CHEMICAL HYGIENE PLAN AND HAZARDOUS MATERIALS SAFETY MANUAL FOR

PURDUE
UNIVERSITY

LABORATORIES

This is the Chemical Hygiene Plan specific to the following areas:

Laboratory name or room number(s):
3144 and 3144A _____

Building: Brown _____

Supervisor: Dr. Angeline Lyon _____

Department: Chemistry _____

Telephone numbers
911 for Emergency and urgent consultation
48221 Police business line
46919 Fire Dept business line
46371 Radiological and Environmental Management

Revised on: **10/8/2014**

Print one full copy and professor sign cover page. That copy must be kept easily accessible to all staff, and all staff aware of, and able to quickly locate it. Signature signifies that information included is this group's CHP and that supervisor has verified accuracy of cover page, SOPs, page (i) and Appendices J & K.

All laboratory chemical use areas must maintain a work-area specific Chemical Hygiene Plan which conforms to the requirements of the OSHA Laboraotry Standard 29 CFR 19190.1450. This document was modified from a Chemistry-specific template <http://www.chem.purdue.edu/chemsafety/CHP/2013CHM-CHPtemplate.docx>, which was modified from the REM-provided template made available to the University. The REM model CHP was version 2010A; updates are to be found at www.purdue.edu/rem

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PURDUE CHEMICAL HYGIENE PLAN
AWARENESS CERTIFICATION
For CHP of: Dr. Angeline Lyon, BRWN 3144 and 3144A

The Occupational Safety and Health Administration (OSHA) requires that laboratory employees be made aware of the Chemical Hygiene Plan at their place of employment (29 CFR 1910.1450).

The *Purdue University Chemical Hygiene Plan and Hazardous Materials Safety Manual* serves as the written Chemical Hygiene Plan (CHP) for laboratories using chemicals at Purdue University. The CHP is a regular, continuing effort, not a standby or short term activity. Departments, divisions, sections, or other work units engaged in laboratory work whose hazards are not sufficiently covered in this written manual must customize it by adding their own sections as appropriate (e.g. standard operating procedures, emergency procedures, identifying activities requiring prior approval). See Appendix K.

After reading the "Purdue Chemical Hygiene Plan and Hazardous Material Safety Manual," complete and return a copy of this form to your supervisor or to your department's Safety Committee Chair. By signing below you acknowledge that you are aware of the Chemical Hygiene Plan and the policies and procedures applicable to the OSHA standard (29 CFR 1910.1450). Your supervisor will provide additional information and training as appropriate.

Please provide legible information. Every group member who is involved in laboratory use of chemicals, and the supervisor of any such people, is required to read the group CHP, and to sign sign and submit a copy of this form annually between Jan 1 and Feb 15.

Name:_____

Email address:_____

Job Classification (if employee):_____

Signature:_____ Date:_____

Completed CHP Awareness Certifications are to be filed with
Paul Bower, WTHR 173.

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PURDUE UNIVERSITY
POLICY STATEMENT

It is the policy of Purdue University to take every reasonable precaution to provide a work environment that is free from recognized hazards for its employees in accordance with the General Duty clause of the OSHA Act (Public Law 91-596, Section 5(a)(l)). Purdue University is also required by the OSHA Laboratory Standard to ensure that the necessary work practices, procedures and policies are implemented to protect laboratory employees from all potentially hazardous chemicals in use in their work area.

Purdue University has established the Chemical Management Committee with the responsibility to promote safe and proper chemical management at all Purdue University Campuses and related facilities. The Charter of the University Chemical Management Committee is reprinted in Appendix A of this document.

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APPENDICES

PART I

THE OSHA LABORATORY STANDARD

AND

THE PURDUE CHEMICAL HYGIENE PLAN

THE OSHA LABORATORY STANDARD

The basis for this standard (29 CFR 1910.1450) is a determination by the Occupational Safety and Health Administration (OSHA), after careful review of the complete rule-making record, that laboratories typically differ from industrial operations in their use and handling of hazardous chemicals and that a different approach than that found in OSHA's substance specific health standards is warranted to protect workers. The final standard applies to all laboratories that use hazardous chemicals in accordance with the definitions of laboratory use and laboratory scale provided in the standard. Generally, where this standard applies it supersedes the provisions of all other standards in 29 CFR, part 1910, subpart Z, except in specific instances identified by this standard. For laboratories covered by this standard, the obligation to maintain employee exposures at or below the permissible exposure limits (PELs) specified in 29 CFR, part 1910, subpart Z is retained. However, the manner in which this obligation is achieved will be determined by each employer through the formulation and implementation of a Chemical Hygiene Plan (CHP). The CHP must include the necessary work practices, procedures and policies to ensure that employees are protected from all potentially hazardous chemicals used or stored in their work area. Hazardous chemicals as defined by the final standard include not only chemicals regulated in 29 CFR part 1910, subpart Z, but also any chemical meeting the definition of hazardous chemical with respect to health hazards as defined in OSHA's Hazard Communication Standard, 29 CFR 1910.1200(c).

Among other requirements, the final standard provides for employee training and information, medical consultation and examination, hazard identification, respirator use and record keeping. To the extent possible, the standard allows a large measure of flexibility in compliance methods.

Effective Date: May 1, 1990. Compliance Date: Employers shall have completed an appropriate Chemical Hygiene Plan and commenced carrying out its provisions by January 31, 1991.

EMPLOYEE RIGHTS AND RESPONSIBILITIES

Employees have the right to be informed about the known physical and health hazards of the chemical substances in their work areas and to be properly trained to work safely with these substances.

Employees have the right to file a complaint with IOSHA if they feel they are being exposed to unsafe or unhealthy work conditions. Employees cannot be discharged, suspended, or otherwise discriminated against by their employer because of filing a complaint, or exercising their rights under the law.

Employees have the responsibility to attend training seminars on the Laboratory Standard and Chemical Hygiene Plan and to stay informed about the chemicals used in their work areas. They have the responsibility to use safe work practices and protective equipment required for safe performance of their job. Finally they have the responsibility to inform their supervisors of accidents and conditions or work practices they believe to be a hazard to their health or to the health of others.

HAZARDOUS CHEMICALS

The Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or health hazard.

A chemical is a **physical hazard** if there is scientifically valid evidence that it is a flammable, a combustible liquid, a compressed gas, an explosive, an organic peroxide, an oxidizer, pyrophoric, unstable material (reactive), or water-reactive.

A chemical is a **health hazard** if 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. Included are:

- carcinogens
- reproductive toxins
- sensitizers
- neurotoxins (nerve)
- hepatotoxins (liver)
- agents that act on the hematopoietic system (blood)
- irritants
- corrosives
- radioactive material
- biohazards
- nephrotoxins (kidney)
- agents that damage the lungs, skin, eyes, or mucous membranes

See Appendix I, Glossary, for definitions of these terms.

In most cases, the label will indicate if the chemical is hazardous. Look for key words like **caution, hazardous, toxic, dangerous, corrosive, irritant, carcinogen**, etc. Old containers of hazardous chemicals (before 1985) may not contain hazard warnings.

If you are not sure a chemical you are using is hazardous, review the **Material Safety Data Sheet (MSDS)** or contact your supervisor, instructor, or the Department of Radiological and Environmental Management (REM).

Designated areas must be established and posted for work with certain chemicals and mixtures **(Appendix G)**, which include **select carcinogens**, **reproductive toxins**, and/or substances which have a **high degree of acute toxicity**. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood. Designated area stickers are available from REM.

MATERIAL SAFETY DATA SHEETS (MSDSs)

A Material Safety Data Sheet (MSDS) is a document containing chemical hazard and safe handling information prepared in accordance with the OSHA Hazard Communication Standard. A sample MSDS is included at the end of Part I.

Chemical manufacturers and distributors must provide a MSDS the first time a hazardous chemical/product is shipped to a facility. (Many manufacturers and distributors consider Purdue University the facility.)

Only MSDSs received must be retained and made available to laboratory workers. However, you can request an MSDS for any laboratory chemical from the manufacturer or distributor.

The Department of Radiological and Environmental Management (REM), Civil Engineering Building, Room B173, extension 49-46371, is a central repository for MSDSs. If you want to review an MSDS, contact your supervisor, instructor, or REM. If you need an MSDS for your work area file, contact the chemical supplier or REM.

CHEMICAL INVENTORIES

The OSHA Laboratory Standard does not require chemical inventories; however, it is prudent to adopt this practice. An annual inventory can reduce the number of unknowns and the tendency to stockpile chemicals. The Department of Radiological and Environmental Management may require that a chemical inventory be prepared for a room, work unit, or department.

PURDUE UNIVERSITY CHEMICAL HYGIENE PLAN

This document serves as the written Chemical Hygiene Plan (CHP) for laboratories using chemicals at Purdue University. The CHP is a regular, continuing effort, not a standby or short term activity. Departments, divisions, sections, or other work units engaged in laboratory work whose hazards are not sufficiently covered in this written manual must customize it by adding their own sections as appropriate (e.g. standard operating procedures, emergency procedures, identifying activities requiring prior approval). See Appendix K.

SCOPE AND APPLICATION

The CHP applies to all personnel at Purdue University's West Lafayette Campus and Regional Campuses, University research farms and agricultural center, and related facilities and operations engaged in the laboratory use of hazardous chemicals.

The CHP does not apply to:

1. Uses of hazardous chemicals which do not meet the definition of laboratory use.
2. Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
    a. Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip, and
    b. Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

Laboratory uses of chemicals not covered by the CHP are subject to the full provisions of the OSHA Hazard Communication Standard and the Purdue University Right-to-Know Program. Contact the Department of Radiological and Environmental Management (REM) for additional information.

RESPONSIBILITY

The Purdue University Chemical Management Committee and the Chemical Hygiene Officer will develop the provisions of the CHP.

The Head of the Department of Radiological and Environmental Management (REM) and his or her designee(s) will serve as Chemical Hygiene Officers. The Chemical Management Committee and REM can establish health and safety work rules for work areas or departments.

The Chemical Management Committee and Chemical Hygiene Officer may assign areas of responsibility to departments, department safety and health committees, supervisors, and other individuals, as necessary, to implement and carry out the provisions of the CHP.

Department heads are responsible for

- implementing and maintaining the CHP in their respective work areas,
- and for providing means and motivations to allow all supervisors and employees to comply with occupational safety regulations.

For more efficient implementation of the CHP, department heads should select one or more individuals to serve as coordinators. Department safety and health committees can also assume these responsibilities.

Laboratory supervisors and principal investigators are responsible for chemical hygiene in the laboratory. They must ensure that

- workers know and follow the chemical hygiene rules.
- any necessary Hazard Assessments have been conducted and a written Hazard Assessment certification has been posted in each work area (see Appendix L).
- that PPE and other protective equipment is available and in working order.
- that appropriate information and training have been provided, including all PPE training.
- facilities and training are at all times appropriate and adequate.
- requests for information or action, from their safety committee or REM, are satisfied promptly.

The responsibilities of laboratory supervisors and principal investigators also include

- providing regular, formal chemical hygiene inspections of their facilities and equipment;
- knowing the current legal and University requirements concerning regulated substances;
- customizing their work area Chemical Hygiene Plan in any way necessary to provide for Standard Operating Procedures, Emergency Procedures, and circumstances and/or procedures and/or operations requiring prior approval of the supervisor, if the hazards of their employees' laboratory work are not sufficiently addressed by the non-customized CHP (see Appendix K).

In customizing the work area Chemical Hygiene Plan, it is only permissible for the supervisor to add and clarify the requirements, standard operating procedures, restrictions and necessary protocols, not to omit or relax any which are given in the manual.

Laboratory workers are responsible for planning and conducting each operation in accordance with University chemical hygiene procedures and for developing good personal chemical hygiene habits.

While students are not covered under the provisions of the OSHA Laboratory Standard, students should be made aware of chemical health and safety hazards in classroom situations, and should be provided with information and equipment to protect themselves from those hazards. Departments should provide student training at the beginning of each course in which hazardous chemicals are used. Specific safety instructions should be provided at the beginning of each class period.

EXPOSURE LIMITS

For laboratory uses of hazardous substances, departments must ensure that laboratory employees' exposures to such substances do not exceed either the permissible exposure limits (PELs) specified in 29 CFR 1910, subpart Z, which are set by the Occupational Safety and Health Administration (OSHA), or the Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH), whichever is lower.

EMPLOYEE INFORMATION AND TRAINING

Departments must provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area and the steps they should take to protect themselves from these hazards. Training may take the form of individual instruction, group seminars, audio-visual presentations, handout material, or any combination of the above. However, the training must include the specific hazards associated with the chemicals in the work area when generic training is insufficient (e.g., extremely toxic materials, carcinogens, reproductive hazards) to address specific hazards. A variety of training aids are available from REM.

Such information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignment involving new exposure situations. Employees should receive periodic refresher information and training.

Note: Although the length of training is not specified in the OSHA regulations, effective information and training generally will take at least 2 hours for most laboratory scale operations. The frequency of periodic refresher information and training will vary with the hazard; however, the length of time between training sessions should not exceed five years.

Information. Information provided by departments to employees must include:

1. The contents of the OSHA standard 29 CFR 1910.1450 and its appendices which shall be available to employees (available from REM);
2. The location and availability of the Purdue University Chemical Hygiene Plan (available from REM);
3. The permissible exposure limits for OSHA regulated substances or published exposure limits for other hazardous chemicals where there is no applicable OSHA standard (available from REM);
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on container labels and Material Safety Data Sheets);
5. The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory (see other applicable sections of this document; also available from REM) including, but not limited to, Material Safety Data Sheets received from the supplier.

Training. Training provided by departments to employees must include:

1. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the University, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);
2. The physical and health hazards of chemicals in the work area;
3. The measures employees can take to protect themselves from these hazards, including specific procedures the University or department has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used;
4. The applicable details of the Purdue University Chemical Hygiene Plan.

Documentation. Awareness of the University CHP should be documented using the form on page (i) of this document. Appendix M contains a generic form which may be used to document many different types of safety training. All CHP training records belonging to a department or other administrative unit should be held in a central administrative location (e.g., by Safety Committee Chair or in Department Head or Business Office), organized in any convenient manner provided the training record(s) for an individual, a research group, or department can be made immediately available during an IOSHA inspection.

Basic Lab Safety Awareness Training from REM. REM offers an introductory Basic Lab Safety Awareness Training which is appropriate for laboratory chemical users of all experience levels. Regularly scheduled sessions are offered, and group meetings can be arranged at other times. The overall training consists of (1) self-paced web based training exercises which

address the basics of lab safety, chemical labeling, chemical handling, personal protective equipment, safety information resources, laboratory housekeeping, safety equipment, waste management and disposal, and regulatory compliance, and (2) a 110-minute meeting which goes into detail on the certain topics as are relevant, such as hazards assessments, PPE, compressed gas cylinder safety, and use, care, testing, and maintenance of safety equipment. Departments are encouraged satisfy part of their training and information obligations by requiring their staff to sign up for this training. Contact the REM Industrial Hygiene section or use the web page sign-up form. The REM website can be accessed from http://www.purdue.edu/rem/.

MEDICAL CONSULTATIONS AND EXAMINATIONS

Note: Acute medical care will normally be provided by the Purdue University Student Health Center in accordance with existing University policies and procedures. Requests for special examinations and consultations should be arranged through REM.

Departments must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.
2. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
3. Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for the purpose of determining the need for a medical examination.

All medical examinations and consultations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

HAZARD IDENTIFICATION

With respect to labels and Material Safety Data Sheets:

1. Departments must ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
2. Departments must ensure that laboratory containers of chemicals are labeled where required. Laboratory containers, including bottles, flasks, sample vials, etc., must be marked, labeled, or coded **in all cases**. (If codes or markings other than chemical names are used, a code key or legend must be available in the workplace where it may be found quickly and easily by emergency responders or other interested parties.) Labels should bear a date of receipt and should identify the owner of the material.
3. Departments must maintain any Material Safety Data Sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

Note: REM has an extensive inventory of Material Safety Data Sheets. Material Safety Data Sheets are also available from the supplier. Material Safety Data Sheets for chemicals in use should be maintained in the laboratory.

CHEMICALS DEVELOPED IN THE LABORATORY

The following requirements apply to chemical substances developed in the laboratory:

1. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the principal investigator must determine if it is a hazardous chemical (e.g., by literature search). If the chemical is determined to be hazardous, the principal investigator must provide appropriate training to protect employees.
2. If the chemical produced is a by-product whose composition is not known, the principal investigator must assume that the substance is hazardous and must comply with the requirements of the CHP.
3. If the chemical substance is produced for another user outside of the laboratory, the principal investigator must comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of Material Safety Data Sheets and labeling.

Note: Item 1 does not require the principal investigator to conduct toxicological testing. However, if a Material Safety Data Sheet or hazard information is available for the chemical, the information must be made available to employees.

USE OF RESPIRATORS

Where the use of respirators is necessary to maintain exposure below permissible exposure limits (PELs) or the Threshold Value Limits (TLVs), whichever is lower, the department must provide, at no cost to the employee, the proper respiratory protective equipment. Respirators must be selected and used in accordance with the requirements of the Purdue University Respiratory Protection Program (contact REM for additional information).

STANDARD OPERATING PROCEDURES

The Chemical Management Committee and the Chemical Hygiene Officer will develop generic standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals. Departments, department safety and health committees, and supervisors will develop written standard operating procedures for work area specific operations. Standard operating procedures must be provided to affected employees.

For work involving extremely toxic chemicals, select carcinogens, and reproductive toxins, standard operating procedures must include the following provisions where appropriate:

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

CONTROL MEASURES

Whenever employee exposures exceed the action level (or in the absence of an action level, the lower of the PEL or TLV), the department must implement control measures to reduce

employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices. Exposures to extremely toxic materials, select carcinogens, and reproductive toxins must be maintained as low as reasonably achievable.

PROTECTIVE EQUIPMENT

Users of hazardous chemicals are responsible for determining that fume hoods and other protective equipment are adjusted and functioning properly prior to initiating an activity requiring their use. All fume hood installations include a continuous monitoring device to allow users to monitor hood performance. Physical Facilities will install a continuous monitoring device on existing fume hoods if needed.

REM will survey chemical fume hoods annually and arrange for repairs when necessary. Call REM at the number posted on your hood if you have questions or wish to report a problem.

SPECIAL HAZARDS

The Laboratory Supervisor will define which if any activities, operations, or procedures constitute circumstances under which prior approval must be obtained by employees before implementation.

Note: OSHA requires each employer to identify those activities which the employer believes to be of a sufficiently hazardous nature to warrant prior "employer approval" before implementation. The Chemical Hygiene Plan identifies activities which involve extremely toxic chemicals, select carcinogens and reproductive hazards, and those activities with a high potential for personal injury and property damage. Supervisors will need to determine if any other existing activities are subject to the requirements of this section. Except for activities identified by the Chemical Management Committee as requiring Committee approval, "employer approval" will occur at the local level (e.g., Supervisor, Department Head, Department Safety and Health Committee). The Chemical Hygiene Officer is available for assistance.

AVAILABILITY

The Chemical Hygiene Plan must be readily available to employees and employee representatives.

Note: The Chemical Hygiene Plan is available as pdf or Microsoft Word document:

- http://www.purdue.edu/rem/home/booklets/CHP2010.pdf
- http://www.purdue.edu/rem/home/booklets/CHP2010.docx

ANNUAL REVIEW

REM is responsible for preparing a written annual review of the Chemical Hygiene Plan. The review process will utilize such resources as results of internal and external audits, accident reports, notices of violation, customer satisfaction surveys, and other information and tracking reports which may become available. The focus of the annual review is to evaluate program effectiveness and to identify strengths and weaknesses which may be updated to improve the program. The written annual review will be made available to the Chemical Management Committee for inclusion in the annual report of that Committee.

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MSDS Name: Acetone

Catalog Numbers: A11 1, A11 20, A11 200, A11 4, A11-1, A11-20, A11-200, A11-4, A11S 4, A11S-4, A16P 4, A16P-4, A16S 20, A16S 20 001, A16S 4, A16S-20, A16S-4, A18 1, A18 20, A18 200, A18 200 001, A18 4, A18 500, A18-1, A18-20, A18-200 A18-4, A18-500, A18S 4, A18S-4, A18SK 4, A18SK-4, A18SS 200, A18SS 50, A18SS-115, A18SS-200, A18SS-30, A18SS-50, A19 1, A19 4, A19-1, A19-4, A20-1 A40 4, A40-4, A928 4, A929 4, A929-1, A929-4, A930-4, A946 4, A946-4, A949 1, A949 4, A949-1, A949-4, A949SK-1, A949SK-4, A949SS 115, A949SS 200, A949SS 30, A949SS 50, A949SS-11, A949SS-115, A949SS-20, A949SS-200, A949SS-30, A949SS-50, HC 300 1GAL, S70090, S70091, S70091-1

Synonyms: Dimethylformaldehyde, dimethyl ketone, 2-propanone, pyroacetic acid, pyroacetic ether

Company Identification:

Generic Chemicals
10 Park Avenue
Anywhere Idaho 11111

For information, call: 111-111-1111	Emergency Number: 222-222-2222
For CHEMTREC assistance, call: 800-424-9300	

SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS

CAS#	Chemical Name	%	Einecs#
67-64-1	2-propanone	99	200-662-2

SECTION 3 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Appearance: Colorless, highly volatile liquid with a sweetish odor. Danger! Extremely flammable liquid FP=-4F (-20C). Causes irritation to eyes, skin, and respiratory tract. Causes central nervous system depression. May cause liver and kidney damage. Toxic effects are enhanced by ethanol.

Target Organs: Kidneys, central nervous system, liver, respiratory system.

Potential Health Effects

Eye: Produces irritation, characterized by a burning sensation, redness, tearing, inflammation, and possible corneal injury.

Skin: Exposure may cause irritation characterized by redness, dryness, and inflammation.

Ingestion: May cause irritation of the digestive tract. May cause central nervous system depression, kidney damage, and liver damage. Symptoms may include: headache, excitement, fatigue, nausea, vomiting, stupor, and coma.

Inhalation: Inhalation of high concentrations may cause central nervous system effects characterized by headache, dizziness, unconsciousness and coma. Causes respiratory tract irritation. May cause liver and kidney damage. May cause motor incoordination and speech abnormalities.

Chronic: Prolonged or repeated skin contact may cause dermatitis. Chronic inhalation may cause effects similar to those of acute inhalation.

SECTION 4 - FIRST AID MEASURES

Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately.

Skin: Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.

Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately.

Inhalation: Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician: Treat symptomatically and supportively. No specific antidote exists.

