Chemical Hygiene Plan

University of Portland

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Review and Approval

This University of Portland Chemical Hygiene Plan is hereby approved and effective as of this date.

University Officer Signature	Printed Name	Title	Date

Section One

Policy Statement and Scope

The objective of this Chemical Hygiene Plan (CHP) is to provide guidance for the control of potentially hazardous occupational exposures to chemical and physical agents in the laboratories of the University of Portland.

It is the University of Portland's policy to provide employees and students with a safe and healthy work environment and to comply with all pertinent federal, state, and local environmental health and safety (EHS) regulatory requirements. University of Portland recognizes that unique chemical and physical hazards may be found in laboratories and this CHP is designed to address those hazards by stating laboratory-specific requirements and guidelines. It is a requirement that all supervisors, engineers, scientists, technical staff, faculty, students, contractors, and visitors who work in the lab areas, and/or chemical and waste storage areas at University of Portland's facility be familiar with and follow the requirements of this document. (Students must be familiar with applicable elements of this plan as determined by the Chemical Hygiene Officer (CHO).) This plan includes all of the elements of the Hazard Communication Standard so it also covers those individuals who work with and perform activities that are not necessarily laboratory specific in nature, e.g., hazardous waste operations.

As an Oregon employer, University of Portland is required by the General Occupational Safety and Health Rules, Subdivision Z – Toxic and Hazardous Substances, Section 27 (as adopted by reference from the federal OSHA rule 29 CFR 1910.1450) Occupational Exposure to Hazardous Chemicals in Laboratories, to provide and maintain this Chemical Hygiene Plan in all work areas where employees may be potentially exposed to hazardous substances. This written CHP is available upon request to any University of Portland student or employee, their designated representative(s), and the Oregon or Federal Occupational Safety and Health Administration. No student or employee will be discharged or otherwise discriminated against for exercising his/her rights afforded by this plan.

Section Two

Program Responsibilities

University of Portland has developed a comprehensive CHP with the objective of protecting students and employees against chemical hazards and effectively informing and training students and employees about the potentially hazardous substances in the laboratory environment. The following are University of Portland employee and student responsibilities under this program.

2.1 University Officers and Administration

University of Portland is ultimately responsible for ensuring a safe, healthful, and environmentally responsible workplace, facilities and campus. University Officers and Administrators recognize this responsibility and have committed to provide the resources necessary to achieve this goal.

2.2 Chemical Hygiene Officer (CHO)

The Laboratory Standard requires the appointment of a Chemical Hygiene Officer (CHO). This officer is qualified either through training or experience to oversee the development and implementation of the CHP. This designated officer may hold another job title provided he or she is technically competent to fulfill the responsibilities of both job titles. The EHS Officer, has been designated the CHO. His/her responsibilities include:

- Providing technical guidance and assisting staff and faculty in the development and implementation of the Chemical Hygiene Plan;
- Overseeing and arranging for the monitoring of student and worker exposures to hazardous materials as defined by the Standard;
- Reviewing the CHP annually and updating it as necessary to remain current with regulatory requirements;
- Overseeing the training of students and employees before using hazardous materials;
- Making certain that Material Safety Data Sheets and other related information are available to all students and employees 24 hours/day;
- Reviewing incoming MSDSs for new and significant health and safety information and ensuring that this information is disseminated to students and employees;
- Reviewing and monitoring the safe disposal of hazardous materials according to the appropriate federal and state regulations;

- Conducting quarterly (every 3 months) inspections of all areas covered by this plan and following up on corrective actions;
- Maintaining copies of safety training documentation, accident investigation forms and annual chemical fume hood performance checks;
- Ensuring that medical consultative services are available to those students and employees requesting or needing such services; and
- Maintaining knowledge of the current legal requirements concerning regulated substances.

2.3 Department Directors and Faculty

The Department Directors and Faculty are responsible for the safe performance of day-to-day work with hazardous chemicals and substances within their respective work areas. They are responsible for:

- Ensuring that appropriate technical and administrative human resources, budget, and equipment are provided to achieve the requirements of this document;
- Providing leadership and direction regarding chemical hygiene and safety within their respective areas;
- Implementing the pertinent requirements of this document in their respective areas;
- Providing specialized training, or ensuring that students and personnel working under their direction in their area or with their equipment are trained specifically on the chemical and physical hazards associated with that work. This training must take place at the beginning of each school term or semester or use of new equipment, new job or class assignment, or changed job or class assignment;
- Ensuring that all safety training is documented. Copies of training documentation must be provided to the CHO;
- Ensuring that Standard Operating Procedures (SOPs) are developed for all "high hazard" operations;
- Ensuring that students and employees are aware of, and familiar with, emergency procedures and the proper use of emergency equipment;
- Ensuring that good housekeeping is practiced;
- Taking appropriate disciplinary action (in coordination with the CHO) when students or employees do not follow safe work procedures;
- Working with University Officers or Administration to initiate corrective actions;
- Placing defective or unsafe equipment out of service and arranging for servicing of equipment that is in need of maintenance and/or repair;
- Maintaining an up-to-date chemical inventory, and ensuring that hazardous materials are handled, stored, transported, and disposed of in the correct manner;

- Investigating all accidents within their area of supervision and submitting a completed Accident Investigation form to the CHO within 24 hours;
- Reviewing and approving equipment installations for compliance with pertinent building codes and regulations;
- Maintaining and servicing facilities-related equipment, including local exhaust ventilation systems and emergency/life safety equipment (e.g. building fire alarms and lighting);
- Providing guidance to maintenance supervisors, technical staff and the CHO regarding appropriate engineering control installations for chemical and physical hazards in the laboratory; and
- Testing the performance of laboratory exhaust hoods annually.

2.4 Students and Employees

Students and employees should be alert to the potential hazards of all the substances/operations in their work areas. Students and employees are responsible for:

- Following documented lab or work procedures and operating equipment in accordance with the manufacturer's and University of Portland's specifications and SOPs;
- Promptly reporting any accidents, unsafe conditions, or unsafe acts to faculty or to their supervisor;
- Suggesting solutions to improve the safety of the process, the laboratory, equipment, and training;
- Obtaining MSDSs for chemicals with which they work and information about EH&S procedures pertinent to their work or job assignment from their instructor or supervisor;
- Serving as good role models to peers or co-workers (and for faculty and supervisors, to subordinates) for safe work;
- Being familiar with and following emergency and evacuation procedures;
- Knowing the location of safety and emergency equipment and how to operate it;
- Maintaining personal work areas in accordance with housekeeping guidelines; and
- Using hazardous chemicals in a manner that prevents exposure via inhalation, ingestion, injection and skin absorption.

2.5 Contractors

All University of Portland personnel utilizing outside contractors are responsible for ensuring that the contractor is informed of the information contained within **Section Nine** of this program.

Section Three

Laboratory Control Measures and Equipment

3.1 Evaluating Employee Exposures

1. The CHO (or designee) will measure a student's or employee's exposure to any regulated hazardous chemical/physical agent if there is reason to believe that exposure levels for that chemical/physical agent routinely exceed the action level [typically set at one-half of the Oregon-OSHA Permissible Exposure Level (PEL)], or in the absence of an action level, the (PEL) or Threshold Limit Value (TLV). Within 15 days of receiving monitoring results University of Portland will notify the affected students or employees of the monitoring results in writing, either individually or by posting them in an appropriate location.
2. Routine monitoring of airborne concentrations is not usually justified nor practical in laboratories, but may be appropriate when testing, redesigning or introducing new fume hoods or other exhaust ventilation devices, or when a highly hazardous chemical/physical agent or process is used in a manner which is likely to cause exposure.
3. The CHO will promptly investigate all student- or employee-reported incidents/accidents in which there is a possibility of student or employee overexposure to a hazardous chemical/physical agent. If employees suspect that chemical exposures may exceed the PEL, they should contact the CHO. If symptoms are present, student(s) or employee(s) should arrange for a visit to the company authorized medical facility through their instructor or supervisor.

Events or circumstances that might reasonably constitute overexposure include:

- A hazardous chemical leaked, spilled, or otherwise was released in an uncontrolled manner;
- An employee or student had direct skin or eye contact with a hazardous chemical;
- An employee or student manifests symptoms, such as a headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, and some or all of the symptoms disappear when the person is taken away from the exposure area and breathes fresh air, and the symptoms reappear soon after the employee or student returns to work with the same hazardous chemicals/physical agents; or
- Two or more persons in the same area/lab have similar complaints.

3.2 Chemical Control Criteria Guidelines

Exposures by inhalation of airborne contaminants (gases, vapors, fumes, dusts, and mists) must not exceed OSHA Permissible Exposure Limits or in the latest edition of Threshold Limit Values of Airborne Contaminants (TLV) published by the American Conference of Governmental Industrial Hygienists (ACGIH), whichever is lowest. These PEL and TLV levels refer to airborne concentrations of substances and represent conditions under which it is believed that students or workers may be repeatedly exposed without adverse effect. PELs and TLVs are normally published on manufacturers' Material Safety Data Sheets (MSDS).

In all cases of potentially harmful exposure, feasible engineering or administrative controls must first be established. In cases where respiratory protective equipment alone or with other control measures is required to protect the student or employee, the protective equipment must be approved by the CHO for each specific use.

3.3 Hazard Control Prioritization

No laboratory can rely on one particular type of control technology to ensure that exposures to hazardous chemical/physical agents are kept as low as reasonably achievable. The primary and most effective approach is through the use of engineering controls. Complementing the engineering controls should be the correct combination of administrative procedures and the use of personal protective equipment.

