tightly closed unless waste is being added?				
Is the bio-bin emptied by safety staff on a regular basis, and before it is 2/3 full?				
Is radioactive waste generated in this area? If yes…				
Is mixed waste (chemical and radioactive) generated in this area?				
Are the radioactive waste containers properly labeled?				

[*] Adapted from *Identifying and Evaluating Hazards in Research Laboratories*; American Chemical Society: Washington, DC, 2015. https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/identifying-and-evaluating-hazards-in-research-laboratories.pdf (accessed 11/4/16)

Appendix 2: GHS Hazard Classes and Definitions

Qualitative definitions of the GHS hazard classes are given below along with their various categories. The lower numbered categories always represent the highest level of hazard. (Eg., For a particular route of exposure, Acute Toxicity, category 1 is more toxic than Acute Toxicity, category 4.) The hazard classes and categories a particular hazardous material is assigned to can be obtained from the material's Safety Data Sheet (SDS). More detailed definitions of the hazard classes listed below, including quantitative criteria, are given in Appendices A and B of 29CFR1910.1200.

Acute Toxicity: Adverse effects that arise after short duration exposures of small doses to a particular substance. Route of exposure (oral, dermal, inhalation) must be specified. Categories 1-4.

Skin Corrosion/Irritation: Damage resulting to skin from short term exposure to a particular substance. Corrosion designates irreversible damage, while Irritation designates reversible damage. Categories 1A-C designate Corrosion; Category 2 designates Irritation.

Serious Eye Damage/Irritation: Tissue damage or changes in the eye resulting from single exposure of the eye to a particular substance. Eye Damage indicates irreversible tissue destruction or impairment of vision, and is denoted at Category 1. Eye Irritation indicates a reversible change in the eye, and is denoted by Categories 2A-B.

Respiratory Sensitizer: A chemical that will lead to hypersensitivity of the airways following inhalation of the chemical. Initial exposure creates an induction phase and subsequent exposures create an elicitation phase where immunological response is observed. Categories 1A-B.

Skin Sensitizer: A chemical that will lead to allergic response following skin contact. Initial exposure creates an induction phase and subsequent exposures create an elicitation phase where immunological response is observed. Categories 1A-B.

Germ Cell Mutagenicity: Chemicals which may cause mutations in the germ cells of humans that may be transmitted to progeny. Categories 1A-B, 2.

Carcinogenicity: Chemicals which induce cancer or increase its incidence. Categories 1A-B, 2.

Reproductive Toxicity: Adverse effects on sexual function and fertility in adult humans and/or on the development of offspring produced by exposure to a particular chemical. Categories 1A-B, 2.

Specific Target Organ Toxicity-Single Exposure: Specific, non-lethal organ toxicity resulting from a single exposure to a particular chemical. The target organ is generally specified along with route of exposure. The effects can be either irreversible or reversible. Categories 1-3.

Specific Target Organ Toxicity-Repeated or Prolonged Exposure: Specific target organ toxicity arising from repeated exposure to a particular chemical. The target organ is generally specified along with route of exposure. The effects can be either irreversible or reversible. Categories 1-2.

Aspiration Hazard: May cause chemical pneumonia, varying degrees of pulmonary injury or death following aspiration. Aspiration is entry of a particular liquid or solid chemical directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system that is initiated in the time to take one breath. Category 1.

Explosives: A chemical capable of reacting by itself to produce enough gas and/or energy to cause damage to surroundings. Division 1.1-1.6.

Flammable Gases: A gas that can mix with air in small quantity to produce a flammable mixture. Categories 1-2.

Oxidizing Gases: Any gas which contributes to the combustion of materials more than air does. Category 1.

Gases Under Pressure: Includes compressed gases, liquefied gases, refrigerated liquefied gases, and dissolved gases.

Flammable Liquids: Liquids with vapor concentrations near the surface of the liquid capable of igniting at low temperatures (93°C or less). Categories 1-4.

Flammable Solids: Solids capable of being easily ignited by an ignition source such as an open flame or friction. Categories 1-2.

Flammable Aerosols: Non-refillable, pressurized container that contains a flammable liquid, gas or solid. Categories 1-2.

Self-Reactive Chemicals: Thermally unstable chemicals which are capable of undergoing a strong exothermic decomposition even in the absence of oxygen. Categories A-G.