SECTION 5 - FIRE FIGHTING MEASURES

General Information: Containers may build up pressure if exposed to heat and/or fire. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Vapors may travel to a source of ignition and flash back. Use water spray to keep fire-exposed containers cool.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. For large fires, use water spray, fog, or alcohol-resistant foam.
Autoignition Temperature: 33oF (0.56oC)
Flash Point: -4oF (-20.00oC)
Explosion Limits: Lower = 2.5; Upper = 12.8

SECTION 6 - ACCIDENTAL RELEASE MEASURES

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Wear appropriate protective clothing to minimize contact with skin. Remove all sources of ignition.

SECTION 7 - HANDLING and STORAGE

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, sparks or open flames.
Storage: Keep away from sources of ignition. Store in a tightly closed container.

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION

Engineering Controls: Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits.

Exposure Limits

Chemical Name	ACGIH		NIOSH	OSHA final PELs
2-propanone	750 ppm	100 ppm STEL	250 ppm TWA	1000 ppm TWA
	1780 mg/m3	2380 mg/m3 STEL	590 mg/m3 TWA	2400 mg/m3 TWA

OSHA Vacated PELs: 2-propanone: 750 ppm TWA; 1800 mg/m3 TWA; 1000 ppm STEL; 2400 mg/m3 STEL

Personal Protective Equipment
Eyes: Wear chemical goggles and face shield.
Skin: Wear appropriate gloves to prevent skin exposure.
Clothing: Wear polyethylene gloves, apron, and/or clothing.
Respirators: Follow the OSHA respirator regulations found in 29CFR 1010.134. Always use a NIOSH-approved respirator when necessary.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Colorless, highly volatile liquid.
Odor	Sweetish
pH	7
Vapor Pressure	180 mm Hg
Vapor Density	2.0 (Air=1)
Evaporation Rate	7.7 (n-Butyl acetate=1)
Viscosity	Not available

Boiling Point	133.2oF
Freeze/Melt Point	-139.6oF
Decomp Temp	Not available
Solubility	Not available
Specific Gravity	0.79 (Water=1)
Molecular Formula	C3H6O
Molecular Weight	58.0414

SECTION 10 - STABILITY AND REACTIVITY

Chemical Stability: Stable.
Conditions to Avoid: High temperatures, temperatures above 220_C.
Incompatibilities with Other Materials: Forms explosive mixtures with hydrogen peroxide, acetic acid, nitric acid, nitric acid+sulfuric acid, chromic anhydride, chromyl chloride, nitrosyl chloride, hexachloromelamine, nitrosyl perchlorate, nitryl perchlorate, permonosulfuric acid, thiodiglycol+hydrogen peroxide.
Hazardous Decomposition Products: Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

SECTION 11 - TOXICOLOGICAL INFORMATION

RTECS#: CAS# 67-64-1: AL3150000
LD50/LC50: CAS# 67-64-1: Inhalation, rat: LC50 =50100 mg/m3/8H; Oral, mouse: LD50 = 3 gm/kg; Oral, rabbit: LD50 = 5340 mg/kg; Oral, rat: LD50 = 5800 mg/kg; Skin, rabbit: LD50 = 20 gm/kg.
Carcinogenicity: 2-propanone - Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: No information available.
Teratogenicity: No information available.
Reproductive Effects: Fertility: post-implantation mortality. Ihl, mam: TCLo=31500 ug/m3/24H (1-13D preg)
Neurotoxicity: No information available.
Mutagenicity: Cytogenetic analysis: hamster fibroblast, 40 g/L, Sex chromosome loss/non-disjunction: S.cerevisiae, 47600 ppm
Other Studies: None.

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicity: Rainbow trout LC50=5540 mg/L/96H; Sunfish (tap water), death at 14250 ppm/24H; Mosquito fish (turbid water) TLm=13000 ppm/48H
Environmental Fate: Volatilizes, leeches, and biodegrades when released to soil.
Physical/Chemical: No information available.

SECTION 13 - DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: waste number U002 (Ignitable waste)

This material is banned from land disposal according to RCRA.

SECTION 14 - TRANSPORT INFORMATION

US DOT	IMO	IATA	RID/ADR	Canadian TDG
Shipping Name: ACETONE	Shipping Name: ACETONE	Shipping Name: ACETONE	Shipping Name: ACETONE	Shipping Name: ACETONE
Hazard Class: 3	Hazard Class: 3.1	Hazard Class: 3	Dangerous Goods Code: 3(3B)	Hazard Class: 3
UN Number: UN1090	UN Number: 1090	UN Number: 1090	UN Number: 1090	UN Number: UN1090
Packing Group: II	Packing Group: 2	Packing Group: 2		Other Information: FLASHPOINT -20 C

SECTION 15 - REGULATORY INFORMATION

A. Federal

TSCA	CAS# 67-64-1 is listed on the TSCA inventory. None of the chemicals are on the Health & Safety Reporting List. None of the chemicals in this product are under a Chemical Test Rule. None of the chemicals are listed under TSCA Section 12b. None of the chemicals in this material have a SNUR under TSCA.
CERCLA/ SARA	None of the chemicals in this material have an RQ. None of the chemicals in this product have a TPQ. This material contains 2-propanone (CAS# 67-64-1, 99%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
Clean Air Act	This material does not contain any hazardous air pollutants, any Class 1 Ozone depletors, nor any Class 2 Ozone depletors
Clean Water Act	None of the chemicals in this product are listed as Hazardous Substances under the CWA. None of the chemicals in this product are listed as Priority Pollutants under the CWA. None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA	None of the chemicals in this product are considered highly hazardous by OSHA

Exposure Limits: OEL-AUSTRALIA:TWA 500 ppm (1185 mg/m3);STEL 1000 ppm. OEL-AUSTRIA:TWA 750 ppm (1780 mg/m3). OEL-BELGIUM:TWA 750 ppm (1780 mg/m3);STEL 1000 pp. OEL-CZECHOSLOVAKIA:TWA 800 mg/m3;STEL 4000 mg/m3. OEL-DENMARK:TWA 250 ppm (600 mg/m3). OEL-FINLAND:TWA 500 ppm (1200 mg/m3);STEL 625 ppm (1500 mg/m3). OEL-FRANCE:TWA 750 ppm (1800 mg/m3). OEL-GERMANY:TWA 1000 ppm (2400 mg/m3). OEL-HUNGARY:TWA 600 mg/m3;STEL 1200 mg/m3. OEL-INDIA:TWA 750 ppm (1780 mg/m3);STEL 1000 ppm (2375 mg/m3). OEL-JAPAN:TWA 200 ppm (470 mg/m3). OEL-THE NETHERLANDS:TWA 750 ppm (1780 mg/m3) JAN9. OEL-THE PHILIPPINES:TWA 1000 ppm (2400 mg/m3). OEL-POLAND:TWA 200 mg/m3. OEL-RUSSIA:TWA 200 ppm;STEL 200 mg/m3. OEL-SWEDEN:TWA 250 ppm (600 mg/m3);STEL 500 ppm (1200 mg/m3). OEL-SWITZERLAND:TWA 750 ppm (1780 mg/m3). OEL-TURKEY:TWA 1000 ppm (2400 mg/m3). OEL-UNITED KINGDOM:TWA 1000 ppm (2400 mg/m3);STEL 1250 ppm. OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

SECTION 16 - ADDITIONAL INFORMATION

Additional Information: No additional information available. MSDS Creation Date: November 1994. The information above is believed to be accurate and represents the best information currently available. However, no warranty is made of merchantability, or any other warranty, express or implied, with respect to such information, and no liability resulting from its use is assumed. Users must make their own investigations to determine the suitability of the information for their particular purposes

PART II

HAZARDOUS MATERIALS

SAFE HANDLING

INFORMATION

SAFE HANDLING OF CHEMICALS

Know the physical and health hazards associated with the chemical(s) you are using. Consider the physical state (gas, liquid, or solid) of the material(s). Consider the process in which you are using the chemical(s), the facilities you have for storage of the materials, and the facilities and equipment you may need to handle an emergency. Know the procedures necessary for safe disposal of the chemicals.

Questions you should consider:

1. Is the material flammable, explosive, corrosive, or reactive?
2. Is the material toxic, and if so, how can I be exposed to the material (inhalation, skin or eye contact, accidental ingestion, accidental puncture)?
3. What kind of ventilation do I need to protect myself? What kind of personal protective equipment (i.e. gloves, respirator, goggles) do I need to protect myself?
4. Will the process generate other toxic compounds, or could it result in a fire, explosion, etc.?
5. Are my storage facilities appropriate for the type of materials I will be using? Can I properly segregate incompatible materials?
6. What possible accidents can occur and what steps can I take to minimize the likelihood and impact of an accident?
7. What are the proper procedures for disposal of the chemical(s)?

Once you evaluate the potential hazards associated with the chemical(s) and the process, you can design your process and work procedures to minimize or eliminate the hazards.

The following sections provide work procedures and engineering controls which can be used to minimize or eliminate hazards in the laboratory. Additional information on chemical hazards and health hazard control measures can be found in the reference list in Appendix O. If you have any questions about any information in these sections, please contact REM at 49-46371.

GENERAL SAFETY GUIDELINES

Know the hazards associated with the materials you are using. Carefully read the label before using a chemical. Review the Material Safety Data Sheet (MSDS) for any special handling information. In some cases it may be necessary to do additional research. Information provided in this booklet and references listed in Appendix O can help. Contact REM (49-46371) for assistance with the evaluation of hazards associated with a specific material.

Be prepared for hazardous material emergencies and know what action to take in the event of an emergency. Be certain that necessary supplies and equipment are available for handling small spills of hazardous materials.

Know the location of safety equipment: emergency shower, eye wash, fire extinguisher, fire alarm pull station.

Do not work alone in the laboratory if you are working with hazardous materials.

Limit access to areas where chemicals are used or stored by posting signs and/or locking doors when areas are unattended. Do not permit children in the laboratory.

Purchase the minimum amount of hazardous materials necessary to accomplish your work and dispense only the minimum amount necessary for immediate use.

Use hazardous chemicals only as directed and for their intended purpose.

Never smell or taste a hazardous chemical.

Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.

Inspect gloves and all other personal protective equipment before use. On equipment such as hoods and biosafety cabinets, be familiar with the certification date or "to be tested again" date given on the test sticker.

Perchloric acid must be used only in specially-designed perchloric acid fume hoods that have built-in wash down systems to remove shock-sensitive deposits. Before purchasing this acid, laboratory supervisors must arrange for use of an approved perchloric acid hood.

Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres.

Do not store cryogens or dry ice in non-ventilated rooms such as cold rooms.

Inspect equipment or apparatus for damage before adding a hazardous chemical or beginning a hazardous procedure. Do not use damaged equipment.

Glass vacuum lines, pressure lines and Dewar flasks should be taped or caged.

Ensure that ventilation is adequate for the materials used. Refer to the MSDS for information on ventilation requirements, or contact REM. See the "Engineering Controls" section of this booklet.

Avoid direct contact with any chemical. Keep chemicals off hands, face and clothing, including shoes.

Avoid practical jokes or other behavior which might confuse, startle or distract another worker.

Confine long hair and loose clothing. Wear shoes at all times in the laboratory, but do not wear sandals or perforated shoes.

Keep the work area clean and uncluttered with chemicals and equipment. Clean up the work area on completion of an operation or at the end of each work day.

Use required personal protective equipment. See the "Personal Protective Equipment" section of this booklet. Remove laboratory coats immediately on significant contamination.

Label all secondary containers with appropriate hazard information. Make sure that labels on primary and secondary containers do not become damaged. Replace them when necessary.

Use good hygiene. Keep your hands and face clean. Wash thoroughly with soap and water after handling any chemical.

Smoking, drinking, eating, and the application of cosmetics is forbidden in areas where hazardous chemicals are in use.

Do not store food or drink for human consumption, or utensils or equipment for preparing food or drink, in the same cabinet, drawer, refrigerator or freezer with chemicals or equipment used with chemicals.

Never use mouth suction to fill a pipette.

Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container.

Promptly clean up spills, using appropriate protective apparel, equipment and procedures. See the "Emergency Response" section of the booklet.

Ensure that adequate storage facilities and containers are provided for hazardous materials. See the "Chemical Storage" section of this booklet.

Ensure that hazardous materials are properly segregated into compatible categories. See the "Chemical Storage" section of this booklet.

For unattended operations, leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of a utility service failure (e.g., loss of cooling water). Plans to conduct unattended operations should be reviewed with the supervisor, or principal investigator.

For specific information regarding chemical handling, contact your supervisor, instructor, or REM.

ENGINEERING CONTROLS

Exposure to hazardous materials should be controlled to the greatest extent feasible by use of engineering controls. For assistance in determining engineering controls necessary for your work situation, contact REM. Engineering controls to reduce or eliminate exposures to hazardous chemicals include:

- substitution of less hazardous equipment, chemical or process (e.g., safety cans for glass bottles)
- isolation of the operator or the process (e.g., use of barriers when handling explosives, or completely enclosing process in glove box or other enclosure)
- local and general exhaust ventilation (e.g., use of fume hoods)

Ventilation Controls. To determine ventilation requirements, check the MSDS. Expressions on an MSDS such as those listed below indicate a need for ventilation:

- use with adequate ventilation
- use in a fume hood
- avoid vapor inhalation
- provide local exhaust ventilation

Ventilation recommendations must be adapted to the worksite and the specific process. For assistance in determining specific ventilation requirements for your work situation, contact REM.

Proper Use of Ventilation Systems. As a rule of thumb, use a hood or other local ventilation device when working with any volatile substance.

Once a ventilation system is installed in a work area, it must be used properly to be effective. The objective of a local exhaust ventilation system is to draw hazardous materials in the air away from the breathing zone of the employee. The system must be checked prior to each use to determine that it is operating. If the system is not working, it should be posted out of order and the Building Deputy should be contacted to have the system repaired. **Do not work with hazardous materials if the required ventilation system is not working.**

Ventilation systems must be properly configured. Be sure you know how to properly use the system in your area for the work you are doing. For use of laboratory fume hoods, the following guidelines should be followed:

1. Fume hoods should be marked to indicate proper sash position for optimum hood performance. The hood sash should be set at this point for procedures which could generate toxic aerosols, gases or vapors. If it is not possible to do work with the sash height set at the point marked, or if there is no marking on the hood, contact REM. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum air flow dynamics are achieved. Most fume hoods are not intended to be used with the sash fully open.
2. Fume hoods should be equipped with a manometer or other continuous reading monitoring device to indicate adequacy of flow. Learn how to read and interpret this gauge, and check it daily. If the gauge indicates a reduced flow in the hood, post the X out of order and contact the Building Deputy to have the hood repaired.
3. Only apparatus and chemicals essential to the specific procedure or process should be placed in the hood. Extraneous materials from previous experiments or procedures should be removed and stored in a safe location outside the hood. Hoods used for experimental work should not be used for chemical or material storage. Hoods used for chemical storage should be dedicated to chemical storage. No experimental work should be conducted in these hoods.

If there are any questions concerning the adequacy of a fume hood or the procedures for safe use of a fume hood, contact REM.

ADMINISTRATIVE CONTROLS

Administrative controls are procedural measures which can be taken to reduce or eliminate hazards associated with the use of hazardous materials. Administrative controls include the following:

- Careful planning of experiments and procedures with safety in mind. Planning includes the development of written work procedures for safe performance of the work.
- Restricting access to areas in which hazardous materials are used.
- Using signs or placards to identify hazardous areas (designated areas).
- Use of labels on hazardous materials.
- Substitution of less toxic materials for toxic materials.
- Good housekeeping.
- Good hygiene (e.g., washing hands and other areas of possible chemical contact).
- Prohibiting the storage and preparation of food in areas where chemicals are used or stored.
- Prohibiting eating, drinking, and smoking where chemicals are used or stored, and providing break areas for this purpose.
- No mouth pipetting.
- Adding acid (or caustic) to water, never water to acid (or caustic).
- Ensuring that employees are provided adequate training for safe work with hazardous materials.

Restricted access areas. Facilities placarded with any of the following or similar warning signs are to be regarded as restricted access areas:

- CAUTION - BIOHAZARD
- CAUTION - CARCINOGENS, REPRODUCTIVE TOXINS, OR OTHER EXTREMELY TOXIC CHEMICALS
- CAUTION - RADIOACTIVE MATERIAL
- CAUTION - RADIATION AREA
- CAUTION - X-RAY
- CAUTION - LASER

Such areas and are not to be entered except by authorized users of the facility and those having permission from authorized users. Children are never permitted in restricted access areas. (See below for considerations relating to Building Services and other support staff.)

All areas which fit the definition of "laboratory use of hazardous chemicals" (see Glossary, Appendix I), regardless of whether they are or contain restricted access areas, must be posted, on the outside of the primary egress door(s), with:

(1) the name of the faculty or administrative staff member having responsibility for the area and

(2) emergency contact name(s) and telephone number(s) of responsible persons.

A template (non-mandatory) which may be used for displaying this and other important safety information is available as Appendix N.

Custodians are permitted to enter restricted areas to perform routine tasks; however, custodians should not touch containers of chemicals (including waste) or other research equipment or materials.

Other support personnel, such as University Police and Safety and Security personnel, are permitted to enter restricted areas provided the work to be performed does not involve disturbing a use area within the facility, equipment, or materials. Examples include:

- fume hoods
- sinks
- chemical or materials in lab
- biological safety cabinets
- placarded equipment
- benches

Support personnel should contact an authorized user of the facility or REM before performing work which may involve any of the above items.

Immediately notify the University Police (See cover page) of any emergency or unusual conditions such as:

- spills
- contamination
- leaks
- injury
- fires

For additional information concerning restricted access areas, contact your supervisor, instructor or REM.

PERSONAL PROTECTIVE EQUIPMENT

General Considerations. Personal protective devices may be needed to supplement available engineering controls, but are never used as a substitute for engineering controls except as a temporary measure while such controls are being instituted or for short term jobs where the implementation of engineering controls is not feasible.

The MSDS will provide some information on the personal protective equipment recommended for use with the chemical. The MSDS addresses "worst case" conditions; therefore, all the equipment described may not be necessary for a specific job. In addition, the MSDS may not provide sufficient information concerning a specific respirator or type of glove appropriate for the chemical.

Hazards Assessments. The supervisor is responsible for determining which personal protective devices are required for each task performed by employees. This is accomplished by performing a hazards assessment, documenting it on a form such as is shown in Appendix L, and posting the completed hazards assessment certification in the

work area. There is no harm in being over protected, but the minimal requirements are to be spelled out by the hazards assessments.

Departments must provide required personal protective equipment to employees, and supervisors must ensure that employees are trained in all necessary aspects of its proper use and care. This training must be documented. **Failure to prescribe, provide, and properly use required personal protective equipment can result in personal injury and disciplinary action.**

Protection Against Inhalation Hazards. When ventilation is not adequate to provide protection against an inhalation hazard, respiratory protective equipment may be necessary. There is a variety of respiratory protective equipment available for use, but no one device will provide protection against all possible hazards. Respirator selection is based on the chemical and process hazard, and the protection factors required.

Respirators are not to be used except in conjunction with a comprehensive respiratory protection program. Such a program includes a review of the process to ensure that proper equipment is selected for the job; training of all respiratory protective equipment users concerning the methods for proper use and care of such equipment; fitting of respirator users when required; and medical surveillance of respirator users when required.

Types of respiratory protective equipment include:

- particle-removing air-purifying respirators
- gas and vapor-removing air-purifying respirators
- atmosphere-supplying respirators

If your work requires the use of a respirator or you suspect your work requires the use of a respirator, you should contact your supervisor. He/she will contact REM for an evaluation of the exposure and will schedule a medical physical examination to determine that you are physically fit to wear respiratory protection, and respirator fit-testing and training.

Do not use respiratory protective equipment until you have received proper training. If you are currently using a respirator and you have not received training in its use and care, contact REM immediately.

In some cases, respiratory protective equipment may be kept on-hand for an emergency. In this situation, all potential users must receive training in its use. In addition, the equipment must be inspected on a monthly basis and this inspection must be documented. If you have respiratory protective equipment on-hand for use in an emergency and you have not received training in its use and care, contact REM immediately.

For more information on the Purdue University Respiratory Protection Program, contact REM.

Protection of Skin and Body. Skin and body protection involves the use of protective clothing to protect various parts of the body.

Eye and face injuries are prevented by the use of the following:

- safety glasses with side shields for dust and flying object hazards
- splash-proof goggles for chemical splash, spray and mist hazards
- full-face and neck shields for head and neck protection from various hazards (must be used with safety glasses or goggles)

Splash-proof goggles provide superior protection against dust, flying objects, and splash, spray and mist hazards. They should be the first choice for primary eye protection.

Cover all unprotected skin surfaces. Do not wear open-toe shoes, sandals, shorts, etc. in a chemical laboratory.

Even when there is minimal danger of skin contact with a hazardous substance, lab coats, coveralls, aprons, or protective suits should be used. General categories of contaminants include:

- toxic dusts (e.g. asbestos)
- lab chemicals
- bacteriological agents
- radioactive materials

Garments contaminated with hazardous materials should not be taken home by staff for laundering. They should be laundered on-site or by a commercial laundry which has been apprised of potential hazards.

For heavily contaminated work, special attention must be given to sealing all openings in the clothing. Tape can be utilized for this purpose. Caps should be worn to protect hair from contamination.

Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of protective equipment that prevents skin contamination. Impervious protective equipment must be utilized. Examples include:

- rubber gloves
- rubberized suits
- rubber boots
- special protective equipment

Protective garments are not equally effective for every hazardous chemical. Some chemicals will "break through" the garment in a very short time; therefore, garment selection is based on the specific chemical utilized. Examples are provided in Appendix H.

CONTAMINATED CLOTHING AND PROTECTIVE EQUIPMENT

Where splash or spill of hazardous chemicals on clothing or protective equipment occurs, the clothing/equipment should be removed and placed in a closed container which prevents dispersion of the hazardous chemical. The clothing/equipment should be disposed of, cleaned, or laundered as appropriate. Employees should not take contaminated clothing/equipment home for cleaning or laundering. Persons or companies cleaning or laundering contaminated clothing or equipment must be informed of the potentially harmful effects of exposure to the chemical contaminant and must be advised of the measures necessary to protect themselves.