3.4 Ventilation and Engineering Controls

3.4.1 Recirculation of Air

Recirculation of contaminated exhaust air using toxic, corrosive, flammable or other hazardous agents is prohibited. Areas/lab facilities using carcinogens and acute toxins, that, if released, could pose a personal injury or environmental impact risk, shall be designed so that a negative pressure differential exists between the area/lab and the exit corridor(s) servicing that area/lab.

3.4.2 Chemical Fume Hoods

3.4.2.1 General Principles

Chemical fume hood must meet the provisions of 29 CFR 1910.1450 (e)(3)(iii).

- Chemical fume hoods should be considered as backup devices that can contain and exhaust toxic, offensive, or flammable materials when the material being used generates vapors, gases, or dusts.
- Hoods are not regarded as a means for disposing chemicals.
- Hoods should be evaluated by operators prior to and during each use by means of simple visual indicators for adequate air flow.

- Except when adjustments of apparatus within the hood are being made, the hood sash should be kept closed. If the hood does not have a bypass grill, then the sash should be left open at least six inches to avoid flow from being choked off. Vertical sashes should be left down and horizontal sashes closed. Sliding sashes should not be removed from horizontal sliding sash hoods.
- During operations, keep the face opening of a hood as small as possible to improve the performance of the hood. Reducing the opening for the hood may also provide protection from explosions due to chemical reactions, over pressurization, etc. Each hood should have arrows (that match up) to indicate the maximum height of the sash when the hood is in-use to meet the air flow rate requirements.
- Performance of a hood depends upon such factors as the placement of materials and equipment in the hood, room drafts from open doors or windows, turbulence caused by persons walking by, and the presence of the user in front of the hood. Keep apparatus back from the front edge of the hood (approximately 6 inches inside the hood if possible) to reduce the potential for contaminant release.
- Hoods are not intended for storage of chemicals. Materials stored in hoods should be kept to a minimum. Stored chemicals should not block vents or alter airflow patterns.
- Students or employees working in the hoods should be prepared for the event of ventilation failure or other unexpected occurrence such as fire or explosion in the hood. Immediately notify responsible faculty and the CHO if ventilation fails. Evacuate the area, activate the fire alarm, dial 911 to report the incident for help, and notify security as soon as possible to get immediate assistance.
- Mechanical ventilation must remain in operation at all times when hoods are in use and for a sufficient time thereafter to clear hoods of airborne hazardous substances.
- Hoods must be inspected frequently and cleaned as necessary to ensure adequate air flow and the prevention of residue buildup. The CHO will conduct the annual ventilation survey and post flow rate data and test dates on each hood.

3.4.2.2 Hood Construction

- Newly purchased chemical fume hoods and installed exhaust ducting for solvent operations shall be constructed of non-combustible materials to reduce the potential for damage should a fire occur within the hood.
- Newly purchased hoods and exhaust ducting for corrosive applications shall be constructed from or coated with materials that are resistant to corrosive compounds.
- Provisions must be made for adequate make-up air for all hoods that are used in an area/lab.
- General air flow should not be turbulent and should be relatively uniform throughout the area/lab.

- Chemical fume hood face velocities (including wet bench enclosures) must be sufficient to maintain an inward flow of air at all openings into the hood under normal operating conditions. Air flow into hoods depends upon configuration but must be at a minimum average face velocity of at least 100 linear feet per minute (lfpm) with a minimum of 70 lfpm at any point, except where more stringent special requirements are identified. Hoods used for carcinogens must have a minimum face velocity of 150 lfpm with a minimum of 125 lfpm at any point.
- When the required face velocity is obtained by partly closing the sash, the sash and/or jamb must be marked to show the maximum opening at which the hood face velocity meets the requirements. Any hood failing to meet the requirements must be considered deficient in airflow and must be posted with placards, plainly visible, which prohibit use of hazardous substances within the hood.
- When sufficient quantities of flammable gases or liquids are used, or when combustible liquids are heated above their flash points, hoods that are not bypassed must have permanent stops installed that restrict closure of the sash so that sufficient airflow is maintained to prevent explosions. Concentrations in the duct must not exceed 10% of the lower explosive/flammable limit. Volume limit signs are posted on the hoods. The CHO will post this data as applicable using the appropriate and current data from one or more of the following sources:
    - Oregon OSHA Permissible Exposure Limits (PEL), OAR 437-004-9000 Air Contaminants
    - Threshold Limit Values of Airborne Contaminants (TLV), published annually by the American Conference of Governmental Industrial Hygienists (ACGIH)
- Exhaust fan systems must be non-sparking where ignition sources are isolated if exhausting sufficient quantities of flammable vapors and corrosion resistant if handling corrosive fumes.
- Exhaust stacks must be located in such a manner with respect to air intakes as to preclude the recirculation of hood emissions within a building.
- Hoods must be seismically braced to prevent toppling or sliding during an earthquake.
- All hoods are checked by the CHO when they are first installed and annually thereafter, for adequate ventilation performance. Performance measurements and the initials of the individual performing the test are left on the hood as record to verify performance.
- Performance of a ventilation system must be checked whenever there has been a change in a system or location.
- Laboratory ventilation equipment scheduled for maintenance or repair work must be cleaned and/or decontaminated.

- All ventilation systems need routine maintenance to prevent blocked or plugged air intakes and exhaust, loose belts, bearings in need of lubrication, motors in need of attention, corroded duct work, and component failure.

3.5 Other Ventilation Systems

The installation or modification of other local exhaust systems used should be coordinated with faculty or department director for the area and conducted in accordance with ACGIH, American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), National Fire Protection Association (NFPA) requirements and other nationally recognized standards.

Do not attach canopy hoods or snorkel (elephant trunk) systems to existing fume hood exhaust ducts without consulting the CHO.

Apparatus/operations that may discharge hazardous vapors (vacuum pumps and distillation columns) should be directly ducted to an auxiliary local exhaust system.

3.6 Personal Protective Equipment (PPE)

The use of personal protective equipment (PPE) is needed to compliment the variety of engineering and administrative controls present in a laboratory and research and development environment. The following is a listing of minimum PPE use guidelines for University of Portland students, employees, faculty, and visitors in lab areas where hazardous chemicals are present or are in use *(Refer to the University of Portland <u>Radiation Safety Handbook</u> for precautions when working with or near radiological chemicals)*:

3.6.1 Apparel

The following practices concerning apparel should be observed at all times:

- Appropriate clothing must be worn and appropriate to the activities being performed or observed, which may include a protective apron or lab coat to protect against chemical splashes or spills, cold, and heat;
- Use protective apparel, including safety glasses, face shields, gloves, and other special clothing or footwear, as needed;
- To prevent spreading contamination to family and friends, lab coats should not be removed from the facility;
- Loose apparel and hair should be tied back or confined;
- No open toed shoes and no sandals;
- No open midriff clothing and shorts or clothing exposing arms, legs, body or face to hazardous chemicals; and
- If lab coats are contaminated with hazardous chemicals, they should be removed immediately and decontaminated prior to laundering.

3.6.2 Gloves

Gloves should be worn whenever working with chemicals, rough or sharp-edged objects, or very hot or very cold materials. Select gloves based on the material being handled, the particular hazard involved, and their suitability for the procedures being conducted. Gloves should be checked visually or by other means prior to each use and should be changed often, based on their frequency of use and permeability to the chemical(s) handled. Gloves are eventually permeated by chemicals. Inspect gloves before each use for discoloration, punctures, and tears. Vinyl and nitrile rubber are the gloves most frequently used at University of Portland.

Glove selection charts are provided in Appendix Two.

3.6.3 Eye Protection

OSHA approved safety goggles are required to be worn by students, employees, faculty and visitors in all areas where chemicals are handled or used**. This includes the laboratory, storage room, waste storage areas or any area where hazardous chemicals are handled or used.** Avoid the use of contact lenses in these areas unless necessary and the faculty and CHO make special alternate arrangements

3.7 Equipment Controls and Guarding

3.7.1 Equipment Guarding

- All machining, test and mechanical equipment shall be adequately furnished with guards that prevent access to hazardous electrical connections, pinch points or moving parts.
- All guards should be inspected before using equipment.
- Employees shall not turn on, use, repair, or operate any equipment unless trained and authorized by the responsible supervisor.

3.7.2 Shields

Safety shields must be used for protection against possible explosions or uncontrolled reactions. Equipment must be shielded on all sides so that there is no line-of sight exposure to personnel. The sash on a chemical fume hood is a readily available partial shield. However, a portable shield is also recommended for use, particularly with hoods that have vertical-rising sashes rather than horizontal-sliding sashes, for operations having the potential for explosion such as:

- Whenever a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards); and
- Whenever a familiar test or reaction is carried out on a larger than usual scale.

3.7.3 Pressure

Standards for the use of pneumatic and high-pressure hydraulic equipment are available in American Society of Mechanical Engineering (ASME) documents. The following are additional requirements:

- Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure;
- Pressurized apparatus shall have an appropriate relief device;
- If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure buildup;
- All pressurized gas cylinders and systems shall be installed and used in accordance with Standard Operating Procedures, SOPs for safe equipment usage, handling, and storage.

3.8 Electrical Equipment

The electrical equipment in use at University of Portland facilities should meet the following minimum requirements:

- Use only UL (USA) or similarly approved electrical equipment.
- Keep all electrical equipment in good working condition.
- Electrical equipment, which requires grounding, must be grounded. Equipment with a three-prong plug must not be plugged into an outlet designed to only accept two-prong plugs.
- Do not overload electrical outlets. Extension cords must be at least 16-gauge. Use 14 gauge cords for equipment rated over 1000 watts. Do not use extension cords as a replacement for hard wiring equipment. Extension cords should be used for “temporary” means.
- Only appropriately trained individuals should undertake electrical repairs. In general, University of Portland personnel should not be performing these activities.