Pyrophoric Liquids: A liquid that is capable of igniting in contact with air. Category 1.

Pyrophoric Solids: A solid that is capable of igniting in contact with air. Category 1.

Self-Heating Chemicals: Reacts with air without a source of energy to produce heat, but will not ignite readily. Categories 1-2.

Chemicals Which, In Contact With Water, Emit Flammable Gases: React with water to become spontaneously flammable or to give off flammable gases in dangerous quantity. Categories 1-3.

Oxidizing Liquids: Liquids which may contribute to the combustion of other materials. Categories 1-3.

Oxidizing Solids: Solids which may contribute to the combustion of other materials. Categories 1-3.

Organic Peroxides: Organic compounds that contain a peroxide (O-O) bond. Peroxides may be unstable and undergo strong exothermic decompositions trigger by friction or shock. Categories A-G.

Corrosive To Metals: A chemical which can react with metals to damage or destroy them. Category 1.

Appendix 3: Chemical Storage Scheme With Examples

- **Highly toxic** materials should be stored in a secure, ventilated area, not above eye level and preferably separate from other materials.

  - Examples include**:**
    - Acutely Toxic, Category 1 (by any route of exposure) compounds
    - Elemental Mercury and most Mercury compounds
    - Neurotoxins
    - Sodium Azide
    - Sodium or Potassium Cyanide
    - Vanadium Compounds

  - Select Agents and Toxins, and DEA Controlled Substance MUST be stored locked up in a safe or other area under the control of the PI only

- **Oxidizers** must be stored separately from all other materials with which they might react, particularly flammable and combustible materials.

  - Examples include**:**
    - Chlorate, Perchlorate, Nitrate, Nitrite salts including:
      - Potassium Nitrate
      - Tetrabutylammonium perchlorate
      - Sodium Nitrite
    - Sodium or Potassium Dichromate
    - Perchloric Acid
    - Nitric Acid
    - Anything with the oxidizer pictogram

- **Acids and Bases** must be separated. Liquid acids and bases should be stored in well ventilated areas or rooms, and not above eye level.

  - Acids include:
    - Acetic Acid
    - Formic Acid
    - Hydrochloric Acid
    - Phosphoric Acid
    - Sulfuric Acid
    - (N.B. Solid carboxylic acid compounds should not be treated as acids for storage purposes)

- Bases include:
  - Amines (N.B. Many liquid amines are also flammable, and should be stored accordingly).
  - Ammonium Hydroxide
  - Sodium or Potassium Hydroxide
  - All other inorganic hydroxide salts

❖ **Flammable** materials must be stored in appropriate cabinets, safety cans, rated refrigerators or freezers (not household type!) or in areas with fire suppression systems, and away from oxidizers

- Flammable liquids include:
  - Most Solvents including:
    - Acetone
    - Acetonitrile
    - Ethanol
    - Ether (Diethyl ether)
    - Ethyl Acetate
    - Hexanes
    - Isopropanol
    - Methanol
    - Mineral Spirits (Petroleum Ether)
    - Tetrahydrofuran (THF)
    - Toluene

  - Many organic liquids with relatively low molecular weights including
    - Allyl bromide and chloride, other short chain alkyl halides
    - Triethylamine and other short chain amines
    - Other short chain organic compounds
  - Any liquid with the flame pictogram
- Flammable solids include:
  - Ferrocene
  - Powdered Carbon (including decolorizing carbon and various catalysts on carbon)
  - Most powdered metals
  - Any solid with the flame pictogram

❖ **Water-reactive** and **pyrophoric** materials must be stored in an inert atmosphere, dessicator or otherwise protected from water or air, respectively, as appropriate.

- Water-reactive materials include:
  - Grignard reagents (magnesium alkylhalide reagents)
  - Metallic sodium and potassium, and other alkali and alkaline metals
  - Most metal hydrides (lithium aluminum hydride, sodium hydride, calcium hydride)
- Pyrophoric materials include:

- DIBAL (Diisobutylaluminum hydride) and other alkylaluminum reagents
- Tert-butyllithium and other alkyllithium reagents
- Triethylborane

Appendix 4: Common Peroxide Forming Materials

The following materials readily form peroxides on exposure to oxygen and should be tested regularly and before concentrating to prevent potential explosions. Items in red should be test every three months. All other items should be tested within six months of opening, or before the manufacturers expiration date (if unopened).