CHEMICAL STORAGE

- Carefully read the label before storing a hazardous chemical. The MSDS will provide any special storage information and incompatibilities.
- Ensure all containers are in good condition and **properly labeled**.
- Do not store unsegregated chemicals in alphabetical order.
- Do not store incompatible chemicals in close proximity to each other.
- Whenever possible, separate chemicals into the following general hazard classes:
    - Flammable/combustible liquids
    - Flammable solids
    - Mineral acids
    - Organic acids (liquid)
    - Caustics
    - Oxidizers
    - Perchloric acid
    - Water-reactive
    - Air-reactive
    - Heat-reactive (require refrigeration)
    - Unstable (shock-sensitive, explosive)
    - Others
    - Gases:
        - toxic
        - flammable
        - oxidizers and inert
- Once separated into hazard classes, chemicals may be stored alphabetically.
- Determine what equipment and space is needed for safe storage of chemicals.
- Except when material is being transferred, keep chemical containers tightly closed.
- Use approved storage cabinets, containers, and safety cans for flammable liquids.
- Refrigerators and freezers used for the storage of chemicals or other laboratory supplies must be posted “No flammables or combustibles” if they have internal sources of ignition.
- Do not store chemicals on refrigerator door shelves. Containers could fall when the door is opened or closed.
- Refrigerators for storage of food (for staff lunches, etc.) must be marked "FOOD ONLY, NO CHEMICALS OR LAB SUPPLIES."
- Do not store food, beverages, or food/beverage preparation supplies or equipment in an area (cabinet, shelf, refrigerator, drawer) that is used for storage of chemicals or equipment used in chemical work.
- Flammable liquids stored in glass containers shall not exceed 1 quart (liter). Exception: For conditions where chemical purity must be protected, flammable liquids stored in glass containers shall not exceed 1 gallon (4 liters).
- Corrosion resistant cabinets are recommended for storage of corrosives.
- Use spill trays under containers of reagents which can cause spill problems.
- Dispose of old chemicals promptly.
- Recycle excess chemicals no longer being used in your area. Contact REM for recycling information.
- Do not store liquids above eye level.
- For more information on chemical storage, contact your supervisor, instructor, or REM.

MODEL WRITTEN STANDARD OPERATING PROCEDURES
SPECIAL PRECAUTIONS FOR WORKING WITH HAZARDOUS CHEMICALS

The Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical hazard or a health hazard. The standard also requires the employer to develop the circumstances under which a particular laboratory operation, procedures or activity shall require prior approval from the employer before implementation. The Laboratory Supervisor will define which if any activities, operations, or procedures constitute circumstances under which prior approval must be obtained by employees before implementation. Except for activities identified by the Chemical Management Committee as requiring Committee approval, employer approval will occur at the local level (e.g., Supervisor, Department Head, Department Safety and Health Committee). The Chemical Hygiene Officer is available for assistance.

The special precautions described in the following sections are to be used in conjunction with the information detailed in the "General Safety Guidelines." The special precautions sections and any other relevant instructions in this Chemical Hygiene Plan Manual may be used as part of the written standard operating procedures required by the OSHA Laboratory Standard. **Project-specific and/or area-specific standard operating procedures must be written and attached at Appendix K by departments, work units, principal investigators, or project directors for hazardous chemical and hazardous operations work not covered by the following special precautions sections.**

PHYSICAL HAZARDS

"Physical hazard" refers to a chemical for which there is evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive. Materials which present a physical hazard can be safely used if the specific hazard(s) are understood, and measures are taken to address the hazards. If appropriate precautions are not taken, a fire, an explosion, unwanted corrosion, personal injury, or property damage could occur.

Certain chemicals cannot be safely mixed or stored with other chemicals because a severe reaction can take place or an extremely toxic reaction product can result. See Appendix B for a table of incompatible chemicals.

An eyewash and safety shower must be readily accessible to areas where injurious materials are used and stored. In the event of skin or eye contact with an injurious material, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Get medical help. Additional information concerning eyewash and safety shower requirements is available from REM.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Flammables and Combustibles:
Flammable/combustible materials are materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. Flammable materials can generate sufficient vapors at temperatures below 100^{O}F (38^{O}C); combustibles, at temperatures at or above 100^{O}F (38^{O}C) and below 140^{O}F (60^{O}C). The vapors of these materials are invisible, and a vapor trail to an ignition source away from the immediate area can result in a flashback. Flammables are more hazardous at elevated temperatures due to more rapid vaporization. In addition, flammable and combustible materials react with oxidizers which can result in a fire. Observe the following special precautions.

1. Eliminate ignition sources such as open flames, smoking materials, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity. Post conspicuous "No Smoking" signs in areas where flammable materials are used or stored.
2. Minimize the quantity kept in the work area.
3. Store in approved flammable liquid containers (safety cans) and storage cabinets, or in a special storage room designed for that purpose. Store away from oxidizers.
4. Flammable liquids stored in glass containers shall not exceed 1 quart. Exception: For conditions where chemical purity must be protected, flammable liquids stored in glass containers shall not exceed 1 gallon.
5. Refrigerators and freezers used for the storage of flammable or combustible liquids must have no internal sources of ignition (lab-safe).
6. Ensure that there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Bonding and grounding must be checked regularly.
7. Ensure that appropriate fire control systems or extinguishers are available.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Corrosives: Corrosives are materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. Acids and bases are corrosives. Observe the following special precautions.

1. Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.
2. Eye protection and rubber gloves should always be used when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.
3. When mixing concentrated acids (caustics) with water, add the acid (caustic) slowly to water. **Never add water to acid (caustic)**.
4. Acids and bases should be stored separately from each other. Organic acids should be stored with flammable materials, separate from oxidizers and oxidizing acids.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Oxidizers: Oxidizers are materials which readily yield oxygen or another oxidizing gas, or that readily react to promote or initiate combustion of flammable/combustible materials. **Oxidation reactions are a frequent cause of chemical accidents.** Observe these precautions to reduce risk when storing or handling oxidizers.

1. Know the reactivity of the materials involved in experiment or process. Make sure that there are no extraneous materials in the area which could become involved in a reaction.
2. If the reaction can be violent or explosive, use shields or other methods for isolating the materials or the process.
3. Use the minimum amounts necessary for the procedure. Do not keep excessive amounts of the material in the vicinity of the process.
4. Store properly, away from organic materials, flammable materials and other reducing agents.
5. Perchloric acid should be used only in specially-designed perchloric acid fume hoods equipped with wash-down systems to prevent deposition of shock-sensitive perchlorates in the ductwork and machinery. Before purchasing perchloric acid, the laboratory supervisor should arrange for use of an approved perchloric acid hood.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Water-Reactive Materials: Materials which react with water to produce a flammable or toxic gas, or other hazardous condition are said to be water-reactive. Fire and explosion are serious concerns when working with these materials. Special precautions for safe handling of water-reactive materials will depend on the specific material, and the conditions of use and storage. Contact REM for information on the safe use of a specific material**.** Examples of water-reactives include alkali and alkaline earth metals (e.g. Li, Na, K, Ca, Mg), metal hydrides, some metal and nonmetal chlorides (e.g. $SiCl_4$, PCl_3, $AlCl_3$), calcium carbide, acid halides and acid anhydrides.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals". If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Pyrophoric Materials: Pyrophoric materials ignite spontaneously upon contact with air. The flame may or may not be visible. Examples include butyllithium, silane, and yellow phosphorous. Store and use all pyrophorics in an inert atmosphere.

Read all available information about work with pyrophorics including but not limited to Aldrich technical bulletins AL-134 (air-sensitive solvents and reagents) and AL-164 (pyrophorics). These will be used as the minimum SOP requirements and additions to operating protocols will be added as found necessary. Additions will be added here to this section and noted in Appendix K.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Peroxidizables: Peroxidizables are substances or mixtures which react with oxygen to form peroxides. Some peroxides can explode with impact, heat, or friction such as that caused by removing a lid. Peroxides form inside the containers of some materials even if they have not been opened. Examples include ethyl ether, tetrahydrofuran, liquid paraffins (alkanes), and olefins (alkenes). See Appendix C for additional materials which may form peroxides. Precautions are given below.

1. Date all peroxidizables upon receipt and upon opening. Unless an inhibitor has been added by the manufacturer, materials should be properly disposed of after 18 months from date of receipt or 3 months from date of opening.
2. Do not open any container having obvious crystal formation around the lid.
3. Other special precautions are similar to those used for flammables.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Light-Sensitive Materials: Light-sensitive materials are unstable with respect to light energy. They tend to degrade in the presence of light, forming new compounds which can be hazardous, or resulting in conditions such as pressure build-up inside a container which may be hazardous. Observe the following precautions.

1. Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.
2. Date containers on receipt and upon opening, and dispose of surplus material after one year if unopened or 6 months if opened.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Shock-Sensitive or Explosive Materials: Shock-sensitive/explosive materials are substances or mixtures which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some materials become increasingly shock-sensitive with age and/or loss of moisture. The inadvertent formation of shock-sensitive/explosive materials such as peroxides, perchlorates, picrates and azides is of great concern in the laboratory. A list of some shock-sensitive materials appears in Appendix D.

1. Contact REM at 49-46371 when work with shock-sensitive or explosive materials is planned or when it is suspected that the inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored has occurred.
2. Date all containers of explosive or shock-sensitive materials upon receipt and when opened. Unless an inhibitor has been added, unopened shock-sensitive materials should be discarded within 12 months after receipt. Open containers of shock-sensitive materials should be discarded within 6 months of the date opened.
3. Use the minimum amount of materials necessary for a procedure. Keep a minimum amount of material on hand.
4. If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Compressed Gases: Special systems are needed for handling materials under pressure. Toxic and corrosive gases present special problems in designing engineering controls. The physical and health hazards of any material are typically compounded by the pressure hazard. Carefully observe special precautions.

1. Always use the smallest size cylinder required to perform the work.
2. Cylinders of compressed gases must be handled as high energy sources.
3. Cylinders on wheeled carts must be capped and secured by an approved cylinder support strap or chain. The cart must be an approved cylinder cart. Do not attempt to take a loaded cylinder cart up or down a stairway.
4. All uncapped cylinders must be secured independently (not ganged behind a single chain) to a solid element of the lab structure. Carts are not acceptable for supporting uncapped or in-use cylinders.
5. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
6. Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder.
7. Always wear goggles or safety glasses with side shields when handling compressed gases.
8. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled. Regulators must be compatible with gas cylinders (do not use adapters).
9. When work with toxic, corrosive, or reactive gases is planned, REM should be contacted for information concerning specific handling requirements for the gas involved. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Cryogens: Some of the hazards associated with cryogens (fluids used to maintain extremely low temperatures) are fire, pressure, embrittlement of materials, and skin or eye burns upon contact with the liquid. Cryogens can condense nearly pure liquid oxygen from the air, creating a severe fire risk. A pressure hazard exists because of the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extreme low temperatures. Brief contact with materials at extreme low temperatures can cause burns similar to thermal burns. Carefully observe all special precautions.

1. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.
2. Mixtures of gases or fluids should be strictly controlled to prevent formation of flammable or explosive mixtures.
3. For flammable cryogens the precautions provided in the "Flammable/Combustible Materials" section of this booklet should be used.
4. Always wear goggles when handling cryogens. If there is a splash or spray hazard, a face shield over the goggles, an impervious apron or coat, cuffless trousers, and fully-covering, non-lacing shoes should be worn. Watches, rings, and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen be spilled. Cryo-gloves or pot holders should also be used. Respirators may be required if the cryogen is toxic and sufficient local exhaust ventilation is not available. Contact REM for exposure monitoring.
5. Containers and systems containing cryogens should have pressure relief mechanisms.
6. Containers and systems should be capable of withstanding extreme cold without becoming brittle. Glass containers should be taped solidly around the outside or encased in plastic mesh.
7. Funnels should not be used for pouring liquid nitrogen or any other cryogen.
8. Large mobile Dewars or LN2 refrigerators (or the trolleys carrying these) used for transporting cryogens within a building or between buildings should be equipped with a braking mechanism.
9. Large mobile Dewars at risk for tipping should be transported on appropriate carts. Wheeled trolleys may not be used if the vessel must pass over elevator thresholds or other slots/crevasses wider than 25% of the wheel width.
10. Dispensing stations designed to allow research staff to fill smaller vessels from a larger self-pressurizing Dewar must be located in non-public areas, and should be posted with standard operating procedures.
11. Smaller vessels of liquid nitrogen or other cryogens transported by hand within or between buildings must have a handle or bail, and must be covered.

HEALTH HAZARDS

"Health hazard" refers to chemicals 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. This term includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. For a detailed discussion of industrial toxicology and information on health hazards associated with specific chemicals, refer to Appendix E.

For many toxic materials, hygienic standards have been established and action must be taken to prevent personnel from receiving exposures in excess of these standards. These standards may be referred to as threshold limit values (TLVs) or permissible exposure limits (PELs). For specific information on the terms TLV or PEL, refer to the glossary in Appendix I.

The MSDS will list the hygienic standard for the hazardous chemical or each component of a mixture. In addition, REM has a complete listing of published TLVs and PELs and other works concerning the subject of industrial toxicology. If you would like to conduct a more thorough review of a particular compound, or if you would like an evaluation of the exposure to a specific material used in your work area, contact REM.

Protection from health hazards is provided by ensuring that exposure to such hazards is minimized or eliminated. To minimize the exposure, it is necessary to determine the route by which the exposure may occur, i.e. inhalation, skin contact, puncture, ingestion, or a combination of exposure routes.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Allergens: The term allergens describes a wide variety of substances that can produce skin and lung hypersensitivity. Examples include diazomethane, chromium, nickel bichromates, formaldehyde, isocyanates, and certain phenols. Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity. Conduct aerosol producing procedures in a fume hood.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Embryotoxins and Reproductive Toxins: Substances that act during pregnancy to cause adverse effects on the fetus are referred to as embryotoxins. These effects include embryolethality (death of the fertilized egg, the embryo, or the fetus), malformation (teratologic effects), retard growth, and postnatal functional deficits. Examples include organo-mercurials, lead compounds, and formamide. Because the period of greatest susceptibility to embryotoxins is the first 8-12 weeks of pregnancy, which includes a period when a woman may not know she is pregnant, women of child-bearing potential should take care to avoid skin contact with all chemicals. The term "reproductive toxins" is used to describe substances which cause harmful effects on the male or female reproductive system or the developing embryo and fetus. These effects include but are not limited to menstrual irregularity, lowered fertility, testicular atrophy, and birth defects.

1. Review each use of embryotoxins with the research supervisor and REM. Review continuing uses annually or whenever a procedural change is made.
2. Label embryotoxins as follows: EMBRYOTOXIN: READ SPECIFIC PROCEDURES FOR USE.
3. Store embryotoxins and reproductive toxins in unbreakable containers or unbreakable secondary containers in a well ventilated area.
4. Guard against spills and splashes. Appropriate safety apparel, especially gloves, should be worn. All hoods, glove boxes, or other essential engineering controls should be known to be operating properly before work is started.
5. Notify your supervisor and REM of all incidents of exposure or spills. REM will arrange for a medical consultation.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Chemicals of Moderate Chronic or High Acute Toxicity: See Appendix E of this manual for definition and discussion of the meanings of chronic and acute toxicity. Examples of chemicals of moderate chronic toxicity or high acute toxicity include diisopropylfluorophosphate, hydrofluoric acid, and hydrogen cyanide, and carbon monoxide.

1. Consult one of the standard compilations that list toxic properties of known substances and learn what is known about the substance that will be used. Follow the specific precautions and procedures for the chemical.
2. Use and store these substances only in designated (restricted access) areas placarded with appropriate warning signs.
3. Use a hood or other containment device for procedures which may result in the generation of aerosols or vapors; trap released vapors to prevent their discharge with fume hood exhaust.
4. Avoid skin contact by use of gloves and long sleeves and other protective apparel as appropriate.
5. Maintain records of the amounts of materials on hand, amounts used, and the names of the workers involved.
6. Be prepared for accidents and spills. At least two people should be present at all times if compounds in use are highly toxic or of unknown toxicity.
7. Store breakable containers in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.
8. If a major spill occurs outside the hood, evacuate the area and call for assistance (See cover page).
9. Thoroughly decontaminate or dispose of contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion to a less toxic product.
10. Store contaminated waste in closed, suitably labeled, impervious containers.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Working with Chemicals of High Chronic Toxicity: See Appendix E of this manual for definition and discussion of the meanings of chronic and acute toxicity. Examples of chemicals exhibiting high chronic toxicity include dimethylmercury, nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, and other human carcinogens or substances with high carcinogenic potency in animals.

1. Conduct all transfers and work in designated (restricted access) areas: a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all persons with access are aware of the substances being used and necessary precautions.
2. Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood..
3. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed there.
4. On leaving the area, remove protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.
5. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. DO NOT DRY SWEEP SPILLED POWDERS.
6. If using toxicologically significant quantities of a substance on a regular basis (in quantities above a few milligrams to a few grams, depending on the substance, 3 or more times per week), contact REM. REM will arrange for a medical consultation, if appropriate.
7. Keep accurate records of the amounts of these substances stored and used, the dates of use, and names of users.
8. The designated area must be conspicuously marked with warning and restricted access signs and all containers should be appropriately labeled with identity and warning labels (e.g., CANCER-SUSPECT AGENT).
9. Ensure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available.
10. For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and at a pressure of at least 0.5 inches of water gauge. For a positive pressure glove box, thoroughly test for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into a fume hood.
11. Use chemical decontamination whenever possible; ensure that containers of contaminated wasted are transferred from the designated area under the supervision of authorized personnel.

MODEL WRITTEN SOP -- The OSHA Laboratory Standard explicitly requires "standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals." If the model SOPs in this "Special Precautions" section do not fulfill this requirement, you must amend and append in some manner so as to comply.

Special Precautions for Animal Work with Chemicals of High Chronic Toxicity: See Appendix E of this manual for definition and discussion of the meanings of chronic and acute toxicity.

1. For large scale studies, special facilities with restricted access are preferable.
2. When possible, administer the substance by injection or lavage instead of in diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed through HEPA filters prior to discharge.
3. Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning; moisten contaminated bedding before removal from the cage; mix diets in closed containers in a hood).
4. When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator).
5. Dispose of contaminated animal tissues and excreta using approved methods.

Standard Operating Procedure

Trichloroacetic Acid

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	10/7/2014
Date SOP was approved by PI/lab supervisor:	10/7/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-796-7005
Location(s) covered by this SOP:	Brown 3144/3144A (Building/Room Number)

Section 2 – Type of SOP:

☐ Process ☒Hazardous Chemical ☐ Hazardous Class

Section 3 – Physical / Chemical Properties

Physical / Chemical Properties:

CAS#: 76-03-9

GHS Classification: Causes severe skin burns and eye damage. Suspected of damaging fertility or the unborn child

Chemical formula: $C_2HO_2Cl_3$

Form (physical state): hygroscopic solid

Color: Colorless/white

Boiling Point: 385 °C

Flash Point: >230 °C

Density: not applicable

Section 4 – Potential Hazards

Trichloroacetic acid causes severe skin and eye burns. Suspected of damaging fertility or the unborn child. Very toxic to aquatic life with long lasting effects. May be corrosive to metals.

Exposure Limits:

2 ppm

Section 5 – Personal Protective Equipment (PPE)

Safety Glasses:

Safety glasses must be worn at all times when working with trichloroacetic acid.

Skin and body protection:

Lab coats at all times when working strong acids. Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants and close-toed shoes.

Hand Protection:

Gloves must be worn. Use proper glove removal technique to avoid any skin contact. Check the resources below for a suitable glove.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with trichloroacetic acid.

Refer to glove selection chart from the links below:

http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

OR

http://www.showabestglove.com/site/default.aspx

OR

http://www.mapaglove.com/

Hygiene Measures:

Trichloroacetic acid waste must be labeled with contents and stored appropriately for pick-up and disposal by REM.

Section 6 – Engineering Controls

Trichloroacetic acid should only be weighed out in the fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 85 – 125 feet per minute.

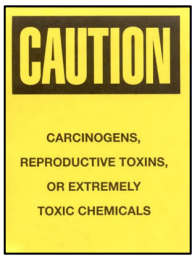
Section 7 – First Aid Procedures

If inhaled:

Supply fresh air. Keep victim at rest in a position comfortable for breathing. Immediate medical attention is required.

In case of skin contact:

Remove all contaminated clothing. Immediately wash with water and soap for at least 15 minutes. Seek medical attention if necessary.



In case of eye contact:

Check for and remove any contact lenses. Rinse cautiously with water for several minutes. Immediate medical attention is required.

If swallowed:

Rinse mouth. Do not induce vomiting; immediately call for medical help.

Section 8 – Special Handling and Storage Requirements

- Trichloroacetic acid is stored in a designated secondary container in BRWN 3144. Handle chemical in hood only.
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Section 9 – Spill and Accident Procedures

Chemical Spill

If the spill is minor, clean up with chemical spill kit and collect waste in designated container. For more information, contact REM at 49-40121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance.

Chemical Spill on Body or Clothes:

Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Clothes must be washed prior to wearing. Seek medical attention if necessary.

Chemical Splash into Eyes:

Immediately rinse eyes and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention immediately.

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

Label Waste:

Make sure the waste container(s) is properly labeled; label should indicate all of the contents of the container. REM provides hazardous waste labels free of charge, call 49-40121 to obtain labels.

Store Waste:

Store hazardous waste in closed containers, and in a designated area.

Dispose of Waste:

Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM. Call REM at 49-40121 or visit the REM webpage for questions. (http://www.purdue.edu/rem/hmm/wststo.htm)

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for trichloroacetic acid must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure

Trichloroacetic acid is located in a secondary container in a cabinet below the hood in BRWN 3144. Work with solid trichloroacetic acid must be conducted within the hood. conducted within the hood. Appropriate PPE should be worn at all times.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training **(signature of all users is required)**

- Prior to conducting any work with strong acids, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date

Name	Signature	Date

Standard Operating Procedure

30 % Acrylamide/Bis Solution

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	10/7/2014
Date SOP was approved by PI/lab supervisor:	10/7/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-796-7005
Location(s) covered by this SOP:	Brown 3144/3144A (Building/Room Number)

Section 2 – Type of SOP:

☐ Process ☒Hazardous Chemical ☐ Hazardous Class

Section 3 – Physical / Chemical Properties

Physical / Chemical Properties:

CAS#: 79-06-1

GHS Classification: Acute toxicity (oral and inhalation); Skin and eye irritation; Carcinogenicity; Reproductive toxicity; Specific target organ toxicity – single exposure: central nervous system

Form (physical state): Liquid

Color: Colorless

Boiling Point: not determined

Flash Point: not determined

Density: 1.00 g/cm^3 at 20^{o}C

Section 4 – Potential Hazards

Acrylamide/Bisacrylamide is a carcinogen. Harmful if swallowed. Causes skin irritation. Causes serious eye irritation. Causes damage to the central nervous system. Suspected of causing cancer. Suspected of damaging the unborn child and fertility. May cause damage through prolonged or repeated exposure.

Exposure Limits:

OSHA PEL (8 HR. TWA):		2 ppm
OSHA Short Term Exposure Limit:	2 ppm	
ACGIH TLV/TWA:		10 ppm

Section 5 – Personal Protective Equipment (PPE)

Safety Glasses:

Safety glasses must be worn at all times when working with liquid 30% acrylamide/bisacrylamide.