3.9 Emergency Equipment

3.9.1 Eyewash & Safety Showers

- Eyewash fountains are required if the substance in use presents an eye hazard (e.g., any corrosive). The eyewash fountain must provide a soft stream or spray of aerated water.
- Safety showers must be provided in areas where a corrosive chemical or rapid fire hazard exists, for immediate first aid treatment of chemical splashes and for extinguishing clothing fires. The shower must be capable of drenching the victim immediately in the event of an emergency.

- Eyewash fountains and safety showers should be located close to each other so that, if necessary, the eyes can be washed while the body is showered. Access to these facilities must remain open at all times and within ten seconds of travel distance. In case of accident, flush the affected body part for at least 15 minutes. Report the accident to the area faculty or supervisor immediately, and proceed to the contract medical facility.
- Eyewash and showers shall be tested and flushed by CHO at least monthly to ensure that they are operating properly. Inspection tags should be filled out to document testing. Faulty equipment shall be reported to the area faculty.

3.9.2 Fire Extinguishers

Laboratories using hazardous chemicals should have a BC or ABC rated, dry chemical fire extinguisher within 30 ft. of any exit for use on ordinary combustibles, flammable liquids, and electrical fires.

3.9.3 Flammable Liquid Storage Cabinets

- Generally, the minimum amount of flammable liquids necessary for one to several days of operation may be kept on hand and stored in an OSHA & NFPA approved cabinet. The cabinet must not exceed its rated capacity and it is recommended to not exceed 80% of its rated capacity.
- Cabinets must be labeled "Flammable - Keep Fire Away."
- Storage of flammable liquids in excess of ten gallons must be in an UL listed, Factory Mutual (FM) approved flammable liquids storage cabinet.
- Flammable liquids storage cabinets should be used for the storage of flammable and combustible liquids only. Do not store corrosives, oxidizers, or reactive chemicals with flammable or combustible liquids.

NOTE: A storage cabinet for flammable liquids is not fireproof, but only protects the contents from extreme temperatures for a limited time to allow evacuation of personnel and prompt entry of fire fighters.

Section Four

Hazard Evaluation

4.1 Material Safety Data Sheet (MSDS)

A Material Safety Data Sheet (MSDS) is kept on file for each hazardous substance listed on University of Portland's chemical inventory. The current up-to-date Hazardous Materials Inventory Statement (HMIS) is used as the site-wide chemical inventory. The MSDS is the most current one supplied by the manufacturer, importer, or distributor. The individual purchasing/obtaining the chemical is responsible for obtaining MSDSs. The contents of the MSDS are described in Appendix One.

The CHO is responsible for maintaining a master list of MSDSs for all products used at University of Portland. Faculty and supervisors must ensure that the CHO receives a copy of the MSDS for all new chemicals brought in and/or used at University of Portland. The CHO will review incoming MSDSs for new and significant health and safety information and ensure that this information is disseminated to students and employees.

4.2 Obtaining and Accessing an Original MSDS

When substances are purchased, or free samples or no charge items are brought into the facility, the individual who obtained the item must procure an MSDS from the manufacturer/supplier and supply a copy to the CHO. The CHO will ensure that the master MSDS binders are updated, as necessary.

4.3 Inventory of Hazardous Substances

A current chemical inventory will be reviewed at least annually to determine the actual chemicals and quantities present at University of Portland. The chemical inventory is maintained by the CHO and contains the following information:

- Location where the chemical is used;
- The common or trade name and the chemical name of the hazardous substances;
- The Chemical Abstract Service (CAS) registry number;
- Physical state;
- Container type;
- Approximate quantity on-site; and
- SARA Hazard Classes;

A copy of the chemical inventory is included at the end of this document as Appendix Four and also kept by the CHO.

4.4 Chemical Hazards and Categories

NOTE: Many chemicals fall into more than one chemical hazard category.

The Occupational Safety and Health Administration Hazard Communication Program (29 CFR 1910.1200) was designed to alert workers about hazardous chemicals by giving them greater access to information on the physical and health hazards of chemicals, safe handling procedures, and emergency and first-aid procedures. In 1990, OSHA issued a regulation (29 CFR 1910.1450) entitled Occupational Exposure to Hazardous Chemicals in Laboratories to address the differences between chemical use in laboratories versus other workplaces. The goal of the regulation is to ensure that laboratory workers are informed about the hazards of chemicals in their workplace and are protected from chemical exposures exceeding allowable levels. A Hazardous Chemical is defined by OSHA as any chemical that is a Physical Hazard or a Health Hazard.

Chemicals that are Physical Hazards are unstable (reactive) and, when handled improperly, could cause a fire or an explosion. OSHA defines a Physical Hazard as a chemical that has at least one of the following characteristics:

-Combustible liquid is defined by the NFPA and DOT as a liquid with a flashpoint of 100^{o}F (37.8^{o}C) or HIGHER, but below 200^{o}F. Store in approved safety cans or cabinets. Segregate from oxidizing acids and oxidizers. Keep away from any source ofignition: heat, sparks, and open flames. Examples include: mineral spirits and kerosene.

-Compressed gas cylinders must be secured, using an approved bracket, anchored to a fixed structure, during use and storage so that they cannot be knocked over. Cylinder valve caps must be in place when the cylinder is being moved or is not in use for an extended period of time. Cylinders should be moved with a hand truck designed for strapping on cylinders. Compressed gases used at University of Portland include: nitrogen, compressed air, carbon dioxide, helium, acetylene, and hydrogen.

-Explosive materials, when subjected to friction, heat, impact, electric or chemical charge can produce a sudden, almost instantaneous release of pressure, gas, or heat. When detonated in an uncontrolled or unexpected circumstance, explosives can result in serious bodily harm or extensive property damage. Shock sensitive explosives are known to detonate when subjected to shock through bumping or normal handling. Nitrated organics and inorganics constitute the largest class of compounds that are explosive when dehydrated. Examples include: diphenyl hydrazine, trinitrobenzene, nitro cellulose, trinitrophenol (picric acid), 3-nitrotoluene, and trinitrotoluene.

-Flammable describes any solid, liquid or vapor or gas that will ignite easily and burn rapidly. A flammable liquid is defined by NFPA and DOT as a liquid with a flashpoint below 100^{o}F (37.8^{o}C). Store in approved safety cans or cabinets. Segregate from oxidizing acids and oxidizers. Keep away from any source of ignition: heat, sparks, or open flames. Examples include: hexane, ethyl ether, diesel fuel, acetone, 1-butanol, and ethyl alcohol.

-Water reactives are chemicals that react violently with water to release a gas that is either flammable or presents a health hazard. Alkali metals, many organometallic compounds, and some hydrides react with water to produce heat and flammable hydrogen gas. Examples include: calcium hydride, phosphorus pentasulfide, hydrobromic acid, trimethyl chlorosilane, and oxalyl chloride.

-**Organic peroxide** forming solvents become shock sensitive when allowed to oxidize and form appreciable quantities of explosive peroxides. Most of these solvents are also flammable. Oxidation can occur when the solvent is exposed to atmospheric oxygen. Over a period of time, peroxide concentrations can increase to hazardous levels. Solvents with high concentrations of peroxides appear viscous or contain needle-like crystals. It is important to use the solvent before the manufacturer's expiration date. Examples of peroxide formers are listed below:

Severe Hazard	**High Hazard**	**Moderate Hazard**
Once exposed to oxygen, rapidly oxidizes, forming explosive peroxides. (3 months)	Once exposed to oxygen, oxidizes at a moderate rate, forming explosive peroxides. (6 months)	Once exposed to oxygen, slowly oxidizes, forming explosive peroxides. (12 months)
Diisopropyl ether	Acetaldehyde	Ethylene glycol ether
Sodium amide	Cumene	Ethyl vinyl ketone
Vinylidene dichloride (1,1-dichloroethylene)	Cyclohexane	Tetrabutyl ammonium fluoride
	Cyclopentane	
	Diethyl ether	
	p-Dioxane	
	Furan	
	Methyl isobutyl ketone	
	Tetrahydro furan	

-**Oxidizers** start or promote combustion in other materials, thereby causing fire either by itself or through the release of oxygen or other gases. Oxidizing agents include halogenated inorganics, nitrates, chromates, persulfates and peroxides. Specific examples include: ammonium nitrate, nitric acid, chromic acid, potassium chlorate, guanidine nitrate, potassium permanganate, sodium nitrate, and sulfuric acid.

-**Pyrophorics** will ignite spontaneously in air at a temperature of 130^{o}F or lower. The oxidation of the compound by oxygen proceeds so rapidly that ignition occurs without a source of ignition. Examples include: triethylphosphine, sodium metal, and lithium-tin alloys.

Other chemicals are hazardous because they can damage an exposed person's tissue, vital organs, or internal systems. OSHA defines Health Hazard as a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Generally, the higher a chemical's toxicity the lower the amount or dose necessary for it to have harmful effects. The effects vary from person to person, ranging from temporary discomfort to permanent damage depending on the dose, the toxicity, and the duration of exposure to the chemical. Chemicals which fall into any of the following categories are considered Health Hazards:

-**Carcinogens** can cause cancer. Examples include: acetaldehyde, chloroform, hydrazine, benzene, formaldehyde, and phenolphthalein.

-**Highly Toxic or Toxic** based on chemical concentrations required during median lethal dose studies-LD_{50} -on oral/dermaland-LC_{50}- air exposure. Examples include: oxalyl chloride, mercuric nitrate, hydrazine, and acetonitrile.

-**Corrosives** destruction of or irreversible alterations in living tissue at the site of contact. Examples include: acetic acid, lactic acid, hydrochloric acid, and sodium hydroxide.

-**Irritants** can cause reversible inflammation of living tissue at site of contact. Examples include: citric acid, furfuryl alcohol, EDTA, and glycerol.