Butadiene

Chloroprene

Compounds with allylic and benzylic hydrogen

Cyclohexane

Cyclohexene

Diethylene glycol dimethyl ether (Diglyme)

Dioxane

Ether (Diethyl Ether)

Isopropanol

Isopropyl ether

Methacrylate compounds

Most Ethers

Secondary alcohols

Styrene

Tetrahydrofuran (THF)

Vinylidene chloride

Appendix 5: Resources and References

Amherst Recombinant DNA Regulations. Amherst Board of Health. https://www.amherstma.gov/DocumentCenter/Home/View/2330 (accessed Nov 7, 2016)

Biosafety in Microbiological and Biomedical Laboratories, 5th Ed.; Center for Disease Control and Prevention, 2009. http://www.cdc.gov/biosafety/publications/bmbl5/BMBL.pdf (accessed Nov 4, 2016)

Chemical Laboratory Safety and Security: A Guide to Developing Standard Operating Procedures; National Academies Press, Washington, DC, 2016. https://www.nap.edu/catalog/21918/chemical-laboratory-safety-and-security-a-guide-to-developing-standard (accessed Nov 4, 2016)

Creating Safety Cultures in Academic Institutions; American Chemical Society: Washington, DC, 2012. https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/academic-safety-culture-report-final-v2.pdf (accessed Nov 4, 2016)

Environmental Protection Agency Hazardous Waste Regulations. Environmental Protection Agency. http://www.ecfr.gov/cgi-bin/text-idx?SID=422c3d707534e16e5827dfae1fdc2c4f&mc=true&tpl=/ecfrbrowse/Title40/40cfrv28_02.tpl#0 (accessed Nov 7, 2016)

Environmental Protection Agency Universal Waste Regulations. Environmental Protection Agency. http://www.ecfr.gov/cgi-bin/text-idx?SID=0501d91ec562faafa833c60c2404d806&mc=true&node=pt40.27.273&rgn=div5 (accessed Nov 7, 2016)

Guidelines for Chemical Laboratory Safety In Academic Institutions; American Chemical Society: Washington, DC, 2016. https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/acs-safety-guidelines-academic.pdf?logActivity=true (accessed Nov 4, 2016)

Hazard Assessment in Research Laboratories. American Chemical Society. https://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety/hazard-assessment.html (accessed Nov 4, 2016)

Hazard Communication Standard. US Department of Labor. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10099 (accessed Nov 4, 2016)

Hill, R.H., Finster, D.C. *Laboratory Safety For Chemistry Students, 2nd* ed.; John Wiley & Sons, Inc.: Hoboken, 2016.

Identifying and Evaluating Hazards in Research Laboratories; American Chemical Society: Washington, DC, 2015. https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/identifying-and-evaluating-hazards-in-research-laboratories.pdf (accessed Nov 4, 2016)

Laboratory Standard. US Department of Labor. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=Standards&p_id=10106 (accessed Nov 4, 2016)

Massachusetts Hazardous Waste Regulations. Massachusetts Department of Environmental Protection. http://www.mass.gov/courts/docs/lawlib/300-399cmr/310cmr30.pdf (accessed Nov 7, 2016)

Massachusetts Medical Waste Regulations. Massachusetts Department of Public Health. http://www.mass.gov/courts/docs/lawlib/104-105cmr/105cmr480.pdf (accessed Nov 7, 2016)

NIH Guidelines For Research Involving Recombinant or Synthetic Nucleic Acid Molecules; National Institutes of Health Office of Science Policy, Bethsada, 2016. http://osp.od.nih.gov/sites/default/files/resources/NIH_Guidelines.pdf (accessed Nov 4, 2016)

Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards; National Academies Press, Washington, DC, 2011. https://www.nap.edu/catalog/12654/prudent-practices-in-the-laboratory-handling-and-management-of-chemical (accessed Nov 4, 2016)

Safe Science: Promoting a Culture of Safety in Academic Chemical Research; National Academies Press, Washington, DC, 2014. https://www.nap.edu/catalog/18706/safe-science-promoting-a-culture-of-safety-in-academic-chemical (accessed Nov 4, 2016)

TOXNET. National Library of Medicine/National Institutes of Health. https://toxnet.nlm.nih.gov/ (accessed Nov 4, 2016)