Skin and body protection:

Lab coats at all times when working with liquid 30% acrylamide/bisacrylamide.. Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants, or equivalent, and close-toed shoes.

Hand Protection:

Gloves must be worn. Use proper glove removal technique to avoid any skin contact. Nitrile and latex disposable gloves are NOT suitable. Polyvinyl Acetate, Viton, or fluorinated rubber gloves are recommended. Check the resources below for a more suitable glove.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with acrylamide.

Refer to glove selection chart from the links below:

http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

OR

http://www.showabestglove.com/site/default.aspx

OR

http://www.mapaglove.com/

Hygiene Measures:

All waste containing liquid acrylamide must be packaged separately for disposal.

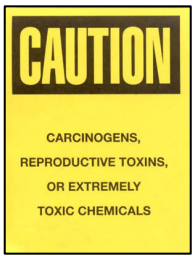
Section 6 – Engineering Controls

Section 7 – First Aid Procedures

Immediately remove any clothing soiled by the product. Symptoms of poisoning may even occur after several hours; therefore medical observation for at least 48 hours after the accident.

If inhaled:

Supply fresh air and to be sure call for a doctor. In case of irregular breathing or respiratory arrest provide artificial respiration.



In case of skin contact:

Immediately wash with water and soap and rinse thoroughly.

In case of eye contact:

Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes. If symptoms persist, consult a doctor.

If swallowed:

Do not induce vomiting; immediately call for medical help. **Information for doctor · Most important symptoms and effects, both acute and delayed Breathing difficulty.**

Section 8 – Special Handling and Storage Requirements

- 30% acrylamide must be stored in a 4C refrigerator when not in use. It may be left on the benchtop when actively used. A designated work area is provided in BRWN 3144A.
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Section 9 – Spill and Accident Procedures

Chemical Spill

If the spill is minor, clean up with chemical spill kit and collect waste in designated container. For more information, contact REM at 49-40121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance. **Chemical Spill on Body or Clothes:**

Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes.

Chemical Splash into Eyes:

Immediately rinse eyes and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. If symptoms persist, see physician.

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

Label Waste:

Make sure the waste container(s) is properly labeled; label should indicate all of the contents of the container. REM provides hazardous waste labels free of charge, call 49-40121 to obtain labels.

Store Waste:

Store hazardous waste in closed containers, and in a designated area.

Dispose of Waste:

Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM. Call REM at 49-40121 or visit the REM webpage for questions. (http://www.purdue.edu/rem/hmm/wststo.htm)

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for acrylamide must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure

Acrylamide is located in the refrigerator in BRWN 3144A. All work with the chemical must be conducted within the on the designated bench in BRWN3144A. Appropriate PPE should be worn at all times.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training **(signature of all users is required)**

- Prior to conducting any work with acrylamide, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date

Name	Signature	Date

Standard Operating Procedure

Strong Acids

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	10/7/2014
Date SOP was approved by PI/lab supervisor:	10/7/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-796-7005
Location(s) covered by this SOP:	Brown 3144/3144A (Building/Room Number)

Section 2 – Type of SOP:

☐ Process ☒Hazardous Chemical ☐ Hazardous Class

Section 3 – Physical / Chemical Properties

Physical / Chemical Properties:

CAS#: Glacial acetic acid 64-19-7, hydrochloric acid 7647-01-0

GHS Classification: Cause severe skin burns and eye damage; May be harmful if swallowed, harmful in contact with skin, may cause allergic skin reactions, toxic if inhaled, harmful to aquatic life; May cause organ damage.

Chemical formula: acetic acid $C_2H_4O_2$; hydrochloric acid HCl

Form (physical state): Liquid

Color: Colorless

Boiling Point: acetic acid 117°C, hydrochloric acid 110 °C

Flash Point: 40 °C for acetic acid, not applicable for hydrochloric acid

Density: acetic acid 1.00 g/cm^3 at 25 ^{o}C; hydrochloric acid 1.20 g/cm^3

Section 4 – Potential Hazards

Glacial acetic acid and hydrochloric acid are harmful if inhaled or swallowed. They cause serious skin irritation if swallowed. They cause severe eye irritation and burns. can cause serious skin and eye burns

Exposure Limits:

Acetic acid – 10 ppm
Hydrochloric acid – 2ppm

Section 5 – Personal Protective Equipment (PPE)

Safety Glasses:

Safety glasses must be worn at all times when working with glacial acetic acid or hydrochloric acid.

Skin and body protection:

Lab coats at all times when working strong acids. Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants, or equivalent, and close-toed shoes.

Hand Protection:

Gloves must be worn. Use proper glove removal technique to avoid any skin contact. Check the resources below for a suitable glove.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with strong acids.

Refer to glove selection chart from the links below:

http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

OR

http://www.showabestglove.com/site/default.aspx

OR

http://www.mapaglove.com/

Hygiene Measures:

Strong acid waste must be labeled with contents and stored appropriately for pick-up and disposal by REM.

Section 6 – Engineering Controls

Strong acids should be used only in the fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 85 – 125 feet per minute.

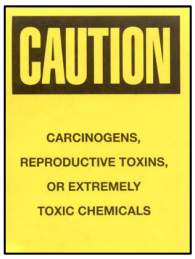
Section 7 – First Aid Procedures

If inhaled:

Supply fresh air. If breathing is difficult supply oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.

In case of skin contact:

Immediately wash with water and soap for at least 15 minutes. Immediate medical attention is required.



In case of eye contact:

Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes. Immediate medical attention is required

If swallowed:

Do not induce vomiting; immediately call for medical help.

Section 8 – Special Handling and Storage Requirements

- Strong acids must be stored in designated secondary containers. Glacial acetic acid is stored in a secondary container in the flammable cabinet in BRWN 3144. Hydrochloric acid is stored in a secondary container in BRWN3144. Handle chemicals in hood only.
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Section 9 – Spill and Accident Procedures

Chemical Spill

If the spill is minor, clean up with chemical spill kit and collect waste in designated container. For more information, contact REM at 49-40121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance. **Chemical Spill on Body or Clothes:**

Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention immediately.

Chemical Splash into Eyes:

Immediately rinse eyes and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention immediately.

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

Label Waste:

Make sure the waste container(s) is properly labeled; label should indicate all of the contents of the container. REM provides hazardous waste labels free of charge, call 49-40121 to obtain labels.

Store Waste:

Store hazardous waste in closed containers, and in a designated area.

Dispose of Waste:

Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM. Call REM at 49-40121 or visit the REM webpage for questions. (http://www.purdue.edu/rem/hmm/wststo.htm)

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for glacial acetic acid and hydrochloric acid must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure

Glacial acetic acid is located in a secondary container in the flammable cabinet storage in BRWN 3144. Hydrochloric acid is located in a secondary container in a cabinet below the hood in BRWN 3144. As much work as possible with the chemicals should be conducted within the hood. Appropriate PPE should be worn at all times.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training **(signature of all users is required)**

- Prior to conducting any work with strong acids, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date

Name	Signature	Date

Standard Operating Procedure

Strong Bases

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	10/7/2014
Date SOP was approved by PI/lab supervisor:	10/7/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-796-7005
Location(s) covered by this SOP:	Brown 3144/3144A (Building/Room Number)

Section 2 – Type of SOP:

☐ Process ☒Hazardous Chemical ☐ Hazardous Class

Section 3 – Physical / Chemical Properties

Physical / Chemical Properties:

CAS#: sodium hydroxide 1310-73-2

GHS Classification: Cause severe skin burns and eye damage; Harmful if swallowed, Harmful if in contact with skin, harmful if inhaled. May cause organ damage.

Chemical formula: NaOH

Form (physical state): solid pellet

Color: white

Boiling Point: 1390 °C

Flash Point: not applicable

Density: not applicable

Section 4 – Potential Hazards

Sodium hydroxide is harmful if inhaled or swallowed. Causes severe eye irritation and burns. Can cause skin dermatitis upon prolonged contact.

Exposure Limits:

Sodium hydroxide 2mg/m^3

Section 5 – Personal Protective Equipment (PPE)

Safety Glasses:

Safety glasses must be worn at all times when working sodium hydroxide.

Skin and body protection:

Lab coats at all times when working strong bases. Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants, or equivalent, and close-toed shoes.

Hand Protection:

Gloves must be worn. Use proper glove removal technique to avoid any skin contact. Check the resources below for a suitable glove.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with chloroform.

Refer to glove selection chart from the links below:

http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

OR

http://www.showabestglove.com/site/default.aspx

OR

http://www.mapaglove.com/

Hygiene Measures:

Strong base waste must be labeled with contents and stored appropriately for pick-up and disposal by REM.

Section 6 – Engineering Controls

Strong acids should be used only in the fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 85 – 125 feet per minute.

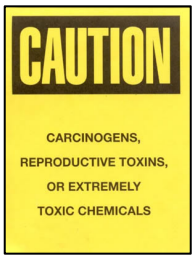
Section 7 – First Aid Procedures

If inhaled:

Move to fresh air. IF breathing is difficult, provide oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.

In case of skin contact:

Wash of immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.



In case of eye contact:

Check for and remove any contact lenses. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

If swallowed:

Do not induce vomiting; immediately call for medical help.

Section 8 – Special Handling and Storage Requirements

- Strong bases are stored in BRWN 3144.
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Section 9 – Spill and Accident Procedures

Chemical Spill

If the spill is minor, clean up with chemical spill kit and collect waste in designated container. For more information, contact REM at 49-40121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance. **Chemical Spill on Body or Clothes:**

Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention immediately.

Chemical Splash into Eyes:

Immediately rinse eyes and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention immediately.

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

Label Waste:

Make sure the waste container(s) is properly labeled; label should indicate all of the contents of the container. REM provides hazardous waste labels free of charge, call 49-40121 to obtain labels.

Store Waste:

Store hazardous waste in closed containers, and in a designated area.

Dispose of Waste:

Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM. Call REM at 49-40121 or visit the REM webpage for questions. (http://www.purdue.edu/rem/hmm/wststo.htm)

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for sodium hydroxide must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure

Sodium hydroxide pellets are stored in BRWN 3144. Appropriate PPE should be worn at all times.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training **(signature of all users is required)**

- Prior to conducting any work with sodium hydroxide, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date

Name	Signature	Date

Standard Operating Procedure

Liquid Nitrogen

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	9/12/2014
Date SOP was approved by PI/lab supervisor:	9/12/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-795-7005
Location(s) covered by this SOP:	BRWN 3144/3144A

Section 2 – Type of SOP:

☐ Process ☒Hazardous Chemical ☐ Hazardous Class

Section 3 – Physical / Chemical Properties and Uses

Physical / Chemical Properties:

CAS#: 7727-37-9

GHS Classification: Gas under pressure, cryogenic liquid

Molecular Formula: N_2

Form (physical state): Liquid

Boiling Point: -196°C (-320°F)

Relative Vapor Density: 0.97 (air = 1)

Section 4 – Potential Hazards

Liquid nitrogen is a cryogenic liquid that may cause severe frostbite or eye damage upon contact. Extremely cold liquid and gas under pressure. Expands by a factor of 700 upon vaporization. Can cause rapid suffocation due to displacement of oxygen. Avoid breathing gas. Substances may become brittle upon contact and shatter.

May cause an explosion of a sealed container. Symptoms to exposure included frostbite, dizziness, salivation, nausea, vomiting, or loss of mobility and/or consciousness.

Section 5 – Personal Protective Equipment (PPE)

For quantities less than 100 mL, safety glasses, lab gloves, long pants, and close-toe shoes are adequate (Figure 1). For intermediate quantities (100 mL – 1 L), also use splash goggles, face shield, and cryogenic gloves (Figure 2). For quantities greater than 1 L or filling a secondary Dewar, a cryogenic apron should be used in addition to the general use intermediate requirements (Figure 3).

Figure 1 – Small quantity PPE requirements

Figure 2 – Intermediate quantity PPE requirements

Figure 3 – Large quantity PPE requirements

Section 6 – Engineering Controls

Liquid nitrogen must only be used in a well-ventilated area or in a properly functioning chemical fume hood whenever possible. Liquid nitrogen should never be used in a poorly ventilated enclosed area where oxygen displacement is a possibility.

Section 7 – Liquid Nitrogen Containers

Vacuum Insulated Containers:

Vacuum insulated containers are used for storing and dispensing liquid nitrogen. They are either sealed (capable of holding 20 psig – 240 psig with pressure relief valve) or ambient pressure (covered loosely with a cap, cork, or stopper and are referred to as Dewars (due'-werz). There are two primary types of Dewars, benchtop and large Dewars. Benchtop Dewars (Figure 4) are typically for small-scale laboratory use and the lid is the only pressure-relief device. Large Dewars (Figure 5) are typically used for storage of lab samples, movement of samples between campus locations, or to fill other secondary containers. Large Dewars may have

a secure seal and pressure relief vent. Liquid nitrogen exposure is a risk when handling Dewars. Therefore, the PPE illustrated in Figure 2 should be worn when working with a Dewar.

Figure 4 – Benchtop Dewar

Figure 5 – Large Dewar

Cryogenic Tubes:

Cryogenic tubes are typically used for storage samples, movement of samples between campus locations, or for shipments off campus for collaborative research (Figure 6). There is no pressure-relief device on a cryogenic tube other than the lid. Consequently, cryogenic tubes can explode without warning. Explosions are likely caused by trapped nitrogen expanding inside of the tube during the thawing process. As the temperature increases, the tube may become over-pressurized and explode and may result in serious injuries. Because of this risk, the PPE illustrated in Figure 2 should be worn when directly handling a sealed cryogenic tube.

Figure 6 – Cryo

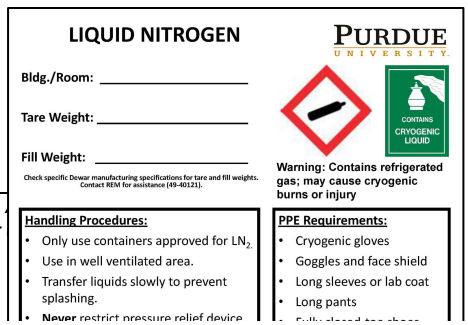
Self-Pressurizing Tanks

Self-pressurizing tanks (Figure 7) are generally a 140 – 260 L double wall, stainless steel tank used to fill other liquid nitrogen containers such as Dewars. These tanks are equipped with pressure relief valves and a backup rupture disk. A loud hissing sound is commonly heard when the pressure relief valve opens. Exposure to liquid nitrogen can occur when connecting and disconnecting equipment, during the filling process, from a leaking valve, or from condensate ice buildup on valves and hoses. Because of these risks, the PPE illustrated in Figure 3 should always be worn when working with a self-pressurized tank.

Figure 7 – Self-Pressurizing Tank

Section 8 – General Safe Handling Practices and Storage Requirements

- Only trained personnel should work with liquid nitrogen.
- Use only in well ventilated and low traffic areas.
- Caution signs should be posted in the area warning others that liquid nitrogen is being stored and used.
- Always wear the appropriate PPE.
- Liquid nitrogen should only be stored in approved containers.
- All liquid nitrogen containers must be labeled. Large containers (e.g., Dewars, Self-Pressurizing Tanks) must be labeled with the REM-provided label illustrated in Figure 8. Smaller containers such as cryogenic tubes should be labeled "Liquid Nitrogen, Cryogenic Hazard" or with similar words that convey the hazards.
- Avoid breathing liquid nitrogen vapors.
- Carry containers away from body and face.
- Never drop a liquid nitrogen container. Damage to a container may result in over-pressurization or container failure.
- Dewars more than 100 pounds require two people to move safely.
- Always use a specially designed cylinder cart to transport liquid nitrogen containers that are too heavy to be hand carried.
- Use the freight elevator whenever possible.



- Do not leave open containers unattended.
- Liquid nitrogen containers should be stored in cool, dry, and well ventilated areas.
- Do not store in a cold room or other controlled environment without air supply.
- Liquid nitrogen containers should be stored out of direct sunlight.

Figure 8 – Liquid Nitrogen Label

Section 9 – Spill and Accident Procedures

In the event of a large liquid nitrogen spill or release, immediately evacuate the area and ensure others are aware of the spill. Remember that frostbite and asphyxiation are the primary hazards so ensure people are protected from these hazards. If there is an imminent threat, pull the nearest fire alarm station to evacuate the building and **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance (**dial 911** if spill occurs after hours and assistance is needed).

Section 7 – First Aid Procedures

If inhaled:

Over exposure of liquid nitrogen may cause rapid suffocation due to displacement of oxygen. With asphyxiation, unconsciousness may happen without warning. If person becomes dizzy, move them to a well-ventilated area and seek immediate medical attention (**dial 911**).

In case of skin contact:

Skin contact with liquid nitrogen may cause severe cold burns and frostbite. Flesh freezes very rapidly and may be torn when attempting to be withdrawn from object. If frostbite or freezing occurs, the following steps should be taken:

1. Flush the area thoroughly with tepid water. Do not apply heat or rub the affected area.
2. Protect the area with bulky, dry, and sterile dressings.
3. Seek immediate medical attention (**dial 911**).

In case of eye contact:

Eye exposure to liquid nitrogen can cause permanent and irreversible damage. Delicate eye tissue can be damaged by exposure to the cold gas alone. If liquid nitrogen is splashed into the eyes, the following steps should be taken, flush the eyes with water for 15 minutes and seek immediate medical attention (**dial 911**).

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

There is typically no waste generation involved with the use of liquid nitrogen. However, if waste disposal questions arise please contact the REM Hazardous Materials Management Section at 49-40121.

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for liquid nitrogen must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure (Additional lab protocol may be added here)

Proper PPE must be used when working with liquid nitrogen. Used or ice-contaminated liquid nitrogen should be poured into a rubber ice bucket or Styrofoam container to boil off.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training (signature of all users is required)

- Prior to conducting any work with liquid nitrogen, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date

Standard Operating Procedure

Compressed Gases

This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and
3) SOP has been signed and dated by the PI and relevant lab personnel.

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	9/12/2014
Date SOP was approved by PI/lab supervisor:	9/12/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-796-7005
Location(s) covered by this SOP:	BRWN 3144/3144A

Section 2 – Type of SOP:

☐ Process ☐Hazardous Chemical ☒ Hazardous Class

Section 3 – Physical / Chemical Properties and Uses

Physical / Chemical Properties:

CAS#: N/A

GHS Classification: Gases under pressure, compressed gas (depending on the type of compressed gas, other hazards such as toxicity and/or flammability often apply as well)

Molecular Formula: N/A

Form (physical state): Gas

Color: N/A

Boiling Point: N/A

Flash Point: N/A

Lower Explosive Limit: N/A

Upper Explosive Limit: N/A

Relative Vapor Density: N/A

Section 4 – Potential Hazards

Contains gas under pressure; may explode if heated. Protect from sunlight. Gases may displace oxygen and present an asphyxiation hazard. Many gases present other hazards; make sure that all of the potential hazards are understood before handling any chemical.

Section 5 – Personal Protective Equipment (PPE)

Respirator Protection:

If compressed gases are being used outside of a chemical fume hood, respiratory protection may be required. If this activity is absolutely necessary, contact REM so a respiratory protection analysis can be performed. Respirators should be used under any of the following circumstances:

- As a last line of defense (i.e., after engineering and administrative controls have been exhausted).
- When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded.
- Regulations require the use of a respirator.
- An employer requires the use of a respirator.
- There is potential for harmful exposure due to an atmospheric contaminant (in the absence of PEL)
- As PPE in the event of a chemical spill clean-up process

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested by REM. This is a regulatory requirement. (http://www.purdue.edu/rem/home/booklets/RPP98.pdf)

Hand Protection:

Gloves must be worn. Use proper glove removal technique to avoid any skin contact. Nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific flammable or combustible liquids being used.

Refer to glove selection chart from the links below:

http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

OR

http://www.showabestglove.com/site/default.aspx

OR

http://www.mapaglove.com/

Eye Protection:

ANSI approved properly fitting safety glasses or chemical splash goggles are required.

Skin and Body Protection:

Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length (flame resistant lab coats must be worn if handling flammable gases such as hydrogen). Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

Hygiene Measures:

Wash thoroughly and immediately after handling. Remove any contaminated clothing and wash before reuse.

Section 6 – Engineering Controls

Use of compressed gases should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 85 – 125 feet per minute. Contact REM for information regarding specific handling requirements when work with toxic, highly toxic, corrosive, and reactive gases. Generally, these of gases need to be stored and used with local exhaust ventilation (e.g., fume hood or gas cylinder cabinet).

Section 7 – First Aid Procedures

If inhaled:

Move into the fresh air immediately. Consult a physician. If not breathing give artificial respiration and seek immediate medical attention.

In case of skin contact:

Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash any contaminated clothing before reuse. Thoroughly clean shoes before reuse. Consult a physician.

In case of eye contact:

Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Seek immediate medical attention.

If swallowed:

Do NOT induce vomiting unless directed by medical personnel. Never give anything by mouth to an unconscious person. Seek immediate medical attention.

Section 8 – Special Handling and Storage Requirements

- Compressed gas cylinders should be stored in a secure, well ventilated location, and in an upright position at all times.
- All compressed gas cylinders should be handled as if full and should never be completely emptied.
- Cylinders that are not in use (meaning that the regulator is not attached) must be secured and the safety cap must be on the cylinder and are permitted to be chained together as shown below in Figure 1.
- Cylinders that are in use, meaning there is a regulator attached, must be individually secured by a chain or strap as shown below in Figure 2.
- Cylinder valves and regulators must be protected from impact or damage.
- A designated storage area must be established for compressed gases.
- Toxic, highly toxic, corrosive, and reactive gases should be stored in a gas cylinder cabinet as shown in Figure 3.
- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and inhalation.
- Keep away from sources of ignition if the gas is flammable.

Figure 1: Not In-Use

Figure 2: In-Use

Figure 3: Gas Cylinder Cabinet

- Follow laboratory supervisor's instructions for PPE, which may differ depending on the type and/or quantity of compressed gas being used.
- Use in the smallest practical quantities for the experiment being performed.
- Work must be conducted in a chemical fume hood if air concentrations above 10% of the LEL could be created, if the chemical is irritating to the eyes or respiratory system, and/or is toxic by inhalation.
- Gas cylinder connections and fittings must be inspected frequently for deterioration and must never be used without a regulator.
- Never use a leaking, corroded, or damaged cylinder and never refill compressed gas cylinders.
- When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut.
- The regulator should be replaced with a safety cap when the cylinder is not in use.
- The safety cap must be in place when a gas cylinder is moved.
- For large gas cylinders (>27 inches), an approved gas cylinder cart should be used. The cylinder must be strapped to the cart and the protective cap must be in place before moving the cylidner. A cylinder should never be moved or transported without the protective cap. The proper way to move a large gas cylinder is illustrated in Figure 4.