-**Sensitizers** can cause allergic reactions after repeated exposure.

-Target organ effects.

a) **Hepatotoxins** (can cause liver damage). Signs & Symptoms: jaundice, liver enlargement. Example chemicals: Carbon tetrachloride, and nitrosamines.

b) **Nephrotoxins** (damage cells or tissues of the kidneys). Signs & Symptoms: Edema, protein in urine. Example chemicals: Halogenated hydrocarbons, and uranium**.**

c) **Neurotoxins** (can damage tissues of the nervous system). Signs & Symptoms: Narcosis, decrease in motor function. Example chemicals: mercury, and carbon disulfide.

d) Agents that act on the **Hematopoietic** (Blood) system: (deprives body tissues of oxygen). Signs & Symptoms: Cyanosis, loss of consciousness. Example chemicals: Carbon monoxide, cyanides.

e) Agents that damage the **Lungs.** Signs & Symptoms: Cough, shortness of breath. Example chemicals: Silica, asbestos.

f) Agents that damage the **Skin.** Signs & Symptoms: Rashes, irritation. Example chemicals: Ketones, chlorinated compounds**.**

g) Agents that are **Eye** hazards. Signs & Symptoms: Conjunctivitis, corneal damage. Example chemicals: Organic solvents, acids.

h) **Reproductive** toxins (can damage reproductive systems, including chromasomal damage-mutations, endrocrine systems, or a developing fetus-teratogenisis). Signs & Symptoms: Birth defects, sterility. Example chemicals: Dibromochloropropane, ethidium bromide.

Special Hazard Classes

Cryogenic: Liquid nitrogen is a cryogenic fluid used to maintain extremely low temperatures. Some of the hazards associated with cryogenics are fire, pressure, embrittlement of materials, and skin or eye burns upon contact with the liquid. Dry ice, prepared from liquid carbon dioxide can also cause burns to eyes and skin. Use containers approved for liquid nitrogen use. Always wear splash goggles or use a face shield if there is a splash hazard. Cryo-gloves should be worn.

Radioactive substances: Ionizing radiation is radiation with sufficient energy to remove electrons from atoms. One source of ionizing radiation is the nuclei of unstable atoms. For these radioactive atoms (also called radionuclides or radioisotopes) to become more stable, the nuclei eject particles and high-energy photons (gamma rays). The major types of radiation emitted are alpha particles, beta particles, and gamma rays. X-rays, another major type of ionizing radiation, arise from processes outside the nucleus.

Alpha particles rapidly lose energy when passing through matter and do not penetrate very far. These particles do not penetrate skin but are very harmful when inhaled or ingested. Alpha particles are stopped by a sheet of paper.

Beta particles are more penetrating than alpha particles, but less damaging over equally traveled distance. Some beta particles can penetrate the skin but are generally more hazardous when inhaled or ingested. Beta particles can be stopped by thin sheets of plastic or metal.

X-rays and gamma rays have essentially the same properties. X-rays are generally lower in energy and therefore less penetrating than gamma rays. A thin sheet of lead can stop most x-rays.

Depending on the level of exposure, ionizing radiation can pose a health risk. Ionizing radiation can increase the risk of cancer or genetic defects. Evidence of injury from low to moderate doses of radiation may not show up for several months or even years. If the dose is large enough to cause massive tissue damage, it may lead to death within a few weeks of exposure. Ionizing radiation may also cause harmful genetic mutations that can be passed onto future generations.

The use of radioactive materials by students and employees of the University of Portland is covered by a "Radioactive Material License" - following The Oregon Rules for the Control of Radiation. Licensing is controlled by the Radiation Protection Services, Oregon Health Division. Radioactive material shall be used by or under supervision of Kathleen O'Reilly, Ph.D., Ami Ahern-Rindell, Ph.D., Angela Hoffman, Ph.D., Jacqueline VanHoomissen, Ph.D., or Terry Favero, Ph.D.

4.5 Labeling

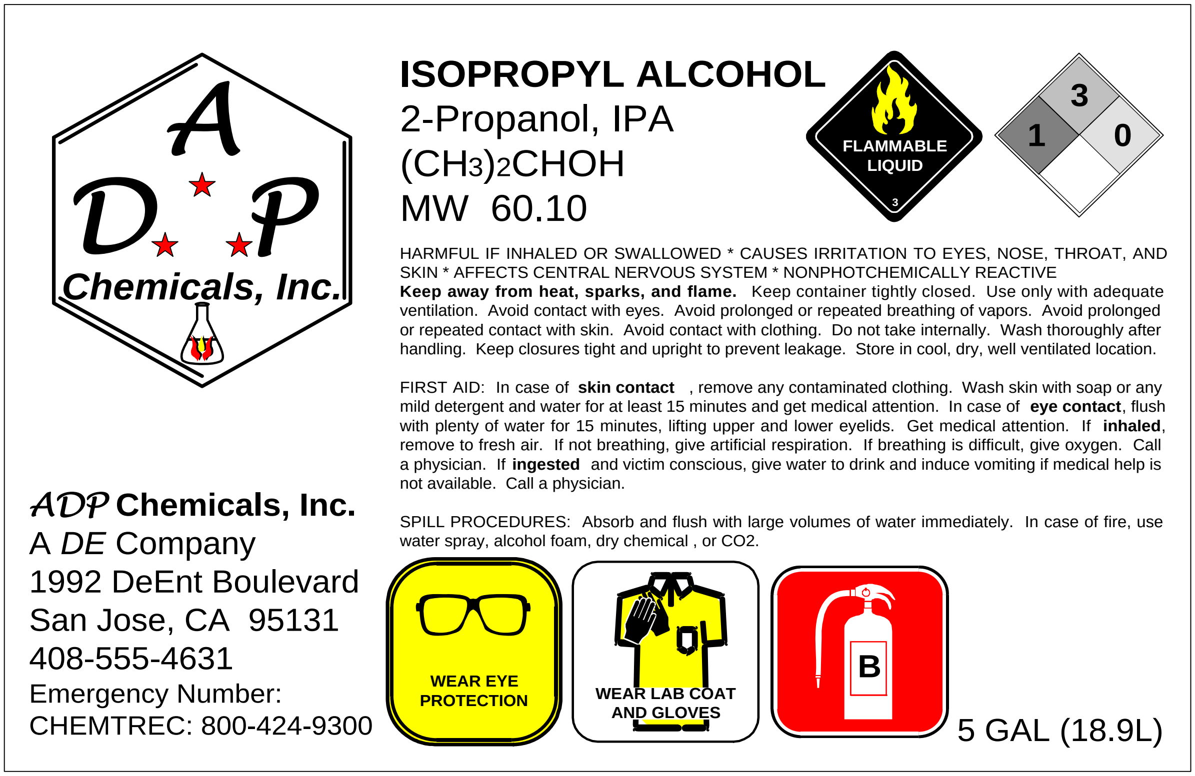
4.5.1 Primary Containers

Definition: A primary container is the container in which the product is received from the manufacturer or distributor.

It is the policy of University of Portland that no primary container of hazardous substances will be used unless the following label information is present:

- Containers are clearly labeled as to the contents;
- Appropriate hazard warnings are noted; and
- Name and address of the manufacturer are listed.

The following is an example of a primary label.



4.5.2 Secondary Containers

Definition: A secondary container is the container in which the product is dispensed for use (e.g., squeeze bottle).

To further ensure that students and employees are aware of the hazards of materials used in their work areas, it is University of Portland policy to label all secondary containers. Examples of secondary containers include squeeze bottles, chemical baths and wet decks. Secondary containers should be labeled with at least the following:

- Identity of the hazardous substance, and
- Appropriate hazard warnings (i.e., flammable, corrosive, etc.).

The following is an example of a secondary label for Isopropyl Alcohol:

ISOPROPYL ALCOHOL
DANGER -- FLAMMABLE

4.5.3 Labeling Systems

There are several acceptable labeling systems available for use. Among these is the National Fire Protection Association (NFPA) 704 labeling system, which provides chemical hazard information utilizing a color coded diamond. This system is described in Appendix Five.

4.6 Storage

It is University of Portland's policy that all primary and secondary containers be closed, capped, or otherwise covered when not being used. All flammable substances, in volumes of greater than one gallon, are to be kept in a flammable storage cabinet when not being used or when the use of the chemical is complete.

4.7 Preplanning and Approval of Proposed Modifications to Equipment/Operations

All proposed new or modified equipment/operations that use chemical substances or equipment that pose the potential for unique physical hazards (radiation, high voltage) require review and approval of the CHO.

4.8 Waste Disposal

Chemical wastes possess the same hazards as the original material. They can still be reactive, flammable, or corrosive. The CHO or designee oversees the disposal of all hazardous waste and coordinates its removal off site. Specific responsibilities for the disposal of biological and chemical waste are assigned to members of the respective departments. (Refer to the University of Portland Hazardous Waste Management Plan for more information.)

4.9 Emergency Response

Direct or suspected chemical contact should be treated immediately:

- Flush the affected area with water for at least 15 minutes;
- Remove contaminated clothing;
- Notify the Director of the area or your Instructor or Supervisor;
- **Contact 911**;
- Seek medical attention, if necessary, as quickly as possible; and

- Notify the CHO or your Instructor or Supervisor as soon as possible following the incident.

Section Five

Safe Work Practices and Standard Operating Procedures

5.1 General Principles

The number of hazardous chemicals/physical agents and the number of reactions among them are so large that previous knowledge of all potential hazards cannot be assumed. Therefore, when the chemical properties of a material are not fully known, it should be assumed hazardous and used in the smallest quantity possible. This will minimize exposure potential and, thus, reduce the probable magnitude of unexpected chemical events.