Figure 4: Cylinder Cart

- A few compressed gas cylinders have a shelf-life and can become more hazardous as time goes on. It is extremely important that these chemicals are identified and managed properly. If any time-sensitive gases are found to be past the manufacturer's expiration date, they must be submitted to REM for hazardous waste disposal immediately. The following is a list of time-sensitive compressed gases:
  - Hydrogen fluoride, anhydrous

- Hydrogen bromide, anhydrous
- Hydrogen sulfide, anhydrous
- Hydrogen cyanide, anhydrous
- Hydrogen chloride, anhydrous

Section 9 – Spill and Accident Procedures

Chemical Spill Dial 911

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**.

Chemical Spill on Body or Clothes:

Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention; **dial 911**.

Chemical Splash into Eyes:

Immediately rinse eyes and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention; **dial 911**.

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

Label Waste:

Make sure the waste container(s) is properly labeled; label should indicate all of the contents of the container. REM provides hazardous waste labels free of charge, call 49-40121 to obtain labels.

Store Waste:

Store hazardous waste in closed containers, and in a designated area (flammable cabinet is recommended).

Dispose of Waste:

Before submitting compressed gas waste to REM, ensure that the cylinder cannot be returned to the manufacturer or distributor. Many gas vendors charge demurrage for gas storage. Most lecture bottles cannot be returned to the manufacturer and must be treated as waste. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM. Call REM at 49-40121 or visit the REM webpage for questions. (http://www.purdue.edu/rem/hmm/wststo.htm)

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for the specific compressed gas being used must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure (Additional lab protocol may be added here)

Compressed nitrogen gas is to be used only within the hood. Make sure tank and regulator are secure at all times. Disconnect tubing line into hood when the cylinder is not in active use.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training (signature of all users is required)

- Prior to conducting any work with compressed gases, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date

Standard Operating Procedure

Chloroform

This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and
3) SOP has been signed and dated by the PI and relevant lab personnel.

Print a copy and insert into your *Lab-Specific Chemical Hygiene Plan*.

Section 1 – Lab-Specific Information

Department:	Chemistry
Date SOP was written:	9/12/2014
Date SOP was approved by PI/lab supervisor:	9/12/2014
Principal Investigator:	Angeline Lyon
Internal Lab Safety Coordinator/Lab Manager:	Angeline Lyon
Lab Phone:	494-5292
Office Phone:	494-5291
Emergency Contact:	Angeline Lyon 512-796-7005
Location(s) covered by this SOP:	Brown 3144/3144A (Building/Room Number)

Section 2 – Type of SOP:

☐ Process ☒Hazardous Chemical ☐ Hazardous Class

Section 3 – Physical / Chemical Properties

Physical / Chemical Properties:

CAS#: 67-66-3

GHS Classification: Acute toxicity (oral and inhalation); Skin and eye irritation; Carcinogenicity; Reproductive toxicity; Specific target organ toxicity – single exposure: central nervous system; Specific target organ toxicity – repeated exposure: liver, kidney; Acute aquatic toxicity

Molecular Formula: $CHCl_3$

Form (physical state): Liquid

Color: Colorless

Boiling Point: 61-62°C

Flash Point: NA (not flammable)

Density: 1.492 g/L at 25°C

Section 4 – Potential Hazards

Chloroform is a carcinogen. Harmful if swallowed. Causes skin irritation. Causes serious eye irritation. May cause drowsiness or dizziness. Suspected of causing cancer. Suspected of damaging the unborn child. May cause damage to organs (liver, kidney) through prolonged or repeated exposure.

Exposure Limits:

OSHA PEL (8 HR. TWA):	2 ppm
OSHA Short Term Exposure Limit:	2 ppm
ACGIH TLV/TWA:	10 ppm

Section 5 – Personal Protective Equipment (PPE)

Respirator Protection:

Respirators should be used only under any of the following circumstances:

- As a last line of defense (i.e., after engineering and administrative controls have been exhausted).
- When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded.
- Regulations require the use of a respirator.
- An employer requires the use of a respirator.
- There is potential for harmful exposure due to an atmospheric contaminant (in the absence of PEL)
- As PPE in the event of a chemical spill clean-up process

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested by REM. This is a regulatory requirement. (http://www.purdue.edu/rem/home/booklets/RPP98.pdf)

Hand Protection:

Gloves must be worn. Use proper glove removal technique to avoid any skin contact. Nitrile and latex disposable gloves are NOT suitable. Polyvinyl Acetate, Viton, or fluorinated rubber gloves are recommended. Check the resources below for a more suitable glove.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with chloroform.

Refer to glove selection chart from the links below:

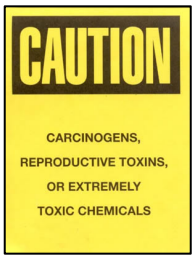
http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

OR

http://www.showabestglove.com/site/default.aspx

OR

http://www.mapaglove.com/



Eye Protection:

ANSI approved properly fitting safety glasses or chemical splash goggles. Face shield is also recommended if there is a high probability of a splash hazard.

Skin and Body Protection:

Lab coats (100% cotton) must be worn and be appropriately sized for the individual and buttoned to their full length. Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

Hygiene Measures:

Wash thoroughly and immediately after handling. Remove any contaminated clothing and wash before reuse.

Section 6 – Engineering Controls

Use of Chloroform must be conducted in a properly functioning chemical fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 85 – 125 feet per minute.

Section 7 – First Aid Procedures

If inhaled:

Move into the fresh air immediately and give oxygen. If not breathing give artificial respiration. Consult a physician.

In case of skin contact:

Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash any contaminated clothing before reuse. Consult a physician.

In case of eye contact:

Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes. Seek immediate medical attention and continue eye rinse during transport to hospital.

If swallowed:

Do NOT induce vomiting unless directed by medical personnel. Never give anything by mouth to an unconscious person. Consult a physician.

Section 8 – Special Handling and Storage Requirements

- A designated storage area must be established for Chloroform and the area should be posted with a "Caution, Carcinogen, Reproductive Toxins, or Extremely Toxic Chemicals" label provided by REM (as shown to the right).
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.

- Containers which are opened must be carefully resealed and kept upright to prevent leakage.
- A suitable storage location is a flammable storage cabinet or lab cabinet that does not contain incompatibles.

Section 9 – Spill and Accident Procedures

Chemical Spill Dial 911

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

Chemical Spill on Body or Clothes:

Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention; **dial 911**.

Chemical Splash into Eyes:

Immediately rinse eyes and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention; **dial 911**.

Section 10 – Medical Emergency

Life Threatening Emergency, After Hours, Weekends And Holidays:

Dial 911

Non-Life Threatening Emergency:

Immediately report injury to supervisor and complete the First Report of Injury. (http://www.purdue.edu/rem/injury/froi.htm)

Section 11 – Waste Disposal Procedures

Label Waste:

Make sure the waste container(s) is properly labeled; label should indicate all of the contents of the container. REM provides hazardous waste labels free of charge, call 49-40121 to obtain labels.

Store Waste:

Store hazardous waste in closed containers, and in a designated area (flammable cabinet or lab cabinet is recommended).

Dispose of Waste:

Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM. Call REM at 49-40121 or visit the REM webpage for questions. (http://www.purdue.edu/rem/hmm/wststo.htm)

Section 12 – Safety Data Sheet (SDS)

A current copy of the SDS for Chloroform must be made available to all personnel working in the laboratory at all times. To obtain a copy of the SDS, contact the chemical manufacturer or REM at 49-46371. Many manufacturers' SDSs can be found online on websites such as Sigma-Aldrich (http://www.sigmaaldrich.com/united-states.html) or Siri MSDS Index (http://hazard.com/msds/).

Section 13 – Protocol/Procedure

Chloroform is located in the fume hood in BRWN 3144. All work with the chemical must be conducted within the hood itself. Appropriate PPE, including chloroform-resistant gloves, should be worn at all times.

NOTE: Any deviation from this SOP requires approval from PI.

Section 14 – Documentation of Training **(signature of all users is required)**

- Prior to conducting any work with Chloroform, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date
		Click here to enter a date.
		Click here to enter a date.
		Click here to enter a date.
		Click here to enter a date.

Name	Signature	Date
		Click here to enter a date.
		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.

BIOLOGICAL HAZARDS

Policies and procedures pertaining to biological safety are contained in the "Purdue University Biological Safety Manual." Contact the REM Environmental Health Section for a copy of this manual.

RADIOACTIVE MATERIAL HAZARDS

Use of radioactive materials at Purdue University is strictly controlled. The policies and procedures for handling radioactive materials are contained in the "Purdue University Radiation Safety Manual." Contact the REM Radiation Safety Section if you are planning on using radioactive materials.

IONIZING AND NON-IONIZING RADIATION HAZARDS

Laser safety, x-ray safety, and all concerns pertaining to the hazards of ionizing and non-ionizing radiation are the purview of the REM Radiation Safety Section. Contact them at 47969 for information on training schedules as well as for printed training materials and policies and procedures documents

TRANSPORTATION OF HAZARDOUS MATERIALS

TRANSPORTATION OVER THE ROAD

Any container of hazardous material transported on a road accessible to or used by the public is subject to the regulation by the U.S. Department of Transportation (DOT). DOT regulations require, in part, that no person may offer or accept a hazardous material for transportation unless the material is properly classified, described, packaged, marked, labeled, manifested, and in condition for shipment. This includes hazardous materials transported between the various University buildings and campuses. DOT regulations require the driver of a vehicle transporting hazardous materials in quantities requiring a placard to possess a Commercial Driver's License. For materials classified as "dangerous by inhalation", there is no exempt quantity. DOT regulations also specify training requirements for any individual who engages in the following activities:

a. Load, unloads, or handles hazardous materials in transportation;
b. Reconditions or tests containers, drums, or packages represented for use in the transportation of hazardous materials;
c. Prepares hazardous materials for transportation;
d. Is responsible for safety of transported hazardous materials; or
e. Operates a vehicle (including personal vehicle) used to transport hazardous materials.

Prior to shipping or transporting a hazardous material, contact the Materials Management Shipping Office (ext. 47103) or REM. Refer to glossary for a complete definition of hazardous materials (see Hazardous Material DOT).

TRANSPORTATION INSIDE BUILDINGS AND BY FOOT

The Chemical Management Committee has adopted the following policy for the transportation of hazardous materials inside of buildings or while on foot:

a. Stock Room personnel shall not dispense or sell chemicals in breakable containers of any size unless the customer has an approved transport container in which to place the chemical for transporting before leaving the Stock Room. Chemical requisitioners may purchase a transport container from Chemistry Stores or General Stores.
b. Approved Transport Container means a commercially available bottle carrier made of rubber, metal, or plastic with carrying handle(s) which is large enough to hold the contents of the container if broken in transit. Carrier lids or covers are recommended, but not required. Rubber or plastic should be used for acids/alkalies; and metal, rubber, or plastic for organic solvents.
c. Laboratory Carts used to transport chemicals from one area to another shall be stable an in good condition. Transport only a quantity which can be handled easily. Plan the route ahead of time so as to avoid all steps or stairs.
d. Freight Elevators, Not Passenger Elevators, should be used to transport hazardous chemicals whenever possible. The individual transporting the hazardous chemicals should operate the elevator alone if possible. Avoid getting on an elevator when a person is transporting hazardous chemicals.

WASTE DISPOSAL

Hazardous chemical disposal must be conducted in accordance with procedures established by REM. Contact REM Hazardous Materials Management (40121) for specific information on disposal procedures.

Unless approved by REM, disposal of chemicals via the sanitary sewer system is not permitted.

Disposal of radioactive material and infectious waste requires special procedures. Contact REM before proceeding.

EMERGENCY RESPONSE

Plan in advance for an emergency. What are the possible emergencies which could occur during your work, e.g., fire, spill, high level chemical exposure? Are systems available to alert you to an emergency situation, e.g., chemical exposure monitoring systems? What supplies and equipment should you maintain in your area to assist you or emergency response personnel in the event of an emergency, e.g., eyewash and safety shower, spill control materials, personal protective clothing? What training do you need to handle an emergency in your area, e.g., emergency first aid or respirator use training? Is it safe for you to work alone?

BASIC STEPS FOR EMERGENCY RESPONSE

Determine the nature of the emergency.

- **High hazard emergency**. If the emergency is immediately dangerous to life and health, involves a large area, major injury to personnel, is a threat to personnel and the public, involves radioactive material, involves an infectious agent, or involves a highly toxic, corrosive, or reactive hazardous material, then proceed with **Plan A** below.
- **Low hazard emergency**. If the emergency is small, there is no fire hazard, involves low to moderately toxic materials in small amounts, or involves a readily treatable injury, proceed with **Plan B** below.
- **Fire and fire-related emergencies.** If the emergency involves a fire or fire-related situation such as abnormal heating of material, hazardous gas leaks, flammable liquid spill, smoke, or odor of burning, proceed with steps in the **"FIRE AND FIRE-RELATED EMERGENCIES"** section below.
- If the emergency involves a mercury spill, see section headed **"MERCURY SPILLS."**
- **Unknown.** If you do not know the nature of the emergency or are in any way uncertain as to how to handle the emergency, proceed with **Plan A** below.

PLAN A, HIGH HAZARD EMERGENCIES

- **Isolate** the area, if possible, and evacuate.
- Keep others out of the area and take action to protect life and limb.
- Call **emergency response** numbers (see cover page) and activate the building fire system. **When you call:**

  - Identify yourself and the reason you are calling.
  - Identify the exact location of the emergency.
  - Identify the nature of the emergency, any injuries or symptoms involved, and any hazardous materials involved if you know them.

- Provide rescue **only** if you are properly protected from the hazard. **Never attempt to rescue someone who is unconscious unless you know what the problem is and you know you are properly protected from the hazard.**

  - Do not move a seriously injured person unless he/she is in further danger.
  - Anyone overcome with smoke or chemical gases or vapors should be removed to uncontaminated air and treated for shock.
  - Provide first aid if you have the capability.

- **For chemical splash in the eyes or on the skin**, remove contact lenses and rinse affected area for at least 15 minutes in emergency eyewash or shower, or use other water source. Remove any contaminated clothing, including undergarments and jewelry. Call an ambulance (see cover page).
- Identify yourself and be available to provide emergency response personnel information when they arrive. If possible, collect Material Safety Data Sheets for chemicals involved and provide these to the emergency response personnel.

PLAN B, LOW HAZARD EMERGENCIES

- For a **minor injury**, report to the Purdue University Student Health Center or local emergency room for treatment. All injuries which occur on the job should be treated at the Health Center or hospital.
- For a **small spill**, use an absorbent material that will neutralize the spill, if available. Spill kits are available from safety equipment supply companies (see Appendix F), or the following materials can be maintained:

  - trisodium phosphate
  - sand (not for use with HF)
  - sodium bicarbonate
  - powdered citric acid
  - "Oil-Dri," "Zorb-All," "Speedi-Dri," etc.
  - absorbent paper towels
  - bentonite, kitty litter, sand and soda ash mixture

A dustpan and brush should be used, and protective clothing (e.g., rubber gloves and goggles) should be worn. The area should be decontaminated with soap and water after clean-up. Residue should be placed in an appropriate container for waste collection. Contact the REM Hazardous Materials Management section (40121) for disposal information.

FIRE AND FIRE-RELATED EMERGENCIES

If you discover a fire or fire-related emergency such as abnormal heating of material, hazardous gas leaks, hazardous material or flammable liquid spill, smoke, or odor of burning, immediately follow these procedures:

- Activate the building fire alarm system (fire pull station). If not available or operational, verbally notify persons in the building.
- Notify the Fire Department (see cover page).
- Isolate the area and evacuate the building:
  - Shut down equipment in the immediate area, if possible
  - Close doors to isolate the area
  - Use a portable fire extinguisher* to:
    - Assist oneself to evacuate
    - Assist another to evacuate
    - Control a small fire, if possible

    *Fire extinguisher training is required in some departments, and is available from Safety and Security. Staff who have not been trained to use extinguishers are not be required to do so.
- Provide the fire/police teams with the details of the problem upon their arrival. Special hazard information you may know is essential.

If fire alarms are ringing in your building:

- evacuate the building
- move at least 200 feet away from the building
- stay clear of driveways, sidewalks and other access ways to the building
- if you are a supervisor, try to account for your employees and report any missing persons to the emergency personnel at the scene.
- Assist emergency personnel, as requested.
- Do not reenter the building until directed to do so.

Follow any special procedures established for your unit.

MERCURY SPILLS

For **small spills**, such as a thermometer break, use a trapped vacuum line attached to a tapered glass tube, similar to a medicine dropper, to pick up mercury droplets.

- Do not use a domestic or commercial vacuum cleaner.
- Cover small droplets in accessible areas with one of the following:
  - sodium polysulfide solution
  - powdered sulfur
  - silver metal compounds
  - dry ice to freeze the mercury droplets
- Place residue in container for hazardous waste collection.

For **larger spills**, or any spill for which you believe unrecovered mercury might remain, contact the REM Hazardous Materials Management section for spill clean-up, instructions, or assistance (40121).

INJURY AND ILLNESS

GENERAL

Employees and students must notify their immediate supervisor or instructor of all illnesses and injuries related to exposure to hazardous chemicals. Employees and students should report to the Purdue University Student Health Center if medical attention is required. Students should be accompanied by a friend, teaching assistant or instructor.

If transportation is necessary, the University Police (see cover page) should be called to get transportation for the victim.

Do not move a seriously injured person unless he/she is in further danger.

Do not transport injured person(s) in personal or department vehicles. Call 911 for ambulance transportation.

In cases of serious injury or illness, it is imperative that appropriate actions be followed immediately. When in doubt as to what should be done, telephone the University Police at (see cover page) for assistance.

Give emergency and medical personnel the following information:

- your name, location and nature of the emergency
- the name of the chemical involved
- the amount involved
- area of the body affected
- symptoms

The supervisor or instructor must ensure the appropriate injury report forms are completed. Contact your Business Office for additional information.

If you have any questions regarding injury and illness procedures, contact your supervisor, instructor, or the University Police.

MINOR FIRST-AID

First Aid Kits. First aid kits are not recommended except for remote operations where emergency care is not readily available. If a department desires a first aid kit, it must be maintained with essential supplies at all times. See the General Stores Catalog for a list of essential supplies. First aid kit supplies can be purchased from General Stores.

- First aid kits must be readily accessible. If the kit is not visible, the area where it is stored must be clearly marked.
- Do not dispense or administer any medications, including aspirin.
- Do not put any ointments or creams on wounds or burns. Use cool water.
- The MSDS contains special first aid information.
- After giving first aid, call the ambulance (see cover page) to transport the victim to a medical facility for evaluation.
- Student and employee first aid cases are treated at the Purdue University Student Health Center (West Lafayette campus). Visitor first aid cases are treated at the nearest off-campus hospital.
- For specific first aid information, contact your supervisor, instructor, or the University Police.

APPENDICES

APPENDIX A
University Chemical Management Committee Charter

The primary responsibility of the University Chemical Management Committee is to promote safe and proper chemical management at the West Lafayette Campus, Regional Campuses, University Research Farms and Agricultural Centers, and related facilities and operations. Chemical management includes, but is not limited to, the procurement and the safe handling, use, storage, and disposal of chemicals.

The Chemical Management Committee shall consist of members appointed from the faculty and staff of the major research, teaching, and service areas where chemicals are handled or used. Committee members shall be appointed annually by the President upon recommendation of the Vice President for Research and the Vice President for Physical Facilities in consultation with the various deans. The Chairperson, a member of the faculty, shall also be appointed by the president. The Head of Radiological and Environmental Management and designees shall serve as ex officio members of the Committee.

The specific duties and responsibilities of the Chemical Management Committee shall include, but are not limited to, the following:

1. Serve as advisor to the University Community on matters related to chemical management.
2. Be cognizant of all applicable government and University policies, procedures, guidelines, laws and regulations related to chemical management and transmit this information in appropriate form to the University Community.
3. Develop, review, and/or approve procedures and guidelines, and prescribe special conditions, requirements, and/or restrictions related to chemical management.
4. Recommend to the Vice President for Research and the Vice President for Physical Facilities policies related to chemical management.
5. Develop, review, approve, and recommend programs of training in chemical management for the University Community.
6. Review conditions not in compliance with government and/or University policies, procedures, guidelines and regulations, and recommend appropriate corrective actions. In extreme circumstances, this may include suspension of the activity in question.
7. Keep a written record of activities, actions, decisions and recommendations of the Committee.
8. Submit to the Vice President for Research and the Vice President for Physical Facilities, and, through appropriate channels, the Faculty an annual report detailing the activities of the Committee.

The business of the Committee is administered through the Department of Radiological and Environmental Management. The Head of Radiological and Environmental Management and the Chairperson shall conduct the interim business of the Committee subject to review by the Committee. Radiological and Environmental Management has the responsibility for ensuring compliance with all government and University policies, procedures, guidelines, laws and regulations related to chemical management and will advise and assist the Committee in areas related to chemical management.

The responsibility for the success of these programs rests with the entire University Community. Vice Presidents, deans, directors, chairpersons and department heads shall inform the faculty and staff of, and require compliance with, all government and University policies, procedures, guidelines, laws and regulations related to chemical management. Individual faculty members and supervisors shall ensure that chemical management requirements are understood and followed by their subordinates, including technicians, undergraduates, graduate students, and post doctorates fellows.

APPENDIX B
Incompatible Chemicals

Certain chemicals should not be stored (and cannot be easily/safely mixed) with certain other chemicals due to severe exothermicity of reaction or uncontrolled production of a toxic product. In the event of earth tremor or other unexpected breakage, especially during fire, the consequences of proximal storage of incompatible materials can be fatal to staff, fire fighters, and other emergency responders. The following list contains examples of incompatibilities. **The list should not be considered complete**. For complete information about a specific chemical, always consult at least one current Material Safety Data Sheet.

Acetic acid	aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene, chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures, acids, amines, oxidizers, plastics
Acetylene	halogens, mercury, potassium, oxidizers, silver, copper
Alkali/alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens, aldehydes, ketones, sulfur, plastics, acids
Ammonia (anhydrous)	mercury, calcium hypochlorite, hydrofluoric acid, acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	acids, alkalis, chloride salts, flammable & combustible materials, metals, organic materials, phosphorous, reducing agents, urea, chlorates, sulfur
Aniline	acids, aluminum, dibenzoyl peroxide, oxidizers, plastics,
Arsenical materials	Any reducing agent
Azides	acids, heavy metals, oxidizers
Bromine	acetaldehyde, alcohols, alkalis, ammonia, amines, petroleum gases, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sodium carbide, sulfur
Calcium oxide	water, acids, ethanol, fluorine, organic materials
Carbon (activated)	alkali metals, calcium hypochlorite, halogens, oxidizers
Carbon tetrachloride	Sodium
Chlorates	finely divided organic or combustible materials ammonium salts, acids, powdered metals, sulfur
Chlorine	acetylene, alcohols, ammonia, benzene, butadiene, butane, combustible materials, ethylene, flammable compounds (hydrazine), hydrocarbons (acetylene, hydrogen, hydrogen peroxide, iodine, metals, methane, nitrogen, oxygen, propane (or other petroleum gases), sodium carbide, sodium hydroxide
Chlorine dioxide	hydrogen, mercury, organic materials, phosphorus, potassium hydroxide, sulfur, methane, phosphine, ammonia, methane, phosphine, hydrogen sulfide
Chromic acid, chromic oxide.	acetone, alcohols, alkalis, ammonia, bases, acetic acid, naphthalene, camphor, glycerin, flammable liquids in general, naphthalene, camphor, glycerol, benzene, hydrocarbons, metals, organic materials, phosphorus, plastics
Copper	calcium, hydrocarbons, oxidizers, acetylene, hydrogen peroxide
Cumene hydroperoxide	acids (organic or inorganic)
Cyanides	acids, alkaloids, aluminum, iodine, oxidizers, strong bases

Flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens, oxygen, oxidizers in general
Fluorine	All other chemicals
Hydrocarbons (liq and gas)	see flammable liquids
Hydrocyanic acid	nitric acid, alkali
Hydrofluoric acid	metals, organic materials, plastics, silica (glass, including fiberglass), sodium, ammonia
Hydrogen peroxide	all organics, nitric acid, phosphorous, sulfuric acid, sodium, most metals or their salts
Hydrogen sulfide	acetylaldehyde, metals, oxidizers, sodium, fuming nitric acid
Hydroperoxide	reducing agents
Hypochlorites	acids, activated carbon
Iodine	acetylaldehyde, acetylene, ammonia, metals, sodium, hydrogen
Mercury	acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium
Nitric acid	acids, nitrites, metals, sulfur, sulfuric acid , most organics, plastics, sodium
Nitrites	acids
Nitroparaffins	inorganic bases, amines
Oxalic acid	oxidizers, silver, mercury, sodium chlorite
Oxygen	all flammable & combustible materials, oil, grease, ammonia, carbon monoxide, metals, phosphorous, polymers
Perchloric acid	all organics, wood, paper, oil, grease, dehydrating agents, hydrogen halides, iodides, bismuth and alloys
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	oxygen, air, alkalis, reducing agents
Potassium chlorate	acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars, reducing agents
Potassium perchlorate	alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid
Potassium permanganate	benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartartic acid, ammonium compounds, fulminic acid, ozonides, peroxyformic acid
Sodium	Carbon tetrachloride, carbon dioxide, water, acids, hydrazine, metals, oxidizers
Sodium nitrate	acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorous, reducing agents, sugars, water
Sulfides	acids
Sulfuric acid	alcohols, bases, chlorates, perchlorates, permanganates of potassium, lithium, sodium, magnesium, calcium
Tellurides	Reducing agents

Reference: Guide for Safety in the Chemical Laboratory, 2nd ed., Manufacturing Chemists' Association, Van Nostrand Reinhold: New York, 1972, pp. 215-217, Safety in Academic Chemistry Laboratories, ACS 7th ed. 2003, and various MSDSs and chemical container labels.

APPENDIX C
Peroxidizables

Peroxidizable chemicals such as those listed below should be dated upon receipt. Storage and use should be limited to the time indicated for each class or list. Containers which show signs of iron oxide or copper oxide should be handled with extra precaution since many metal oxides promote peroxide formation.

The most hazardous compounds - those which can accumulate a hazardous level of peroxides simply on storage after exposure to air - are in List A. Compounds forming peroxide that are hazardous only on concentration of impurities (as in distillation or evaporation) are in List B. List C consists of vinyl monomers that may form peroxides which can initiate explosive polymerization of the monomers.

List A -- 12 months	**List B -- 18 months**	**List C -- 18 months**
Diethyl ether	Acetal	Styrene
Isopropyl ether	Dioxane	Butadiene
Divinyl acetylene	Tetrahydrofuran	Tetrafluoroethylene
Vinylidene chloride	Vinyl ether	Chlorotrifluoroethylene
Ethylene glycol dimethyl ether (glyme)	Vinyl acetate	
Dicyclopentadiene	Vinyl chloride	
Methyl acetylene	Vinyl pyridine	2-Butanol
Cumene	Chlorobutadiene (Chloroprene)	2-Propanol
Tetrahydronaphthalene	Ethylbenzene	3-Methyl-1-butanol
Cyclohexene	Methylcyclopentane	2-Pentanone
1-Pentene	Benzyl alcohol	3-Pentanone
1-Octene		

APPENDIX D
Shock-Sensitive Materials

The following are examples of materials which can be shock-sensitive:

acetylides
aluminum ophorite explosive
amatol
ammonal
ammonium nitrate
ammonium perchlorate
ammonium picrate
ammonium salt lattice
butyl tetryl
calcium nitrate
copper acetylide
cyanuric triazide
cyclotrimethylenetrinitramine
dinitroethyleneurea
dinitroglycerine
dinitrophenol
dinitrophenolates
dinitrophenyl hydrazine
dinitrotoluene
dipicryl sulfone
dipicrylamine
erythritol tetranitrate
fulminate of mercury
fulminate of silver
fulminating gold
fulminating mercury
fulminating platinum
gelatinized nitrocellulose
guanyl nitrosamino guanyltetrazene
guanyl nitrosamino guanylidene hydrazine
guanylidene
heavy metal azides
hexanite
hexanitrodiphenylamine
hexanitrostilbene
hexogen
hydrazine mixtures
hydrazinium nitrate
hydrazoic acid
lead azide
lead mannite
lead mononitroresorcinate
lead picrate
lead salts
lead styphnate
magnesium ophorite
mannitol hexanitrate
mercury oxalate

mercury tartrate
nitrated carbohydrate
nitrated glucoside
nitrated polyhydric alcohol
nitrogen trichloride
nitrogen tri-iodide
nitroglycerin
nitroglycide
nitroglycol
nitroguanidine
nitroparaffins
nitronium perchlorate
nitrotoluene
nitrourea
organic amine nitrates
organic nitramines
organic peroxides (t-butyl peroxide)
picramic acid
picramide
picric acid
picryl chloride
picryl fluoride
polynitro aliphatic compounds
potassium nitroaminotetrazole
silver acetylide
silver azide
silver styphnate
silver tetrazene
sodatol
sodium amatol
sodium dinitro-ortho-cresolate
sodium/potassium nitrate explosive mixtures
sodium picramate
syphnic acid
tetrazene
tetranitrocarbazole
tetrytol
trimonite
trinitroanisole
trinitrobenzene
trinitrobenzoic acid
trinitrocresol
trinitronaphthalene
trinitrophenetol
trinitrotoluene
tritonal
urea nitrate

APPENDIX E
Industrial Toxicology Overview

Chemical Toxicology

Toxicology is the study of the nature and action of poisons.

Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body.

Toxicity hazard is the probability that injury will occur considering the manner in which the substance is used.

Dose-Response Relationships

The potential toxicity (harmful action) inherent in a substance is manifest only when that substance comes in contact with a living biological system. A chemical normally thought of as "harmless" will evoke a toxic response if added to a biological system in sufficient amount. The toxic potency of a chemical is thus ultimately defined by the relationship that is produced in a biological system.

Routes of Entry into the Body

There are four main routes by which hazardous chemicals enter the body:

- Inhalation: Absorption through the respiratory tract. Most important in terms of severity.
- Skin absorption.
- Ingestion: Absorption through the digestive tract. Can occur through eating or smoking with contaminated hands or in contaminated work areas.
- Injection. Can occur by accidental needle stick or puncture of skin with a sharp object.

Most exposure standards, Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs), are based on the inhalation route of exposure. They are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter (mg/m^3) concentration in air.

If a significant route of exposure for a substance is through skin contact, the TLV or PEL will have a "skin" notation. Examples are pesticides, carbon disulfide, carbon tetrachloride, dioxane, mercury, thallium compounds, xylene, hydrogen cyanide.

Types of Effects

Acute poisoning is characterized by rapid absorption of the substance and the exposure is sudden and severe. Normally, a single large exposure is involved. Examples are carbon monoxide or cyanide poisoning.

Chronic poisoning is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Examples are lead or mercury poisoning, pesticide exposure.

Local refers to the site of action of an agent and means the action takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples are strong acids or alkalis and war gases.

Systemic refers to a site of action other than the point of contact and presupposes absorption has taken place. For example, an inhaled material may act on the liver. Examples are arsenic affects the blood, nervous system, liver, kidneys and skin; benzene affects bone marrow.

Cumulative poisons are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Examples are heavy metals.

Substances in combination, meaning two or more hazardous materials present at the same time whose resulting effect is greater than the effect predicted based on the individual substances. This combined effect is called a **synergistic** or **potentiating** effect. An example is exposure to alcohol and chlorinated solvents.

Other Factors Affecting Toxicity

- Rate of entry and route of exposure; that is, how fast the toxic dose is delivered and by what means.
- Age can effect the capacity to repair tissue damaged.
- Previous exposure can lead to tolerance, increased sensitivity, or make no difference.
- State of health, medications, physical condition, and life style can affect the toxic response. Pre-existing disease can result in increased sensitivity.
- Environmental factors, such as temperature and pressure.
- Host factors, including genetic predisposition and the sex of the exposed individual.

Physical Classifications of Toxic Materials

Gas applies to a substance which is in the gaseous state at room temperature and pressure.

A **vapor** is the gaseous phase of a material which is ordinarily a solid or a liquid at room temperature and pressure.

When considering the toxicity of gases and vapors, the **solubility** of the substance is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body.

An **aerosol** is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its concentration in milligrams per cubic meter (mg/m^3). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above 1 micrometer tend to deposit in the upper respiratory tract. Below 1 micrometer particles enter the lung. Very small particles (< 0.2 um) are generally not deposited.

Physiological Classifications of Toxic Materials

Irritants are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from concentrations far below those needed to cause corrosion. Examples include:

- ammonia
- hydrogen chloride
- halogens
- phosgene
- nitrogen dioxide
- arsenic trichloride
- phosphorus chlorides
- alkaline dusts and mists
- diethyl/dimethyl sulfate
- hydrogen fluoride
- ozone

Irritants can also cause changes in the mechanics of respiration and lung function. Examples include:

- sulfur dioxide
- formaldehyde
- sulfuric acid
- iodine
- acetic acid
- formic acid
- acrolein

Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

A **primary irritant** exerts no systemic toxic action either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

A **secondary irritant's** effect on mucous membranes is over-shadowed by a systemic effect resulting from absorption. Examples include hydrogen sulfide and aromatic hydrocarbons.

Exposure to a secondary irritant can result in pulmonary edema, hemorrhage, and tissue necrosis.

Corrosives are chemicals which may cause visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact. Examples include sulfuric acid, potassium hydroxide, chromic acid, and sodium hydroxide

Asphyxiants have the ability to deprive tissue of oxygen.

> **Simple asphyxiants** are inert gases that displace oxygen. Examples include, nitrogen. nitrous oxide, carbon dioxide, hydrogen, and helium.
> **Chemical asphyxiants** have as their specific toxic action rendering the body incapable of utilizing an adequate oxygen supply. They are toxic at very low concentrations (few ppm). Examples include carbon monoxide and hydrogen cyanide.

Primary anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples include halogenated hydrocarbons, ether, and alcohols.

Hepatotoxic agents cause damage to the liver. Examples include carbon tetrachloride, nitrosamines, and tetrachloroethane.

Nephrotoxic agents damage the kidneys. Examples include halogenated hydrocarbons and uranium compounds.

Neurotoxic agents damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples include:

- trialkyl tin compounds
- methyl mercury
- organic phosphorus
- insecticides
- tetraethyl lead
- carbon disulfide
- thallium
- manganese

Some toxic agents act on the blood or hematopoietic system. The blood cells can be directly affected or bone marrow can be damaged. Examples include:

- nitrites
- toluidine
- benzene
- aniline
- nitrobenzene

There are toxic agents that produce damage of the pulmonary tissue (lungs) but not by immediate irritant action. Fibrotic changes can be caused by free crystalline silica and asbestos. Other dusts can cause a restrictive disease called pneumoconiosis. Examples include coal dust, cotton dust and wood dusts.

A **carcinogen** commonly describes any agent or mixture which contains an agent that can initiate or speed the development of malignant or potentially malignant tumors or malignant neoplastic proliferation of cells. Known human carcinogens include:

- asbestos
- alpha-napthylamine
- 3,3'-dichlorobenzidine
- vinyl chloride
- ethylene oxide
- N-nitrosodimethylamine
- inorganic arsenic
- 1,2-dibromo-3-chloropropane (DBCP)
- coal tar pitch volatiles
- 4-nitrobiphenyl
- methyl chloromethyl ether
- bis-chloromethyl ether

A **mutagen** affects the chromosome chains of exposed cells. The effect is hereditary and becomes part of the genetic pool passed on to future generations.

A **teratogen** (embryotoxic or fetotoxic agent) is an agent which interferes with normal embryonic development without damage to the mother or lethal effect on the fetus. Effects are not hereditary. Examples include lead and dibromodichloropropane.

A **sensitizer** causes a substantial proportion of exposed people to develop an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock. Examples include:

- epoxides
- amines
- poison ivy
- toluene diisocyanate
- chromium compounds
- chlorinated hydrocarbons
- formaldehyde
- nickel compounds

Target Organ Effects

The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects.

- **Hepatotoxics cause liver damage**
  Signs and symptoms: jaundice, liver enlargement
  Example chemicals: carbon tetrachloride, nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate

- **Nephrotoxics produce kidney damage**
  Signs and symptoms: edema, proteinuria
  Example chemicals: halogenated hydrocarbons, uranium, chloroform, mercury, dimethyl sulfate

- **Neurotoxins affect the nervous system**
  Signs and symptoms: narcosis, behavioral changes, decreased muscle coordination
  Example chemicals: mercury, carbon disulfide, benzene, carbon tetrachloride, lead, mercury, nitrobenzene

- **Hematopoietic agents decrease blood functions**
  Signs and symptoms: cyanosis, loss of consciousness.
  Example chemicals: carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene

- **Pulmonary agents irritate or damage the lungs**
  Signs and symptoms: cough, tightness in chest, shortness of breath.
  Example chemicals: silica, asbestos, nitrogen dioxide, ozone, hydrogen sulfide, chromium, nickel, alcohol.

- **Reproductive toxins affect the reproductive system. (mutations and teratogenesis)**
  Signs and symptoms: birth defects, sterility.
  Example chemicals: lead, dibromodichloropropane.

- **Skin hazards affect the dermal layer of the body**
  Signs and symptoms: defatting of skin, rashes, irritation.
  Example chemicals: ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene.

- **Eye hazards affect the eye or vision**
  Signs and symptoms: conjunctivitis, corneal damage.
  Example chemicals: organic solvents, acids, cresol, quinone, hydroquinone, benzyl chloride, butyl alcohol, bases.

APPENDIX F
Laboratory Safety/Supply Checklist

The presence/availability of items marked *** is required in all areas of laboratory use of hazardous chemicals. Supervisors must determine which of the others are required.

___	Fire extinguisher	___	Safety shower and eyewash
___	Fire blanket	___	Splash-proof goggles
___	Fire alarm	___	Specialty goggles U.V., IR, Laser, etc.)
___	Dust pan and broom***	___	Face shield (8" minimum)
___	Safety cans for chemical storage	___	Gloves appropriate for material(s) being used (see Table 1)***
___	Acid/corrosive storage cabinet	___	Lab coat***
___	Bottle carrier(s) (rubber, polyethylene)	___	Dust masks
___	Hazard Assessments documented and posted	___	Other PPE (list)
___	Flammable storage cabinets	___	Respirators with appropriate cartridges*
___	Spill control trays	___	Hearing protection (i.e., ear plugs)
___ ___ ___ ___ ___ ___	Spill clean-up media for: • Acid • Base • Solvent • Oil • Mercury • Radioactivity	___ ___ ___	Emergency procedures for: a)Fire*** b)Tornado*** c)Chemical spill or explosion***
___ ___ ___	Biosafety supplies: a. Sharps containers b. Autoclave bags c. Biohazard warning labels	___	Laboratory hoods (fan operational, adequate face velocity, no broken glass, clean and orderly)
___	Chemical Hygiene Plan***	___	Standard Operating Procedures***
___	Material Safety Data Sheets	___	Labeled Containers***

* Cartridge respirators may only be worn by employees enrolled in the Purdue Respiratory Protection Program. Contact the REM Industrial Hygiene Section for more information.

APPENDIX G
Chemicals Requiring Designated Areas: Select Carcinogens, Reproductive Toxins, and Substances Which Have a High Degree of Acute Toxicity

Partly revised summer 2003

This list is revised periodically to reflect changes in the publications used as references (National Toxicology Program, OSHA regulations, and International Agency for Research on Cancer). Contact the REM Industrial Hygiene section at 46113 to inquire about the most recent updates.

1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea	[13909-09-6]
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU,	[13010-47-4]
1,1,2,2-Tetrachloroethane	[79-34-5]
1,1,2-trichloroethane (vinyl trichloride)	[79-00-5]
1,1-Dichloroethane	[75-34-3]
1,1-Dichloroethylene (vinylidene chloride)	[75-35-4]
1,1-dimethylhydrazine (UDMH)	[57-14-7]
1,2,3-Trichloropropane	[96-18-4]
1,2-dibromo-3-chloropropane (DBCP, Fumazone)	[96-12-8]
1,2-Dichloropropane	[78-87-5]
1,2-Diethylhydrazine	[1615-80-1]
1,2-Dimethylhydrazine	[540-73-8]
1,3-Butadiene	[106-99-0]
1,3-Dichloropropene	[542-75-6]
1,3-Propane sultone	[1120-71-4]
1,4-butanediol dimethanesulfonate (Busulphan, Myleran)	[55-98-1]
1,4-Dichloro-2-butene	[764-41-0]
1,4-Dioxane	[123-91-1]
1,6-Dinitropyrene	[42397-64-8]
1,8-Dihydroxyanthraquinone (Danthron, Chrysazin)	[117-10-2]
1,8-Dinitropyrene	[42397-65-9]
1-[(5-nitrofurfurylidene)-amino]-2-imidazolidinone (Nifuradene)	[555-84-0]
1-Amino-2,4-dibromoanthraquinone	[81-49-2]
1-Amino-2-methylanthraquinone	[82-28-0]
1-Chloro-1-nitroethane	[598-92-5]
1-Chloro-2,4-Dinitrobenzene	[97-00-7]
1-Nitropyrene	[5522-43-0]
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole	[3570-75-0]
2, 4, 5-Trichlorophenol	[95-95-4]
2,2-Bis(bromomethyl)-1,3-propanediol	[3296-90-0]
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	[1746-01-6]
2,3-Dibromo-1-propanol	[96-13-9]
2,4,5-Trimethylaniline	[137-17-7]
2,4,5-Trimethylaniline and its strong acid salts	
2,4,6-Trichlorophenol	[88-06-2]
2,4-Diaminoanisole	[615-05-4]
2,4-Diaminotoluene	[95-80-7]
2,4-Dichlorophenoxyacetic acid (2,4-D)	[94-75-7]
2,4-Dichlorophenyl-p-nitrophenyl ether (nitrofen)	[1836-75-5]
2,4-Dinitroaniline	[97-02-9]
2,4-Dinitrotoluene	[121-14-2]
2,6-Dimethylaniline (2,6-Xylidine)	[87-62-7]
2,6-Dinitrotoluene	[606-20-2]
2-Acetylaminofluorene	[53-96-3]
2-Amino-1-methyl-6-phenylimidazol[4,5-b]pyridine (PhIP)	[105650-23-5]
2-Amino-3,4-dimethylimidazo[4,5-f]quinoline (MeIQ)	[77094-11-2]
2-Amino-5-(5-nitro-2 furyl)-1,3,4-thiadiazole	[59716-87-9]
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	[712-68-5]
2-Aminoanthraquinone	[117-79-3]
2-Aminofluorene	[153-78-6]
2-Aminopyridine	[504-29-0]
2-Methyl-1-nitroanthraquinone	[129-15-7]
2-Nitrofluorene	[607-57-8]
2-Nitropropane	[79-46-9]
3-(N-Nitrosomethylamino)propionitrile	[60153-49-3]
3,3'-Dichloro-4,4'-diaminodiphenyl ether	[28434-86-8]
3,3'-Dichlorobenzidine	[91-94-1]
3,3'-Dichlorobenzidine dihydrochloride	[612-83-9]
3,3'-Dimethoxybenzidine (o-dianisidine)	[119-90-4]
3,3'-dimethoxybenzidine dihydrochloride (o-dianisidine	[20325-40-0]
3,3'-dimethylbenzidine (o-tolidine)	[119-93-7]
3,3'-Dimethylbenzidine dihydrochloride	[612-82-8]
3,7-Dinitrofluoranthene	[105735-71-5]
3,9-Dinitrofluoranthene	[22506-53-2]
3-Amino-9-ethylcarbazole hydrochloride	[6109-97-3]
3-Bromopropyne (Propargyl Bromide)	[106-96-7]
3-Methylcholanthrene	[56-49-5]
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK)	[64091-91-4]
4,4'-diaminodiphenyl ether (4,4'-oxydianiline)	[101-80-4]
4,4'-Methylene bis(2-methylaniline)	[838-88-0]
4,4'-Methylenebis(2-chloraniline) (MBOCA)	[101-14-4]
4,4'-methylenebis(N,N-dimethylaniline)	[101-61-1]
4,4'-Methylenedianiline (4,4'-diaminodiphenylmethane)	[101-77-9]
4,4'-Methylenedianiline Dihydrochloride	[13552-44-8]
4,4'-Thiodianiline	[139-65-1]
4-Amino-2-nitrophenol	[119-34-6]
4-aminodiphenyl (4-aminobiphenyl)	[92-67-1]
4-Chloro-o-phenylenediamine	[95-83-0]
4-dimethylaminoazobenzene (p-dimethylaminoazobenzene)	[60-11-7]
4-Nitrobiphenyl (4-Nitrodiphenyl)	[92-93-3]
4-Nitropyrene	[57835-92-4]
4-vinyl-1-cyclohexene diepoxide (vinyl cyclohexenedioxide)	[106-87-6]
4-Vinylcyclohexene	[100-40-3]
5-(Morpholinomethyl)-3-[(5-nitro-furfurylidene)-amino]-2-	[139-91-3]
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-	[3795-88-8]
5-Chloro-o-toluidine	[94-79-4]
5-chloro-o-toluidine, strong acid salts	
5-Fluorouracil	[51-21-8]
5-Methoxypsoralen (bergapten, heraclin, majudin)	[484-20-8]
5-Methylchrysene	[3697-24-3]
5-Nitroacenaphthene	[602-87-9]
5-Nitro-o-anisidine	[99-59-2]
6-methyl-2-thiouracil (methylthiouracil)	[56-04-2]
6-Nitrochrysene	[7496-02-8]
7,12-Dimethylbenz(a)anthracene	[57-97-6]
7H-Dibenzo[c,g]carbazole	[194-59-2]
A-alpha-C (2-Amino-9H-pyrido[2,3-b]indole)	[26148-68-5]
Acetaldehyde	[75-07-0]
Acetamide	[60-35-5]
Acetochlor	[34256-82-1]
Acetohydroxamic acid	[546-88-3]
Acetylene tetrabromide	[79-27-6]
Acifluorfen	[62476-59-9]
Acrolein (2-Propenal)	[107-02-8]
Acrylamide	[79-06-1]
Acrylonitrile	[107-13-1]
Acrylyl Chloride	[814-68-6]
Actinomycin D	[50-76-0]
Adriamycin (Doxorubicin hydrochloride)	[23214-92-8]
Aflatoxin	[7220-81-7]
Aflatoxin M1	[6795-23-9]
Aflatoxins	[1402-68-2]
Alachlor	[15972-60-8]
Aldrin	[309-00-2]