The following general safety principles should be observed by all students, faculty and personnel when working with chemicals:

- Substitute less toxic materials whenever possible. For example, toluene may be substituted for benzene.
- Minimize all chemical exposures through the use of engineering (e.g., chemical fume hoods), administrative (e.g., SOPs), and personal protective equipment (e.g., gloves) controls.
- Obtain and read the MSDS and other hazard information on solids, liquids, and gases used in laboratory operations.
- Be knowledgeable in the use of emergency equipment such as eye washes, safety showers, and fire extinguishers, and know how to obtain additional help in an emergency.
- Carefully label or cross-reference every secondary container with the identity of its contents. Appropriate hazard warnings are required on all secondary containers.
- Utilize equipment only for its designed purpose.
- Keep the work area clean and orderly.
- Determine compatibility of chemicals and store incompatibles separately.
- Provide a means of containing the materials if equipment or containers should break or spill their contents (secondary containment). A pre-determined spill procedure should be developed for each area.
- Limit the volume of volatile or flammable materials to the minimum needed for short operation periods.

- Position and clamp reaction apparatus thoughtfully in order to permit manipulation without the need to move the apparatus until the entire reaction is complete.
- Combine reagents in appropriate order, and avoid adding solids to hot liquids.
- Ensure that all chemical storage cabinets and racks, and all laboratory equipment using hazardous materials are seismically braced in accordance with best structural engineering practices.
- Consider the appropriateness of engineering design controls for systems that can generate or operate at high or low pressure.

5.2 Standard Operating Procedures, SOPs

Standard Operating Procedures, SOPs are operation-specific documents that are required for "high hazard" operations and recommended for other potentially hazardous operations.

5.2.1 High Hazard Operations Requiring SOPs

- Equipment, processes and operations which use known or suspect carcinogenic, mutagenic, or teratogenic substances, will be monitored closely and may be required to be used in a "Designated Area";
- Equipment, processes and operations that use bulk quantities of organic solvents, acids, bases, oxidizers, heavy metals, or toxic particulates.
- Equipment, processes and operations which involve accessible hazardous electricity, ionizing and non-ionizing radiation, including laser light, very high or low temperatures, or high or low pressure.
- Any other operation as deemed appropriate by the CHO.

5.3 Health and Hygiene

The following general rules pertain to good health and hygiene in the laboratory:

- NEVER use mouth suction to pipette chemicals or to start a siphon; a pipette bulb or an aspirator should be used to provide vacuum.
- Contamination of food, drink, and smoking materials is a potential route for exposure to toxic substances. Food shall be stored, handled, and consumed in areas free of hazardous substances, hence outside of chemical use/storage areas.
- Food, drink and chewing gum shall not be permitted in areas where chemicals or chemical equipment are being used.
- Glassware or utensils that have been used with chemicals should never be used to prepare or consume food or beverages. Refrigerators storing chemicals/substances shall not be used for food storage. Separate equipment should be dedicated to that use and prominently labeled.

5.4 Unattended Operations and Working Alone

Precautions should be taken for unattended laboratory operations that are carried out continuously or overnight. Unattended operations should be designed to be safe, and plans should be made to avoid hazards in case of failure. If possible, make arrangements for routine surveillance (e.g., each hour) of the operation, leave the lights on, and leave an appropriate sign on the door to indicate that the operation is going but has been left unattended.

- Names and telephone numbers of operator(s) and responsible faculty are to be posted on the entrance door for unattended operations. Chemical hazards are to be identified and posted on the door as well.
- Faculty and or supervisor must approve and be available at short notice to respond if needed.
- Security must be notified ahead of time and arrangements made for surveillance. Security must be informed of hazards, proper responses, possible incident scenarios, and how to respond.
- Operations requiring cooling water shall employ monitoring devices that will shut the operation down in the event of water supply failure.
- Laboratory work known to be hazardous must not be undertaken by a student or worker who is alone in a laboratory. At least two persons must be present.

5.5 Laboratory & Equipment Decommissioning

The Instructors, Supervisors or Directors are ultimately responsible for assuring that all laboratory space is maintained free from undue hazards. In particular, when vacating laboratory space, the Instructor, Supervisor or Director must ensure that all chemicals or hazardous wastes are removed and properly disposed. The CHO can provide assistance in labeling, packaging and removing chemicals and waste. If laboratory premises are left in an environmentally unacceptable state, it may be necessary to obtain the services of outside contractors to identify and dispose of unidentified chemicals and waste. Should this be necessary, the costs of these services will be borne by the vacating organization.

Equipment that is surplus or to be disposed of, must be checked for hazardous material contamination as part of the decommissioning process. Equipment decommissioning and decontamination may require the use of internal or external contractor services. The Instructor, Supervisor or Director is responsible to ensure that the decommissioning process leaves the equipment free of hazardous contamination prior to off-site transport or shutdown in place.

Section Six

Lab Safety and Housekeeping Inspections

Safety and housekeeping inspections will be conducted by the CHO on a quarterly basis. The CHO will maintain copies of the inspection reports and be responsible for overseeing/implementing the corrective actions on the reports. A copy of an inspection checklist is provided in Appendix Six.

Section Seven

Student, Faculty, and Employee Information and Training

Students, faculty, and employees must be provided area-specific training on the hazards to which they may be exposed and the means to avoid these hazards. Training must be updated when a new hazard is introduced into the work place. The CHO is responsible for providing assistance in the development of this training and ensuring that training is provided to all laboratory students and employees.

At a minimum, area-specific training must include:

- Requirements of applicable health and safety standards (e.g., Laboratory Standard) and where employees can access copies of such documents;
- Operations in their work area where hazardous substances/agents are present;
- Location and availability of the written Chemical Hygiene Plan;
- Signs, symptoms and potential health effects of the hazardous substances/agents to which employees might be exposed;
- Methods or techniques students and employees may use to determine the presence or release of hazardous substances/agents in the work area;
- Types of controls (ventilation, chemical fume hoods, personal protective equipment, etc.) used to control or minimize exposure to hazardous substances/agents;
- Review of Standard Operating Procedures, SOPs, that apply;
- Emergency and first aid procedures to follow if students or employees are exposed to hazardous substances/agents;
- Purpose of and access to exposure monitoring records;
- Location of MSDSs;
- How to read labels and review MSDSs to obtain appropriate hazard information;
- How to react to a chemical spill, leak, or other exposure and how to use emergency equipment; and
- Where to go to get help and information on health and safety issues.

A copy of the completed Training Documentation Form should be sent to the CHO. A copy of the Training Documentation Form can be found in Appendix Seven.

Section Eight

Medical Consultation

8.1 General

Medical consultation and examinations are provided under the direction of consulting physician(s) at a contract medical services facility. The primary objectives of medical consultation and monitoring are:

- To ensure students and employees are assigned duties they are physically able to perform;
- To provide medical care and rehabilitation of the occupationally ill or injured;
- To provide emergency medical treatment of serious injuries or illnesses;
- To encourage students and employees to maintain their physical and mental health;
- To assist in maintaining a safe and healthful work environment.

NOTE: A carcinogen medical surveillance program assessment will need to be completed by the CHO to carefully assess the conditions for on-going and projected exposure potential and frequency of use prior to identifying the need for specialized physical examinations. The CHO will routinely consult with faculty and supervisors to assess chemicals in use in the laboratories and the workplace. Based on these reviews and consultation with faculty and supervisors, the CHO will determine whether a medical surveillance program is appropriate. At a minimum the following resources will be consulted in assessing chemical hazards, exposure potentials, carcinogenicity, reproductive effects, and pregnancy effects:

- ❑ Professional consultants competent in the discipline of Occupational Health and chemical exposure assessments;
- ❑ OSHA 29 CFR 1910 guidance and standards for medical surveillance assessments;
- ❑ OSHA Technical Manual;
- ❑ OSHA consultant staff;
- ❑ EPA Technical Assistance staff;
- ❑ University of Portland occupational health clinic or staff;
- ❑ Available databases and resources, such as:
    - ♦ MSDS, manufacturer information, and technical staff or if not available consult, http://www.ilpi.com/msds/ ;
    - ♦ Patty’s Industrial Hygiene Manuals;

- National Institute of Environmental Health Sciences at: http://www.niehs.nih.gov/;
- National Institute of Occupational Safety and Health at: http://www.cdc.gov/niosh/homepage.html
- Toxicology and Environmental Health Information Program (TEHIP)
- The National Library of Medicine's ToxNet
- CROET - Center for Research on Occupational and Environmental Toxicology , http://www.croetweb.com
- EPA's new Chemical Registry System, http://www.epa.gov/crs/index.htm
- NTP Chemical Health and Safety Data, http://ntp-server.niehs.nih.gov/Main_Pages/Chem-HS.html
- Environmental Health Information Service, http://ehis.niehs.nih.gov/roc/toc8.html
- The EPA's Integrated Risk Information System (IRIS) http://www.epa.gov/iriswebp/iris/index.html,

8.2 Hazardous Materials and Reproductive Effects

Both men and women may be exposed to hazardous substances/agents that pose reproductive hazards such as infertility, hormonal changes, birth defects and genetic damage. These agents include ionizing radiation, alcohol, cigarette smoke, pharmaceuticals, and some of the thousands of different chemicals that are used in the home or workplace. Although many of these have been tested to determine whether they cause acute (immediate) effects on the body, few have been studied to see if they cause birth defects (teratogens) or genetic defects (mutagens). Even fewer have been studied to see if they can cause infertility, reduced sperm count, menstrual disorders, or other disorders relating to reproduction. Therefore, the CHO shall consider the potential reproductive effects of chemicals prior to selecting materials for use. The CHO will consult a variety of resources in evaluating

8.3 Hazardous Materials and Pregnancy

The primary path for hazardous substances/agents to reach an unborn child is through the placenta. Many chemicals and drugs that enter a pregnant woman's body (through breathing, swallowing, absorption through the skin, etc.) will eventually enter the mother's blood circulation, cross the placenta and thus affect the developing fetus. In general, the important questions of exactly how much of the toxic substance that enters the mother's body will reach the fetus, or what concentration the fetus can tolerate without harmful effects, have not yet been answered.

The fetus is usually most vulnerable in the early weeks of pregnancy (first 13 weeks or first trimester) but may also be at risk later in pregnancy. In light of the potential harm from workplace exposures to both the pregnant woman and her developing fetus, it is important for the woman to inform her instructor or supervisor of her pregnancy as soon as possible, so that necessary steps to avoid exposure to reproductive toxicants can be taken. This recommendation is not intended to discriminate against women; rather, it is intended to provide the pregnant woman with information about the possible hazards and her options.

Section Nine

Contractors

9.1 Responsibility of the Area Director or Department Director

As part of their responsibility of maintaining equipment, processes, and University of Portland property, Directors will:

- Ensure MSDSs are obtained for all maintenance-related chemicals procured and used at University of Portland;
- Communicate potential chemical hazards to all facilities-related contractors prior to the commencement of work;
- Obtain information on hazardous work performed by the contractor (e.g., welding, volatile solvent use, operating equipment powered by internal combustion engines, laser use, etc.);
- Prepare a contingency plan for isolating the construction/work area from adjacent occupied work areas and for preventing the release of hazardous materials to the environment (e.g., release of contaminated liquid to a storm drain);
- Ensure that contractors provide University of Portland with all appropriate chemical hazard documentation prior to the commencement of work;
- Prevent University of Portland students and employees from being exposed to maintenance-related chemicals by coordinating facility projects in a safe manner (i.e., painting);
- Restrict access and use of maintenance chemicals to appropriately trained personnel;
- Inform contractors of precautions and protective measures to be utilized while working in specific areas; and
- Provide contractors with emergency procedures and contact lists while working on-site at University of Portland.

9.2 Responsibility of Contractors

To ensure the safety of students and employees and to protect University of Portland property, contractors who use hazardous substances will make available upon request to the Area Director:

- MSDSs for each material used during the job;

- An explanation of the labeling and/or warning system used to identify hazardous chemicals or materials;
- Information on hazardous work performed by the contractor (e.g., welding, volatile solvent use, operating equipment powered by internal combustion engines, laser use, etc.); and
- Contingency plan for isolating the construction/work area from adjacent occupied work areas and for preventing the release of hazardous materials to the environment (e.g., release of contaminated liquid to a storm drain).

Contractors are responsible for providing all personal protective equipment for their employees. All hazardous waste generated by the contractor must be removed from University of Portland property and disposed of properly at the contractor's own facility.

Section Ten

Recordkeeping

Accurate documentation and recordkeeping of exposure monitoring, medical consultation and health and safety training is an important component of the CHP. This section defines the recordkeeping requirements for important aspects of the Plan.

10.1 Responsibility of the CHO

The CHO will have the responsibility to keep and maintain the following records:

- A complete up-to-date chemical inventory for all the products containing hazardous materials used at University of Portland *(located in the science building Chemical Storage Room)* ;
- Copies of Material Safety Data Sheets, MSDSs in a master file *(located in the science building Chemical Storage Room)*;
- Copies of Standard Operating Procedures, SOPs, that are developed *(copies with all science building staff and original with CHO);*
- Copies of the quarterly inspections and corrective actions taken for resolution of issues noted *(copies with all science building staff and original with CHO);*
- Documentation for exposure monitoring for hazardous chemicals and harmful physical agents *(copies with all science building staff and original with CHO);*
- Documentation of the annual chemical fume hood (ventilation) performance checks *(copies with all science building staff and original with CHO);* and
- Environmental, Health and Safety (EHS) related documentation including:
    - Student and employee training documentation for a period of no less than 3 years *(copies with all science building staff and original with CHO);*
    - Completed Accident Investigation forms for a period of not less than 3 years *(copies with applicable University of Portland Supervisor and original with CHO;* and
    - Medical consultation/physician reports for a period of at least 30 years beyond employment or study as a student at the University *(copies with applicable University of Portland Supervisor and original with CHO).*

Appendix One

Understanding a Material Safety Data Sheet (MSDS)

Introduction

The MSDS must include, at a minimum, all eight of the described sections. Although the style and layout may vary by manufacturer or distributor, every section must be complete, even if the item is not applicable (indicated by N/A). There should be no blank spaces. Note that some information, such as the chemical family, may be included, but is not required.

The MSDS is prepared by the manufacturer of the product. Some data sheets contain excellent information, some are adequate, and others are poor. Other sources of data on toxic and health effects can be consulted for more complete information. Contact the CHO if additional information or clarification is needed.

Product Identity [MSDS Section I]

Identity: The name of the product as it appears on the label. A product may be a mixture of two or more chemicals.

Manufacturer's Name, Address, and Phone Number: Self explanatory. If the data comes from a source other than the manufacturer, the actual source must be indicated. The date of preparation or revision must be indicated.

Emergency Telephone Number(s): 24-hour number(s) provided by the manufacturer to supply emergency information (e.g., medical emergencies).

Chemical Family: A general class of compounds to which the hazardous substance or mixture belongs (e.g., ethers, acids, ketones, and solvents). This term does not give you the exact content of the product.

Chemical Name: A scientific name of the hazardous substance. The Chemical Abstract Service (CAS) registry number may also be given for specific chemicals.

Formula: The chemical formula may be given for single elements and compounds [e.g., sulfur dioxide (SO_2), formaldehyde (HCHO)]. This is not the formulation for mixtures.

Hazardous Ingredients [MSDS Section II]

If the product is a mixture, all hazardous ingredients must be listed. However, ingredients that are not hazardous or hazardous ingredients that make up less than 1% of the product (less than 0.1% for carcinogens), do not have to be reported.

Exposure standards, e.g., Threshold Limit Value (TLV) or Permissible Exposure Limit (PEL), are included either in this section or under Health Hazards. **Note:** The higher the number for a TLV or PEL, the less hazardous the substance.

The percent (%) column is intended to show the approximate percentage by weight or volume of each hazardous ingredient compared to the total weight or volume of the product. Normally, percentages will be listed to the nearest 5%. When the substance constitutes less than 5% of the product, this is indicated.

Physical Data [MSDS Section III]

This section contains important data to help predict the behavior of the substance during use. The information provided may be for the substance as a whole, or for each hazardous ingredient. Some physical data communicate the same information. For example, vapor pressure, vapor density, % volatiles, and evaporation rate, all indicate whether vapors are likely to be present, creating a potential breathing problem, fire hazard, or ventilation problem.

Boiling Point: A temperature at which a liquid changes to a vapor at a given pressure, usually in degrees Fahrenheit (°F) at the sea-level pressure of 760 millimeters of mercury (mm of Hg). For mixtures, the initial boiling point or the boiling range may be given. A low boiling point may indicate a special fire hazard.

Vapor Pressure: Refers to the pressure exerted by a saturated vapor above its own liquid, usually stated in millimeters (mm) of Hg at 25°C (77°F). A high vapor pressure indicates easy evaporation. In general, the lower the boiling point, the higher the vapor pressures.

Vapor Density: Indicates whether the vapor is heavier or lighter than air. If the vapor density is heavier than air, the vapor of the substance may concentrate in low places, such as floors, elevator shafts, sewers, trenches, or the bottom of tanks. This information is useful in identifying confined-space hazards.

% Volatiles by Volume: An amount of the substance that evaporates at room temperature. A substance that is 100% volatile will evaporate completely, leaving no residues.

Evaporation Rate: A rate at which the substance will evaporate when compared to the rate of evaporation of a known material, usually butyl acetate. If another material is used for comparison, it should be indicated. If the evaporation rate number is greater than 1, the product evaporates more easily than the comparison material.

Solubility in Water: A percentage of a substance (by weight) that will dissolve in distilled water, at room temperature.

Specific Gravity: A ratio of the weight of a volume of a substance to the weight of an equal volume of water. A specific gravity of less than one means the material is lighter than water and will float. Greater than one means the substance sinks in water.

Melting Point: A temperature at which a solid becomes a liquid at a given pressure (usually under normal room conditions).

Appearance and Odor: The brief description of the substance at normal room temperature and atmospheric conditions. Do not rely on odor to alert you to a dangerous exposure. Some substances can reach hazardous levels and have no noticeable odor.

Fire & Explosion Hazard Data [MSDS Section IV]

This section should clearly indicate whether the substance is flammable. If it is flammable, make sure there are no ignition sources nearby and that the correct fire extinguisher is on hand. This section is particularly important if you work with solvents, peroxides, explosives, metal dusts, or other unstable substances.

Flash Point: The lowest temperature at which the material gives off enough vapor to ignite; this will help determine storage and handling procedures. The method used to obtain this information should be stated (e.g., closed cup).

Flammable or Explosive Limits: A range over which a flammable vapor, when mixed with the proper proportions of air, will flash or explode if ignited. The range is designated by lower explosive limit (LEL) and upper explosive limit (UEL), and is expressed in % of volume of vapor in the air.

Extinguishing Media: Indicates what type of fire extinguisher to use, such as water, fog, foam, alcohol foam, carbon dioxide, or dry chemical.

Special Fire fighting Procedures: Special handling procedures, personal protective equipment, and unsuitable fire fighting substances should be listed. For example, water should not be used on fires involving reactive metals. General fire fighting methods are not described.

Unusual Fire and Explosive Hazards: Hazards that might occur as a result of overheating or burning of the substance, including any chemical reactions or change in chemical form or composition.

Reactivity Data [MSDS Section V]

This section evaluates the stability and reactivity of the substance and lists conditions to avoid and prevent dangerous reactions. This information will help you handle and store the substance properly.