Alkylaluminums	
all-trans retinoic acid	[302-79-4]
Allyl alcohol [2-Propen-l-ol]	[107-18-61]
Allyl chloride	[107-05-1]
Allylamine	[107-11-9]
alpha-Hexachlorocyclohexane	[319-84-6]
alpha-Naphthylamine (1-napthylamine)	[134-32-7]
Alprazolam	[28981-97-7]
Amikacin sulfate	[39831-55-5]
Aminoglutethimide	[125-84-8]
Aminoglycosides	
Aminopterin	[54-62-6]
Amiodarone hydrochloride	[19774-82-4]
Amitrole (3-amino-1,2,4-triazole)	[61-82-5]
ammonia (gas, liquified)	[7664-41-7]
Ammonium Perchlorate	[7790-98-9]
Ammonium Permanganate	[7787-36-2]
Amoxapine	[14028-44-5]
Anabolic steroids (androgenic steroids)	
Analgesic mixtures containing phenacetin	
Angiotensin converting enzyme (ACE) inhibitors	
Aniline	[62-53-3]
Aniline hydrochloride	[142-04-1]
Anisindione	[117-37-3]
Antimony oxide (Antimony trioxide)	[1309-64-4]
Aramite (butylphenoxyisopropyl chloroethyl sulfite)	[140-57-8]
Aroclor	[12767-79-2]
Aroclor 1254	[11097-69-1]
Aroclor 1260	[11096-82-5]
arsenic and all its compounds	
Asbestos (amosite)	[12172-73-5]
Asbestos (ascarite, tremolite)	[1332-21-4]
Asbestos (crocidolite)	[12001-28-4]
Asbestos (serpentine chrysotile)	[12001-29-5]
Aspirin	[50-78-2]
Atenolol	[29122-68-7]
Atrazine	[1912-24-9]
Auramine O	[2465-27-2]
Azacytidine (Azacitidine, Mylosar, 5-azacytidine)	[320-67-2]
Azaserine	[115-02-6]
Azathioprine	[446-86-6]
Azobenzene	[103-33-3]
Barbiturates	
Beclomethasone dipropionate	[5534-09-8]
Benomyl	[17804-35-2]
benz[a]anthracene (benzo[a]anthracene)	[56-55-3]
benzal chloride (benzylidine chloride, alpha, alpha-	[98-87-3]
Benzene	[71-43-2]
Benzidine	[92-87-5]
benzidine salts	
Benzidine-based dyes	
Benzo[a]pyrene	[50-32-8]
Benzo[b]fluoranthene	[205-99-2]
Benzo[j]fluoranthene	[205-82-3]
Benzo[k]fluoranthene	[207-08-9]
Benzodiazepines	
Benzofuran	[271-89-6]
Benzotrichloride (alpha,alpha,alpha-trichlorotoluene)	[98-07-7]
Benzphetamine hydrochloride	[5411-22-3]
benzyl chloride (alpha-chlorotoluene)	[100-44-7]
Beryl Ore	[1302-52-9]
beryllium	[7440-41-7]
Beryllium Aluminum Alloy	[12770-50-2]
beryllium chloride	[7787-47-5]
beryllium and all of its compounds	
Beryllium Phosphate	[13598-15-7]
Beryllium sulfate tetrahydrate	[7787-56-6]
beryllium zinc silicate (zinc beryllium silicate)	[39413-47-3]
beta-Butyrolactone	[3068-88-0]
beta-Hexachlorocyclohexane	[319-85-7]
beta-naphthylamine (C.I. 37270, 2-aminonaphthalene)	[91-59-8]
beta-Propiolactone	[57-57-8]

Betel quid with tobacco	
Bis(2-chloroethyl)ether	[111-44-4]
Bis(2-ethylhexyl) Phthalate (Dioctyl phthalate , Di-sec-octyl	[117-81-7]
bis(chloromethyl) ether	[542-88-1]
bischloroethyl nitrosourea (BCNU, Carmustine)	[154-93-8]
Bitumens , extracts of steam-refined and air-refined	[8052-42-4]
Bitumens, extracts of steam-refined and air refined	
Bleomycins	[11056-06-7]
Boron Trichloride	[10294-34-5]
Boron trifluoride	[7637-07-2]
Boron trifluoride compound with methyl ether	[353-42-4]
Bracken fern	
Bromine	[7726-95-6]
Bromine Chloride	[13863-41-7]
Bromine Pentafluoride	[7789-30-2]
Bromine Trifluoride	[7787-71-5]
Bromodichloromethane	[75-27-4]
Bromoform	[75-25-2]
Bromoxynil	[1689-84-5]
Butabarbital sodium	[143-81-7]
Butyl Hydroperoxide (Tertiary)	[75-91-2]
Butyl Perbenzoate (Tertiary)	[614-45-9]
Butylated Hydroxyanisole (BHA)	[25013-16-5]
C.I. 12055 (C.I. Solvent Yellow 14, Sudan I)	[842-07-9]
C.I. 12075 (D&C Orange No. 17, Permanent Orange)	[3468-63-1]
C.I. 12100 (Oil Orange SS)	[2646-17-5]
C.I. 12156 (C.I. solvent red 80, Citrus Red No. 2)	[6358-53-8]
C.I. 15585 (D&C Red No. 8)	[2092-56-0]
C.I. 15585:1 (D&C Red No. 9)	[5160-02-1]
C.I. 16150 (Xylidine Ponceau 2R, Ponceau MX, D&C Red No.	[3761-53-3]
C.I. 16155 (Ponceau 3R, D&C Red No. 15)	[3564-09-8]
C.I. 22610 (Direct Blue 6)	[2602-46-2]
C.I. 23635 (C. I. Acid Red 114)	[6459-94-5]
C.I. 23850 (C.I. Direct blue 14, Trypan blue)	[72-57-1]
C.I. 24400 (C.I. Direct Blue 15)	[2429-74-5]
C.I. 24401 (C.I. Direct Blue 218)	[28407-37-6]
C.I. 41000B (C.I. Basic Yellow 2, Auramine, (Brilliant Oil	[492-80-8]
C.I. 42500 (Basic Red 9 monohydrochloride, pararosanilin)	[569-61-9]
C.I. 42640 (Benzyl violet 4B)	[1694-09-3]
C.I. 45170 (D&C Red No. 19, Rhodamine B, Basic Violet 10))	[81-88-9]
C.I. 64500 (Disperse Blue 1)	[2475-45-8]
Cacodylic acid	[75-60-5]
Cadmium	[7440-43-9]
Cadmium Chloride	[10108-64-2]
cadmium compounds	
Cadmium Oxide	[1306-19-0]
Cadmium Sulfate	[10124-36-4]
Cadmium Sulfide	[1306-23-6]
Caffeic acid	[331-39-5]
Calcium arsenate	[7778-44-1]
Captafol	[2425-06-1]
Captafol (Crisfolatan, Difolatan, Folcid)	[2939-80-2]
Captan	[133-06-2]
Carbaryl (Sevin)	[63-25-2]
Carbazole	[86-74-8]
Carbon black	[1333-86-4]
Carbon disulfide	[75-15-0]
Carbon monoxide	[630-08-0]
Carbon tetrachloride	[56-23-5]
Carbon-black extracts	
Carbonyl Fluoride	[353-50-4]
Carboplatin	[41575-94-4]
Carrageenan, degraded	[9000-07-1]
Cellulose Nitrate (concentration greater than 12.6% nitrogen	[9004-70-0]
Ceramic fibers (airborne particles of respirable size)	
Chenodiol	[474-25-9]
Chinomethionat (Oxythioquinox)	[2439-01-2]
Chlorambucil	[305-03-3]
Chloramphenicol (chloromycetin)	[56-75-7]
Chlorcyclizine hydrochloride	[1620-21-9]
Chlordane	[57-74-9]
Chlordecone (Kepone)	[143-50-0]

Chlordiazepoxide	[58-25-3]
Chlordiazepoxide hydrochloride	[438-41-5]
Chlordimeform	[6164-98-3]
Chlorendic acid	[115-28-6]
Chlorinated Paraffins (avg C12 , 60% Chlorine)	[108171-26-2]
Chlorine	[7782-50-5]
Chlorine dioxide	[10049-04-4]
Chlorine Pentrafluoride	[13637-63-3]
Chlorine Trifluoride	[7790-91-2]
Chlornaphazine (N,N-bis(2-chloroethyl)-2-naphthylamine)	[494-03-1]
Chlorodibromomethane	[124-48-1]
Chlorodiethylaluminum (also called Diethylaluminum Chloride)	[96-10-6]
Chloroethane (Ethyl chloride)	[75-00-3]
Chlorofluoromethane (fluorocarbon 31)	[593-70-4]
Chloroform	[67-66-3]
chloromethyl methyl ether (methyl chloromethyl ether)	[107-30-2]
Chlorophenols	
Chlorophenoxy herbicides	
Chloropicrin	[76-06-2]
Chloropicrin and Methyl Bromide mixture	
Chloropicrin and Methyl Chloride mixture	
Chloroprene (2-chloro-1,3-butadiene)	[126-99-8]
Chlorothalonil	[1897-45-6]
Chlorotrianisene	[569-57-3]
Chlorozotocin	[54749-90-5]
Chromium Hexavalent Compounds	
Chrysene	[218-01-9]
Ciclosporin (Cyclosporine, Sandimmune, Neoral)	[79217-60-0]
Cinnamyl anthranilate	[87-29-6]
Cisplatin	[15663-27-1]
Cladribine	[4291-63-8]
Clarithromycin	[81103-11-9]
Clobetasol propionate	[25122-46-7]
Clofibrate	[637-07-0]
Clomiphene citrate	[50-41-9]
Clorazepate dipotassium	[57109-90-7]
Coal tars (coke oven emissions)	[8007-45-2]
Coal-tar pitches	[65996-93-2]
Cobalt (powder)	[7440-48-4]
Cobalt [II] oxide	[1307-96-6]
cobalt compounds	
Cocaine	[50-36-2]
Codeine phosphate	[52-28-8]
Coke Oven Emissions	
Coke oven emissions	
Colchicine	[64-86-8]
Commune Hydroperoxide	[80-15-9]
creosote (coal tar creosote, creosote oil, liquid pitch oil)	[8001-58-9]
creosote (wood creosote)	[8021-39-4]
cresols	
Crotonaldehyde (E)- [2-Butenal, (E)-]	[123-73-9]
Crotonaldehyde [2-Butenal]	[4170-30-3]
Cupferron (ammonium N-nitrosophenylhydroxylamine)	[135-20-6]
Cyanazine	[21725-46-2]
Cyanogen (oxalonitrile, oxalic acid dinitrile)	[460-19-5]
cyanogen chloride	[506-77-4]
cyanuric fluoride	[675-14-9]
Cycasin	[14901-08-7]
Cyclohexanol	[108-93-0]
Cycloheximide	[66-81-9]
Cyclohexylamine [Cyclohexanamine]	[108-91-8]
Cyclophosphamide	[50-18-0]
cyclophosphamide hydrate	[6055-19-2]
Cyclosporin A (Cyclosporine A; Ciclosporin)	[59865-13-3]
Cyhexatin	[13121-70-5]
Cytarabine	[147-94-4]
Cytembena	[21739-91-3]
Dacarbazine	[4342-03-4]
Daminozide	[1596-84-5]
Danazol	[17230-88-5]
Daunomycin	[20830-81-3]
Daunorubicin hydrochloride	[23541-50-6]

DDD (Dichlorodiphenyldichloroethane)	[72-54-8]
DDE (Dichlorodiphenyldichloroethylene)	[72-55-9]
DDT (dichlorodiphenyltrichloroethane, 1,1,1-trichloro-2,2-bis(p-	[50-29-3]
Decaborane	[17702-41-9]
Decabromobiphenyl	[13654-09-6]
Demeclocycline hydrochloride (internal use)	[64-73-3]
Diacetyl Peroxide	[110-22-5]
Diaminotoluene (any isomer or mixed)	
Diazepam	[439-14-5]
Diazomethane	[334-88-3]
Dibenz[a,h]acridine	[226-36-8]
Dibenz[a,h]anthracene	[53-70-3]
Dibenz[a,j]acridine	[224-42-0]
Dibenzo[a,e]pyrene	[192-65-4]
Dibenzo[a,h]pyrene	[189-64-0]
Dibenzo[a,i]pyrene	[189-55-9]
Dibenzo[a,l]pyrene	[191-30-0]
Dibenzoyl Peroxide	[94-36-0]
Diborane	[19287-45-7]
Dichloroacetic acid	[79-43-6]
Dichloroacetylene	[7572-29-4]
Dichloromethane (Methylene Chloride)	[75-09-2]
Dichlorosilane	[4109-96-0]
Dichlorvos (No-Pest Strip, 2,2-dichloroethenyl dimethyl	[62-73-7]
Dicumarol	[66-76-2]
Dieldrin	[60-57-1]
Dienestrol	[84-17-3]
Diepoxybutane	[1464-53-5]
Diesel engine exhaust	
Diethyl sulfate	[64-67-5]
Diethylstilbestrol (DES)	[56-53-1]
Diethylzinc	[557-20-0]
Diglycidyl ether (di(2,3-epoxypropyl) ether)	[2238-07-5]
diglycidyl resorcinol ether (DGRE)	[101-90-6]
Dihydroergotamine mesylate	[6190-39-2]
Dihydrosafrole	[94-58-6]
Diisopropyl Peroxydicarbonate	[105-64-6]
Diisopropyl sulfate	[2973-10-6]
Dilauroyl Peroxide	[105-74-8]
Dimethyl sulfate (methyl sulfate)	[77-78-1]
Dimethylamine, Anhydrous	[124-40-3]
Dimethyldichlorosilane	[75-78-5]
Dimethyldisulfide	[624-92-0]
Dimethylformamide	[68-12-2]
Dimethylsulfide (methyl sulfide)	[75-18-3]
dimethylvinyl chloride (1-chloro-2-methylpropene)	[513-37-1]
Dinitrotoluene	[25321-14-6]
Dinitrotoluene mixture, 2,4-/2,6-	
Dinocap	[39300-45-3]
Dinoseb	[88-85-7]
Di-n-propyl isocinchomeronate (MGK Repellent 326)	[136-45-8]
Dioxathion	[78-34-2]
diphenylhydantoin (phenytoin)	[57-41-0]
Diphenylhydantoin (Phenytoin), sodium salt	[630-93-3]
Direct Black 38	[1937-37-7]
Direct Brown 95 (technical grade)	[16071-86-6]
Di-t-butyl Peroxide	[110-05-4]
Doxorubicin hydrochloride (Adriamycin)	[25316-40-9]
Doxycycline (internal use)	[564-25-0]
Doxycycline calcium (internal use)	[94088-85-4]
Doxycycline hyclate (internal use)	[24390-14-5]
Doxycycline monohydrate (internal use)	[17086-28-1]
Endrin	[72-20-8]
Epichlorohydrin	[106-89-8]
Ergotamine tartrate	[379-79-3]
Erionite	[12510-42-8]
Erionite	[66733-21-9]
Estradiol 17B	[50-28-2]
estrogens, conjugated	
estrogens, nonsteroidal	
estrogens, steroidal	
Estrone (1,3,5(10)-estratrien-3-ol-17-one, beta-Estrone)	[53-16-7]

Ethidium bromide	[1239-45-8]
ethinyl estradiol	[57-63-6]
Ethionamide	[536-33-4]
Ethyl acrylate	[140-88-5]
Ethyl methanesulfonate	[62-50-0]
Ethyl Nitrite	[109-95-5]
Ethyl-4,4'-dichlorobenzilate	[510-15-6]
Ethylamine	[75-04-7]
Ethylene chlorohydrin	[107-07-3]
Ethylene Dibromide [1,2-Dibromoethane (EDB)]	[106-93-4]
Ethylene Dichloride (1,2-Dichloroethane)	[107-06-2]
Ethylene fluorohydrin	[371-62-0]
Ethylene glycol monoethyl ether	[110-80-5]
Ethylene glycol monoethyl ether acetate	[111-15-9]
Ethylene glycol monomethyl ether	[109-86-4]
Ethylene glycol monomethyl ether acetate	[110-49-6]
Ethylene oxide	[75-21-8]
Ethylene thiourea	[96-45-7]
Ethylenediamine [1,2-Ethanediamine]	[107-15-3]
Ethyleneimine (aziridine)	[151-56-4]
Etoposide	[33419-42-0]
Etretinate	[54350-48-0]
FireMaster BP-0	
Fluazifop butyl	[69806-50-4]
Flunisolide	[3385-03-3]
Fluorine	[7782-41-4]
Fluoxymesterone	[76-43-7]
Flurazepam hydrochloride	[1172-18-5]
Flutamide	[13311-84-7]
Fluticasone propionate	[80474-14-2]
Fluvalinate	[69409-94-5]
Folpet	[133-07-3]
Formaldehyde (gas or mixture of any concentration)	[50-00-0]
Furan	[110-00-9]
Furazolidone	[67-45-8]
Furmecyclox	[60568-05-0]
furylfuramide (2-(2-furyl)-3-(5-nitro-2-furyl)acrylamide, AF-2)	[3688-53-7]
Fusarin C	[79748-81-5]
gamma-Butyrolactone	[96-48-0]
Ganciclovir sodium	[82410-32-0]
Gasoline engine exhaust (condensates/extracts)	
Germane	[7782-65-2]
Glasswool fibers (airborne particles of respirable size)	
Glu-P-1 (2-Amino-6-methyldipyrido[1,2-a:3',2'-d]imidazole)	[67730-11-4]
Glu-P-2 (2-Aminodipyrido[1,2-a:3',2'-d]imidazole)	[67730-10-3]
Glycidaldehyde	[765-34-4]
Glycidol	[556-52-5]
Glycol ethers	
Goserelin acetate	[65807-02-5]
Griseofulvin	[126-07-8]
Gyromitrin (Acetaldehyde methylformylhydrazone)	[16568-02-8]
Halazepam	[23092-17-3]
Halothane	[151-67-7]
HC Blue No. 1	[2784-94-3]
Heptachlor	[76-44-8]
Heptachlor epoxide	[1024-57-3]
Hexachlorobenzene (benzene hexachloride, C6Cl6)	[118-74-1]
Hexachlorobutadiene	[87-68-3]
Hexachlorocyclohexanes	[608-73-1]
Hexachlorodibenzodioxin	[34465-46-8]
Hexachloroethane	[67-72-1]
Hexafluoroacetone	[684-16-2]
Hexamethyl phosphoramide (HMPA)	[680-31-9]
Hexamethylene diisocyanate	[822-06-0]
Histrelin acetate	
Hydrazine Sulfate	[10034-93-2]
Hydrazine, anhydrous	[302-01-2]
hydrazobenzene (1,2-diphenylhydrazine)	[122-66-7]
Hydrogen	[1333-74-0]
Hydrogen Bromide	[10035-10-6]
hydrogen chloride (gas only)	[7647-01-0]
Hydrogen cyanide	[74-90-8]
hydrogen fluoride (gas or any mixture)	[7664-39-3]
Hydrogen Peroxide (52% by weight or greater)	[7722-84-1]
Hydrogen Selenide	[7783-07-5]
Hydrogen sulfide	[7783-06-4]
Hydroxylamine	[7803-49-8]
Hydroxyurea	[127-07-1]
Ifosfamide	[3778-73-2]
Indeno[1,2,3-cd]pyrene	[193-39-5]
Iodine	[7553-56-2]
Iodine-131	[10043-66-0]
Iprodione	[36734-19-7]
IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)	[76180-96-6]
Iron dextran complex	[9004-66-4]
Iron pentacarbonyl	[13463-40-6]
Isobutyl nitrite	[542-56-3]
Isobutyronitrile [Propanenitrile,2-methyl-]	[78-82-0]
Isoprene	[78-79-5]
Isopropyl chloroformate [Carbonochloridic acid, 1-	[108-23-6]
Isopropyl formate	[625-55-8]
Isopropylamine	[75-31-0]
Isosafrole	[120-58-1]
Isotretinoin	[4759-48-2]
Kanechlor 500 (under Polychlorinated Biphenyls)	[37317-41-2]
Ketene	[463-51-4]
L-5-Morpholinomethyl)-3-[(5-nitro-furfurylidene)amino]-2-	[3031-51-4]
Lactofen	[77501-63-4]
Lasiocarpine	[303-34-4]
Lead	[7439-92-1]
Lead acetate	[301-04-2]
Lead arsenate	[7784-40-9]
Lead Chromate (under Chromium and Certain Chromium	[7758-97-6]
lead compounds	
lead compounds, inorganic	
Lead Phosphate	[7446-27-7]
Lead subacetate	[1335-32-6]
Leuprolide acetate	[74381-53-6]
Levonorgestrel implants	[797-63-7]
Lindane (gamma hexachlorocyclohexane, BHC gamma)	[58-89-9]
Lithium carbonate	[554-13-2]
Lithium citrate	[919-16-4]
Lorazepam	[846-49-1]
Lovastatin	[75330-75-5]
Magenta	[632-99-5]
Mancozeb	[8018-01-7]
Maneb	[12427-38-2]
m-Chlorophenol	[108-43-0]
m-diaminoanisole sulfate (2,4-diaminoanisole sulfate)	[39156-41-7]
m-Dinitrobenzene	[99-65-0]
Me-A-alpha-C (2-Amino-3-methyl-9H-pyrido[2,3-b]indole, MeA-	[68006-83-7]
Medroxyprogesterone acetate	[71-58-9]
Megestrol acetate	[595-33-5]
MeIQx (2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)	[77500-04-0]
MeIQx(2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)	[7500-04-1]
Melphalan	[148-82-3]
Menotropins	[9002-68-0]
Meprobamate	[57-53-4]
Mercaptopurine	[6112-76-1]
Mercury	[7439-97-6]
mercury compounds	
Mercury, organic cmpds	
Merphalan	[531-76-0]
Mestranol	[72-33-3]
Methacrylaldehyde	[78-85-3]
Methacryloyl chloride	[920-46-7]
Methacryloyloxyethyl isocyanate	[30674-80-7]
Methacycline hydrochloride	[3963-95-9]
Metham sodium	[137-42-8]
Methimazole	[60-56-0]
Methotrexate	[59-05-2]
Methotrexate sodium	[15475-56-6]
Methoxsalen (8-Methoxsypsoralen)	[298-81-7]
Methoxyflurane	[76-38-0]