Stability: A checked box will indicate whether the material is stable or unstable and under what conditions instability occurs.

Incompatibility: Lists materials and conditions to avoid. Such conditions may include extreme temperatures, jarring, or inappropriate storage. This is important in determining what other chemicals with which the material can be stored or used.

Hazardous Decomposition Products: A list of the hazardous materials that may be produced through aging or if the material is exposed to burning, oxidation, heating, or certain chemical reactions. The product shelf life should be included, when applicable.

Hazardous Polymerization: Polymerization is a chemical reaction in which two or more molecules of a substance combine to form repeating structural units of the original molecule. A hazardous polymerization causes an uncontrolled release of energy (heat). If this reaction can occur, it must be indicated.

Health Hazard Data [MSDS Section VI]

This section discusses health hazards and first aid information. The potential routes of entry into the body - inhalation, skin absorption, and ingestion - are evaluated. Specific short-term (acute) and long-term (chronic) health effects due to overexposure to the identified substance are discussed. Signs and symptoms of acute overexposure may include eye irritation, skin rash, or dizziness. Symptoms of chronic overexposure may include cancer (carcinogenicity), birth defects (teratogenicity), or "target organ" damage. Some products cause both short-term and long-term effects.

Information on exposure standards, such as TLV, PEL, or STEL, as well as toxicity data (e.g., an LD_{50} number), may be included here. Carcinogenicity data from the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC) may be presented if available. It is important to note that toxicity data from animal studies gives only an estimate of potential human responses. Experimental animals and humans do not always react the same way to the same chemicals.

Instructions for first aid and emergency procedures for victims of acute inhalation, ingestion, or skin or eye contact must be included. Medical conditions that can be aggravated by exposure must also be listed.

Handling Precautions [MSDS Section VII]

This section includes appropriate health and safety practices for handling the substance, protective measures to be taken during transport, and spill management requirements. Instructions for safe handling and storage, such as the warning not to store acids and bases together, may be included. Any additional special precautions not addressed elsewhere in the MSDS should also be listed here. These may include instructions for storage life or transportation, such as special packaging or temperature control.

The information on methods, special equipment, and precautions necessary to control and clean up spills, leaks, and other releases will help prepare for emergencies. For example, the MSDS may state that respirators are required to clean up a spill. Acceptable waste-disposal methods are also described. The user will be alerted to any potential environmental danger to the general population, crops, water supplies, or other receptors.

Control Measures [MSDS Section VIII]

This section is essential for protecting students and employees from overexposure. It lists personal protective equipment, such as proper gloves, safety glasses, or respirators; ventilation necessary to work safely with the material; and safe work/hygienic practices. Types and descriptions of necessary equipment should be specified (e.g., organic vapor cartridge, neoprene gloves). If the material has a low TLV, indicating a potentially dangerous health hazard, local exhaust ventilation is typically recommended, not general or dilution ventilation.

Appendix Two

Glove Selection Charts

Fabric:	Natural rubber
Advantages:	Low cost, good physical properties, dexterity
Disadvantages:	Poor vs. oils, grease, organics. Frequently imported; may be poor quality
Uses:	Bases, alcohols, dilute water solutions; fair vs. aldehydes, ketones
Fabric:	Natural rubber blends
Advantages:	Low cost, dexterity, better chemical resistance than natural rubber vs. some chemicals
Disadvantages:	Physical properties frequently inferior to natural rubber
Uses:	Same as natural rubber
Fabric:	Polyvinyl chloride (PVC)
Advantages:	Low cost, very good physical properties, medium chemical resistance
Disadvantages:	Plasticizers can be stripped; frequently imported; may be poor quality
Uses:	Strong acids and bases, salts, other water solutions, alcohols
Fabric:	Neoprene
Advantages:	Medium cost, medium chemical resistance, medium physical properties
Disadvantages:	N/A
Uses:	Oxidizing acids, anilines, phenol, glycol, ethers

Fabric:	Nitrile
Advantages:	Low cost, excellent physical properties, dexterity
Disadvantages:	Poor vs. benzene, methylene chloride, trichlorethylene, many ketones
Uses:	Oils, greases, aliphatic chemicals, xylene, perchloroethylene, trichloroethane; fair vs. toluene
Fabric:	Butyl
Advantages:	Specialty glove, polar organics
Disadvantages:	Expensive, poor vs. hydrocarbons, chlorinated solvents
Uses:	Glycol ethers, ketones, esters
Fabric:	Polyvinyl alcohol (PVA)
Advantages:	Specialty glove, resists a very broad range of organics, good physical properties
Disadvantages:	Very expensive, water sensitive, poor vs. light alcohols
Uses:	Aliphatics, aromatics, chlorinated solvents, ketones (except acetone), esters, ethers
Fabric:	Fluoroelastomer (Viton)
Advantages:	Specialty glove, organic solvents
Disadvantages:	Extremely expensive, poor physical properties, poor vs. some ketones, esters, amines
Uses:	Aromatics, chlorinated solvents, also aliphatics and alcohols
Fabric:	Norfoil (Silver Shield)
Advantages:	Excellent Chemical resistance
Disadvantages:	Poor fit, easily punctures, poor grip, stiff
Uses:	Use for hazmat work

Appendix Three

Chemical Incompatibility Tables

Compound/Class/Chemical	Avoid Storage Near or Contact With
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Conc. Nitric acid and sulfuric acid mixtures
Acetylene	Fluorine, chlorine, bromine, copper, silver, mercury
Alkaline metals (e.g., Na, K, Mg, Ca, Al)	Carbon dioxide, carbon tetrachloride or other chlorinated hydrocarbons, halogens, water
Ammonia (anhyd.)	Mercury, chlorine, bromine, iodine, hydrofluoric acid, calcium hypochlorite
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenicals	Reducing agents (or will generate arsine)
Azides	Acids (or will generate hydrogen azide)
Bromine	Ammonia, acetylene, butadiene, methane, propane, butane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite, oxidizing agents
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic acid, Chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, turpentine, alcohol, or other flammable liquids
Chlorine	Ammonia, acetylene, butadiene, methane, propane, butane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Organic or inorganic acids
Cyanides	Acids (or will generate hydrogen cyanide)
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens

Compound/Class/Chemical	Avoid Storage Near or Contact With
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, other oxidants
Hydrocarbons (propane, butane, benzene, gasoline, turpentine, etc.)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkalies
Hydrofluoric acid (anhyd.)	Ammonia (aq. or anhyd.)
Hydrogen peroxide	Copper, chromium, iron, most other metals or their salts, alcohols, acetone, or other flammable liquids, aniline, nitromethane, or other organic or combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids (or will generate chlorine or hypochlorous acid)
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, ammonia, fulminic acid (produced in nitric acid- ethanol mixtures)
Nitrates	Sulfuric acid (or will generate nitrogen dioxide)
Nitric acid (conc.)	Acetic acid, aniline, chromic acid, acetone, alcohol, or other flammable liquids, hydrocyanic acid, hydrogen sulfide, or other flammable gases, nitratable substances; copper, brass, or any heavy metals (or will generate nitrogen dioxide/nitrous fumes)
Nitrites	Acids (or will generate nitrous fumes)
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, other flammable gases, liquids, or solids
Perchloric acid	Acetic acid, bismuth & its alloys, alcohol, paper, wood, grease, oils
Peroxides (organic)	Organic or inorganic acids. Also: avoid friction and store cold
Phosphorus (white)	Air, oxygen, caustic alkalies as reducing agents (or will generate phosphine)
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Acids, especially sulfuric acid
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde,

Compound/Class/Chemical	Avoid Storage Near or Contact With
	sulfuric acid
Selenides	Reducing agents (or will generate hydrogen selenide)
Silver	Acetylene, oxalic acid, tartaric acid, fulminic acid (produced in nitric acid-ethanol mixtures), ammonium compounds
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Any oxidizable substance such as methanol, ethanol, glycerol, ethylene glycol, glacial acetic acid, acetic anhydride, furfural, benzaldehyde, methyl acetate, ethyl acetate, carbon disulfide
Sulfides	Acids (or will generate hydrogen sulfide)
Sulfuric acid	Light metals (lithium, sodium, potassium), chlorates, perchlorates, permanganates
Tellurides	Reducing agents (or will generate hydrogen telluride)

Appendix Four

Chemical Inventory

University of Portland
Science Building Chemical Inventory

Storage Location	Common or Trade Name	Chemical Name	CAS No.	Physical State	Container Type	Approx. Quantity	SARA Hazard Classes

Staff Person: ____________________ Page __________ Date __________________

University of Portland

Science Building Chemical Inventory

Storage Location	Common or Trade Name	Chemical Name	CAS No.	Physical State	Container Type	Approx. Quantity	SARA Hazard Classes

Staff Person: ____________________ Page __________ Date __________________

University of Portland

Science Building Chemical Inventory

Storage Location	Common or Trade Name	Chemical Name	CAS No.	Physical State	Container Type	Approx. Quantity	SARA Hazard Classes

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Science Building Chemical Inventory

Storage Location	Common or Trade Name	Chemical Name	CAS No.	Physical State	Container Type	Approx. Quantity	SARA Hazard Classes

Staff Person: ____________________ Page __________ Date __________________

University of Portland
Science Building Chemical Inventory

Storage Location	Common or Trade Name	Chemical Name	CAS No.	Physical State	Container Type	Approx. Quantity	SARA Hazard Classes

Staff Person: _____________________ Page __________ Date ___________________

Appendix Five

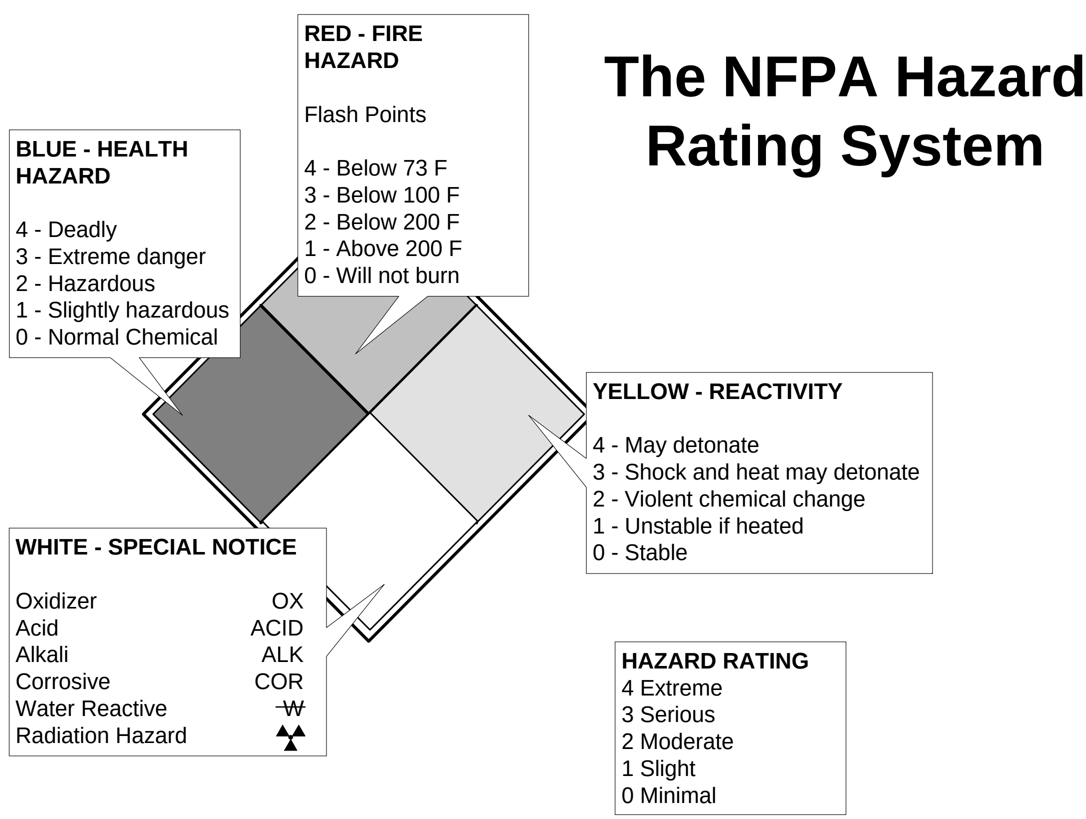
NFPA Labeling System

The National Fire Protection Association (NFPA) 704 standard presents a hazard labeling system that incorporates information on toxicity, flammability, reactivity, and special hazards. This system was designed to provide uniform, clearly visible information to Fire Department personnel (e.g., fire fighters, inspectors). The following, adapted from the appendix of the NFPA standard, summarizes the hazard information.

The numbers from 0 through 4 are placed in the three upper squares of the diamond to show the degree of hazard present for each of the three hazard categories. The 0 indicates the lowest degree of hazard, and 4, the highest. The fourth square, at the bottom, is used for special information. Two symbols for this bottom space are recognized by NFPA 704 (See Figure). They are:

1. A letter *W* with a bar (~~W~~) indicates that a material may react with water. This does not mean "do not use water," since some forms of water - fog or fine spray - may be used in many cases.
2. The letters *OX* indicate an oxidizer.

Although not recognized by NFPA 704, some users will insert the letters *ALK* for alkaline materials and *ACID* for acidic materials.



Appendix Six

Inspection Checklist

University of Portland

Science Building Lab Safety & Housekeeping Inspection Checklist

Inspector: ______________________ Date: ______________________

1. All chemical containers are clearly labeled, including secondary containers. (Yes) (No)

   Comment: ____

2. All chemical containers are secured and closed. (Yes) (No)

   Comment: ____

3. Only chemicals being used are outside the chemical storeroom, unless they are appropriately secured in compatible and approved storage cabinets. (Yes) (No)

   Comment: ____

4. Incompatible chemicals are not placed or stored in close proximity to each other. (Yes) (No)

   Comment: ____

5. Hazardous Waste is stored in labeled and appropriate containers under one designated hood in each lab. Labels contain hazard codes, inventory of contents including quantity. (Yes) (No)

   Comment: ____

6. Fume hoods have labels marking proper adjustment of sashes. (Yes) (No)

   Comment: ____

7. Fume hoods appear to be ventilating properly and sashes are adjusted to labeled marks. (Yes) (No)

   Comment: ____

8. Labs, Chemical Storage Rooms, and Hazardous Waste Storage Rooms are kept locked when not in use and only authorized persons are allowed to enter these rooms. (Yes) (No)

   Comment: ____

9. MSDS books are in the Chemical Storage Room and appear to be complete. (Yes) (No)

   Comment: ____

10. A Chemical Inventory is complete, current, dated and signed by staff and located in the Chemical Storage Room. (Yes) (No)

    Comment: ____

11. All students, employees, faculty, and visitors are wearing approved safety goggles when and where chemicals are open or in use and during handling. (Yes) (No)

    Comment: ____

12. Students, employees, faculty, and visitors are using appropriate gloves, goggles, aprons, splash shields and other Personal Protective Equipment in accordance with the CHP and SOPs and appropriate to the nature of work being performed. (Yes) (No)

    Comment: ____________________

13. Appropriate protective clothing is being worn in all laboratory settings. (Yes) (No)

    Comment: ____________________

14. Anyone wearing a respiratory has been properly trained, fit tested and has been cleared by the CHO to wear the respirator. (Yes) (No)

    Comment: ____________________

15. Horseplay is not observed in the lab setting, in the Chemical Storage Room or in the Hazardous Waste Storage Room. (Yes) (No)

    Comment: ____________________

16. Food and beverage are not brought into or consumed in the laboratories, Chemical Storage Room, Hazardous Waste Storage Room or in any other location where chemicals are used or handled. (Yes) (No)

    Comment: ____________________

17. Chemicals are being handled properly. (Yes) (No)

    Comment: ____________________

18. All spillage is quickly and appropriately cleaned up. There are no signs of chemicals outside of appropriate containers and containers are in good condition. (Yes) (No)

    Comment: ____________________

19. Housekeeping is good. No slip, trip, or fall hazards. (Yes) (No)

    Comment: ____________________

20. All labs, storage rooms, and aisles are free of clutter and trip, slip, and fall hazards. (Yes) (No)

    Comment: ____________________

21. Safety showers are clear of clutter, clean, and have been tested recently. (Yes) (No)

    Comment: ____________________

22. Eye wash stations and equipment are clean and have recently been tested and are readily accessible. (Yes) (No)

    Comment: ____________________

23. Appropriate fire extinguishers are available, in all locations required, have been recently inspected and serviced. Fire extinguishers are visible and labeled with a sign marking their location. (Yes) (No)

    Comment: ____________________

24. Noxious fumes and odors are not present throughout the science building. (Yes) (No)

    Comment: ____

25. Interviews with supervisors and staff show that all accidents and near misses have been reported and investigated. (Yes) (No)

    Comment: ____

26. Unsafe conditions are being noticed and reported by students, employees, and faculty. Safety suggestions are being encouraged. (Yes) (No)

    Comment: ____

27. Lab doors are appropriately labeled for the type of work carried out in its area. This includes signage when experiments are in progress, indicating entry is not permitted, or other hazards are present. (Yes) (No)

    Comment: ____

28. Lab chemical storage areas are limited to only amounts needed for an ongoing experiment, lab exercise, or research project. All bulk and quantity storage of chemicals is in the Chemical Storage Room in approved cabinets, containers, and storage spaces. All chemical storage cupboards and cabinets are properly labeled according to the contents (e.g. acids, bases, flammables, etc.). (Yes) (No)

    Comment: ____

29. All equipment requiring guarding is properly guarded. (Yes) (No)

    Comment: ____

30. Sharps and broken glass are properly managed. (Yes) (No)

    Comment: ____

31. All doorways are labeled with NFPA labels and signs so fire and security officials can know what is on the other side of the door. (Yes) (No)

    Comment: ____

32. No flame is present when not in use. All flames are properly vented. (Yes) (No)

    Comment: ____

33. No defective equipment is in use and all defective equipment is labeled as being defective and is sent out for repair or disposal. (Yes) (No)

    Comment: ____

34. Student, employee, staff, and faculty safety training records are available and up-to-date. (Yes) (No)

    Comment: ____

35. Evacuation routes, aisles, halls, doorways are clear for evacuation when needed. Exit and evacuation route maps are adequately posted and up-to-date. (Yes) (No)

Comment: ____

36. Safety and emergency equipment is appropriately located and in good working order. Employees and staff are trained on equipment use and know where to find it. (Yes) (No)

Comment: ____

37. Confined spaces have been identified and proper signage and permit access instructions are in place. (Yes) (No)

Comments: ____

38. Electrical cords are being properly used and are not being substituted for more permanent wiring. (Yes) (No)

Comment: ____

39. Electrical grounding is in place and has not been removed or bypassed. (Yes) (No)

Comment: ____

40. Pressurized containers and vessels are properly equipped with pressure release valves. (Yes) (No)

Comment: ____

41. Gas cylinders and gas storage bottles are secured and properly labeled and protective caps are in place. (Yes) (No)

Comment: ____

Appendix Seven

Training Documentation Form

Training Documentation Form

Date: ________________________

Subject(s) Covered: ____

____

____

Trainer: ____

Attendees	**Department**