Methyl acrylonitrile	[126-98-7]
methyl allyl chloride (3-chloro-2-methylpropene)	[563-47-3]
methyl bromide	[74-83-9]
methyl carbamate	[598-55-0]
methyl chloride	[74-87-3]
methyl chloroformate	[79-22-1]
Methyl Ethyl Ketone Peroxide	[1338-23-4]
Methyl fluoroacetate	[453-18-9]
Methyl Fluorosulfate (Methyl fluorosulfonate)	[421-20-5]
methyl hydrazine (monomethylhydrazine)	[60-34-4]
methyl iodide	[74-88-4]
Methyl isocyanate	[624-83-9]
methyl mercaptan	[74-93-1]
methyl mercury compounds	
methyl methanesulfonate (methyl mesylate)	[66-27-3]
Methyl thiocyanate [Thiocyanic acid, methylester]	[555-64-9]
methyl vinyl ketone	[78-94-4]
methylamine, anhydrous	[74-89-5]
methylazoxymethanol	[590-96-5]
Methylazoxymethanol acetate	[592-62-1]
Methylene biphenyl isocyanate	[101-68-8]
Methylhydrazine salts	
Methylmercury compounds	
Methyltestosterone	[58-18-4]
Methyltrichlorosilane	[75-79-6]
Metiram	[9006-42-2]
Metronidazole	[443-48-1]
Michler's Ketone [4,4'-(Dimethylamino)benzophenone]	[90-94-8]
Midazolam hydrochloride	[59467-96-8]
Mineral Oils	
Minocycline hydrochloride (internal use)	[13614-98-7]
Mirex (Dechlorane)	[2385-85-5]
Misoprostol	[59122-46-2]
Mitomycin C	[50-07-7]
Mitoxantrone hydrochloride	[70476-82-3]
Monocrotaline	[315-22-0]
MOPP and other combined chemotherapy including alkylating	
Mustard gas (2,2'-dichlorodiethyl sulfide, Sulfur mustard)	[505-60-2]
N,N'-Diacetylbenzidine	[613-35-4]
N,N-dimethylcarbamoyl chloride (dimethylcarbamoyl chloride)	[79-44-7]
N-[4-(5-Nitro-2-furyl)-2-thiazolyl] acetamide	[531-82-8]
Nafarelin acetate	[86220-42-0]
Nafenopin	[3771-19-5]
Nalidixic acid	[389-08-2]
Naphtha (coal tar naphtha, coal tar, petroleum benzine)	[8030-30-6]
Neomycin sulfate (internal use)	[1405-10-3]
N-ethyl-N-nitrosourea	[759-73-9]
N-Ethyl-N-nitrosovinylamine	[13256-13-8]
Netilmicin sulfate	[56391-57-2]
nickel	[7440-02-0]
Nickel [II] Hydroxide	[12054-48-7]
Nickel Acetate	[373-02-4]
nickel alloys	
Nickel Carbonate	[3333-67-3]
Nickel Carbonyl (Nickel Tetracarbonyl)	[13463-39-3]
nickel compounds	
Nickel Hydroxide	[11113-74-9]
Nickel II Oxide	[1313-99-1]
Nickel refinery dust from the pyrometallurgical process	
Nickel subsulfide	[12035-72-2]
Nickelocene	[1271-28-9]
Nicotine	[54-11-5]
Niridazole	[61-57-4]
Nitric Acid (94.5% by weight or greater)	[7697-37-2]
nitric oxide (nitrogen monoxide)	[10102-43-9]
nitriloacetic acid	[139-13-9]
Nitrilotriacetic acid salts	
Nitrilotriacetic acid, trisodium salt monohydrate	[18662-53-8]
Nitrobenzene	[98-95-3]
Nitrofurantoin	[67-20-9]
Nitrofurazone	[59-87-0]
Nitrogen Dioxide	[10102-44-0]
Nitrogen mustard (N,N-bis(2-chloroethyl)methylamine,	[51-75-2]
nitrogen mustard hydrochloride (Mechloroethamine	[55-86-7]
Nitrogen mustard N-oxide	[126-85-2]
Nitrogen mustard N-oxide hydrochloride (2-chloro-N-(2-	[302-70-5]
Nitrogen Oxides (NO; NO(2); N2O4; N2O3)	
Nitrogen tetroxide	[101022-44-0]
Nitrogen Tetroxide (Nitrogen Peroxide)	[10544-72-6]
Nitrogen Trifluoride	[7783-54-2]
nitrogen trioxide (dinitrogen trioxide)	[10544-73-7]
Nitromethane	[75-52-5]
Nitrous oxide	[10024-97-2]
N-methyl-N'-nitro-N-nitrosoguanidine	[70-25-7]
N-methyl-N-nitrosourea (N-nitroso-N-methylurea)	[684-93-5]
N-Methyl-N-nitrosourethane (N-Nitroso-N-methylurethane)	[615-53-2]
N-Methylolacrylamide	[924-42-5]
N-Nitroso- n-butyl- N-(3-carboxypropyl)amine	[38252-74-3]
N-Nitroso- n-butyl- N-(4-hydroxybutyl)amine	[3817-11-6]
N-Nitrosodiethanolamine	[1116-54-7]
N-nitrosodiethylamine (diethylnitrosamine; DEN)	[55-18-5]
N-Nitrosodimethylamine (Dimethylnitrosamine)	[62-75-9]
N-nitrosodi-n-butylamine (N-butyl-N-nitroso-1-butylamine)	[924-16-3]
N-Nitrosodiphenylamine	[86-30-6]
N-Nitrosomethylethylamine	[10595-95-6]
N-Nitrosomethylvinylamine	[4549-40-0]
N-Nitrosomorpholine	[59-89-2]
N-nitroso-N-dipropylamine (N-nitroso-N-di-n-propylamine, N-	[621-64-7]
N-Nitrosonornicotine	[16543-55-8]
N-Nitrosopiperidine	[100-75-4]
n-nitrosopyrrolidine	[930-55-2]
N-Nitrososarcosine	[13256-22-9]
Norethisterone (Norethindrone)	[68-22-4]
Norethisterone acetate (Norethindrone acetate)	[51-98-9]
Norgestrel	[6533-00-2]
N-Phenyl beta-naphthylamine	[135-88-6]
o,p'-DDT	[789-02-6]
o-Aminoazotoluene	[97-56-3]
o-Anisidine	[90-04-0]
o-Anisidine hydrochloride	[134-29-2]
o-Chlorophenol	[95-57-8]
Ochratoxin A	[303-47-9]
Octabromobiphenyl	[61288-13-9]
o-Dichlorobenzene	[95-50-1]
o-Dinitrobenzene	[528-29-0]
Oleum (65% to 80% by weight; also called Fuming Sulfuric	[8014-94-6]
Oleum (Fuming Sulfuric acid) [Sulfuric acid, mixture with sulfur	[8014-95-7]
o-Nitroanisole (2-Nitroanisole)	[91-23-6]
o-Nitrotoluene	[88-72-2]
o-Phenylenediamine and its salts	[95-54-5]
Oral contraceptives, combined	
Oral contraceptives, sequential	
Organo tin compounds	
Osmium tetroxide	[20816-12-0]
o-Toluidine	[95-53-4]
o-Toluidine Hydrochloride	[636-21-5]
Oxadiazon	[19666-30-9]
Oxazepam	[604-75-1]
Oxydemeton methyl	[301-12-2]
Oxygen Difluoride (Fluorine Monoxide)	[7783-41-7]
Oxymetholone	[434-07-1]
Oxytetracycline (internal use)	[79-57-2]
Oxytetracycline hydrochloride (internal use)	[2058-46-0]
Ozone	[10028-15-6]
p-a,a,a-Tetrachlorotoluene	[5216-25-1]
Paclitaxel	[33069-62-4]
Palygorskite (attapulgite) (long fibres, > 5 micrometers)	[12174-11-7]
p-Aminoazobenzene	[60-09-3]
Panfuran S	[794-93-4]
p-Anisidine	[104-94-9]
Paramethadione	[115-67-3]
p-Chloro -o-toluidine Hydrochloride	[3165-93-3]
p-Chloroaniline	[106-47-8]
p-Chloroaniline hydrochloride	[20265-96-7]

p-Chloro-o-toluidine	[95-69-2]
p-Chloro-o-toluidine strong acid salts	
p-Chlorophenol	[106-48-9]
p-cresidine (5-methyl-o-anisidine)	[120-71-8]
p-dichlorobenzene (1,4-dichlorobenzene)	[106-46-7]
p-Dinitrobenzene	[100-25-4]
Penicillamine	[52-67-5]
Pentaborane	[19624-22-7]
Pentachlorophenol	[87-86-5]
Pentobarbital sodium	[57-33-0]
Pentostatin	[53910-25-1]
peracetic acid (peroxyacetic acid)	[79-21-0]
Perchloric Acid (concentration greater than 60% by weight)	[7601-90-3]
Perchloroethylene (tetrachloroethylene)	[127-18-4]
Perchloromethyl Mercaptan	[594-42-3]
Perchloryl Fluoride	[7616-94-6]
Phenacemide	[63-98-9]
Phenacetin (p-acetophenetidide, p-ethoxyacetanilide)	[62-44-2]
Phenazopyridine	[94-78-0]
Phenazopyridine hydrochloride	[136-40-3]
Phenesterin	[3546-10-9]
Phenobarbital	[50-06-6]
Phenolphthalein	[77-09-8]
Phenoxybenzamine	[59-96-1]
Phenoxybenzamine hydrochloride	[63-92-3]
Phenprocoumon	[435-97-2]
Phenyl glycidyl ether	[122-60-1]
Phenylhydrazine	[100-63-0]
Phenylhydrazine salts	
phosgene (carbonyl chloride)	[75-44-5]
Phosphine (Hydrogen Phosphide)	[7803-51-2]
phosphorus oxychloride (phosphoryl chloride)	[10025-87-3]
Phosphorus pentafluoride	[7647-19-0]
Phosphorus trichloride	[7719-12-2]
piperazine estrone sulfate (Estropipate)	[7280-37-7]
Piperidine	[110-89-4]
Pipobroman	[54-91-1]
Plicamycin	[18378-89-7]
p-Nitroaniline	[100-01-6]
p-nitrosodiphenylamine (4-nitrosodiphenylamine)	[156-10-5]
Polybrominated biphenyls (PBBs)	
Polybrominated biphenyls (PBBs)	[59536-65-1]
Polybrominated Biphenyls (PBBs)	[67774-32-7]
Polychlorinated biphenyls (PCBs)	
Polychlorinated Biphenyls (PCBs)	[1336-36-3]
Polychlorinated dibenzofurans	
Polychlorinated dibenzo-p-dioxins	
Polycyclic Aromatic Hydrocarbons (PAHs)	
Polygeenan	[53973-98-1]
Potassium bromate	[7758-01-2]
Procarbazine	[671-16-9]
Procarbazine Hydrochloride	[366-70-1]
Procymidone	[32809-16-8]
Progesterone	[57-83-0]
Progestins	
Pronamide	[23950-58-5]
Propargite	[2312-35-8]
Propionitrile [Propanenitrile]	[107-12-0]
Propyl chloroformate [Carbonochloridic acid, propylester]	[109-61-5]
Propyl Nitrate	[627-3-5]
Propylene oxide	[75-56-9]
Propylenimine (2-Methylaziridine)	[75-55-8]
Propylthiouracil	[51-52-5]
p-Toluidine	[106-49-0]
Quazepam	[36735-22-5]
Quinoline	[91-22-5]
Quinoline strong acid salts	
Radionuclides	
Radon	[10043-92-2]
Radon decay products	
Reserpine (Regroton)	[50-55-5]
Residual (heavy) fuel oils	

Resmethrin	[10453-86-8]
Resorcinol	[108-46-3]
Retinol/retinyl esters	
Ribavirin	[36791-04-5]
Rockwool	
saccharin (benzisothiazol-3(2H)-one-1,1-dioxide)	[81-07-2]
Saccharin, sodium	[128-44-9]
Safrole	[94-59-7]
Salicylazosulfapyridine	[599-79-1]
Sarin (isopropyl methanefluorophosphonate)	[107-44-8]
Secobarbital sodium	[309-43-3]
Selenium	[7782-49-2]
Selenium hexafluoride	[7783-79-1]
Selenium sulfide	[7446-34-6]
Selenium, and all cmpds	
Shale-oils	[68308-34-9]
Silica - amorphous	[7699-41-4]
Silica - amorphous, fused	[60676-86-0]
Silica - crystalline, tripoli	[1317-95-9]
Silica - Tridymite (respirable)	[15468-32-3]
silica (quartz, respirable)	[14808-60-7]
Silica, crystalline (airborne particles of respirable size)	
Silica, crystalline, cristobalite	[14464-46-1]
Silicon tetrafluoride	[7783-61-1]
Slagwool	
Sodium Equilin Sulfate (under Conjugated Estrogens)	[16680-47-0]
Sodium Estrone Sulfate (under Conjugated Estrogens)	[438-67-5]
Sodium fluoroacetate	[62-74-8]
Sodium o-phenylphenate	[132-27-4]
Soots, tars, and mineral oils (untreated and mildly treated oils	
Spironolactone	[52-01-7]
Stanozolol	[10418-03-8]
Sterigmatocystin	[10048-13-2]
Stibine (antimony trihydride)	[7803-52-3]
Streptomycin sulfate	[3810-74-0]
Streptozotocin	[18883-66-4]
Strontium Chromate (under Chromium and Certain Chromium	[7789-06-2]
Styrene (phenylethylene, vinyl benzene)	[100-42-5]
styrene oxide (styrene-7,8-oxide)	[96-09-3]
Sulfallate (diethyldithiocarbamic acid 2-chlorallyl ester)	[95-06-7]
sulfur dioxide	[7446-09-5]
sulfur monochloride (sulfur chloride, disulfur dichloride)	[10025-67-9]
sulfur pentafluoride (disulfur decafluoride)	[5714-22-7]
sulfur pentafluoride (radical)	[10546-01-7]
sulfur tetrafluoride	[7783-60-0]
sulfur trioxide (sulfuric anhydride)	[7446-11-9]
sulfuryl chloride	[7791-25-5]
Talc (fibrous)	[14807-96-6]
Talc containing asbestiform fibers	
Tamoxifen	[10540-29-1]
Tamoxifen citrate	[54965-24-1]
Tamoxifen salts	
Tellurium hexafluoride	[7783-80-4]
Temazepam	[846-50-4]
Teniposide	[29767-20-2]
Terrazole	[2593-15-9]
Testosterone and its esters	[58-22-0]
Testosterone cypionate	[58-20-8]
Testosterone enanthate	[315-37-7]
Tetracycline (internal use)	[60-54-8]
Tetracycline hydrochloride (internal use)	[64-75-5]
Tetrafluoroethylene	[116-14-3]
Tetrafluorohydrazine	[10036-47-2]
Tetramethyl Lead	[75-74-1]
Tetramethyl succinonitrile	[3333-52-6]
Tetranitromethane	[509-14-8]
Thalidomide	[50-35-1]
Thioacetamide	[62-55-5]
Thioguanine	[154-42-7]
Thionyl chloride	[7719-09-7]
Thiotepa (tris(1-aziridinyl)phosphine sulfide)	[52-24-4]
Thiourea	[62-56-6]

Thorium Dioxide	[1314-20-1]
Titanium tetrachloride [Titanium chloride (TiCl4) (T-4)-]	[7550-45-0]
Tobramycin sulfate	[49842-07-1]
Toluene	[108-88-3]
Toluene 2, 6- diisocyanate [Benzene, 1,3- diisocyanato-2-	[91-08-7]
Toluene diisocyanates (any isomer or mixed)	[26471-62-5]
Toluene-2,4-diisocyanate	[584-84-9]
Toxaphene (chlorinated camphene)	[8001-35-2]
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)-	[25962-77-0]
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-	[55738-54-0]
Treosulfan (Treosulphan)	[299-75-2]
Triazolam	[28911-01-5]
Trichlormethine (trimustine hydrochloride, 2,2',2''-	[817-09-4]
trichloro (chloromethyl) silane	[1558-25-4]
Trichloro (dichlorophenyl) Silane	[27137-85-5]
Trichloroethylene	[79-01-6]
Trichlorosilane	[10025-78-2]
Triethylamine (TEA)	[121-44-8]
Trifluorochloroethylene	[79-38-9]
Trilostane	[13647-35-3]
Trimethadione	[127-48-0]
Trimethlchlorosilane [Silane, chlorotrimethyl-]	[75-77-4]
Trimethyl phosphate	[512-56-1]
Trimethylamine	[75-50-3]
Trimethyoxysilane	[2487-90-3]
Trimetrexate glucuronate	[82952-64-5]

Triphenyltin hydroxide	[76-87-9]
Tris(2,3-dibromopropyl) phosphate	[126-72-7]
Tris(2-chloroethyl) phosphate	[115-96-8]
Tris(aziridinyl)-p-benzoquinone (Triaziquone)	[68-76-8]
Tryptophan-P-1 (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole,	[62450-06-0]
Tryptophan-P-2 (3-Amino-1-methyl-5H-pyrido[4,3-b]indole, Trp-	[62450-07-1]
Uracil mustard	[66-75-1]
Uranium, all cmpds	
Uranium, natural	[7440-61-1]
Urethane (Urethan; Ethyl carbamate)	[51-79-6]
Urofollitropin	[26995-91-5]
Valproate (Valproic acid)	[99-66-1]
Vinblastine sulfate	[143-67-9]
Vinclozolin	[50471-44-8]
Vincristine	[57-22-7]
Vincristine sulfate	[2068-78-2]
Vinyl acetate	[108-05-4]
Vinyl bromide	[593-60-2]
Vinyl chloride	[75-01-4]
Vinyl fluoride	[75-02-5]
Vinylidene fluoride (1,1-difluoroethylene)	[75-38-7]
Warfarin (in any quantity or concentration)	[81-81-2]
Wood dusts (hardwoods)	
Zinc Chromate	[13530-65-9]
Zineb	[12122-67-7]

APPENDIX H
Chemical Resistance Examples

	1	2	3	4
*Acetaldehyde	VG	G	VG	G
Acetic acid	VG	VG	VG	VG
*Acetone	G	VG	VG	P
Ammonium hydroxide	VG	VG	VG	VG
*Amyl acetate	F	P	F	P
Aniline	G	F	F	P
*Benzaldehyde	F	F	G	G
*Benzene	P	P	P	F
Butyl acetate	G	F	F	P
Butyl alcohol	VG	VG	VG	VG
Carbon disulfide	F	F	F	F
*Carbon tetrachloride	F	P	P	G
*Chlorobenzene	F	P	F	P
*Chloroform	G	P	P	E
Chloronaphthalene	F	P	F	F
Chromic acid (50%)	F	P	F	F
Cyclohexanol	G	F	G	VG
*Dibutyl Phthalate	G	P	G	G
Diisobutyl ketone	P	F	G	P
Dimethylformamide	F	F	G	G
Dioctyl phthalate	G	P	F	VG
Epoxy resins, dry	VG	VG	VG	VG
*Ethyl acetate	G	F	G	F
Ethyl alcohol	VG	VG	VG	VG
*Ethyl ether	VG	G	VG	G
*Ethylene dichloride	F	P	F	P
Ethylene glycol	VG	VG	VG	VG
Formaldehyde	VG	VG	VG	VG
Formic acid	VG	VG	VG	VG
Freon 11, 12, 21, 22	G	P	F	G
*Furfural	G	G	G	G
Glycerin	VG	VG	VG	VG
Hexane	F	P	P	G
Hydrazine (65%)	F	G	G	G
Hydrochloric acid	VG	G	G	G
Hydrofluoric acid (48%)	VG	G	G	G
Hydrogen peroxide (30%)	G	G	G	G
Ketones	G	VG	VG	P
Lactic acid (85%)	VG	VG	VG	VG

	1	2	3	4
Linseed oil	VG	P	F	VG
Methyl alcohol	VG	VG	VG	VG
Methylamine	F	F	G	G
Methyl bromide	G	F	G	F
*Methyl ethyl ketone	G	G	VG	P
*Methyl isobutyl ketone	F	F	VG	P
Methyl methacrylate	G	G	VG	F
Monoethanolamine	VG	G	VG	VG
Morpholine	VG	VG	VG	G
Naphthalene	G	F	F	G
Naphthas, aliphatic	VG	F	F	VG
Naphthas, aromatic	G	P	P	G
*Nitric acid	G	F	F	F
Nitric acid, red and white fuming	P	P	P	P
Nitropropane (95.5%)	F	P	F	F
Oleic acid	VG	F	G	VG
Oxalic acid	VG	VG	VG	VG
Palmitic acid	VG	VG	VG	VG
Perchloric acid (60%)	VG	F	G	G
Perchloroethylene	F	P	P	G
Phenol	VG	F	G	F
Phosphoric acid	VG	G	VG	VG
Potassium hydroxide	VG	VG	VG	VG
Propyl acetate	G	F	G	F
Propyl alcohol	VG	VG	VG	VG
Isopropyl alcohol	VG	VG	VG	VG
Sodium hydroxide	VG	VG	VG	VG
Styrene (100%)	P	P	P	F
Sulfuric acid	G	G	G	G
Tetrahydrofuran	P	F	F	F
*Toluene	F	P	P	F
Toluene diisocyanate	F	G	G	F
*Trichloroethylene	F	F	P	G
Triethanolamine	VG	G	G	VG
Tung oil	VG	P	F	VG
Turpentine	G	F	F	VG
*Xylene	P	P	P	F

Appendix H Key

1	Neoprene
2	Latex or Rubber
3	Butyl
4	Nitrile Latex
VG	Very Good
G	Good
F	Fair
P	Poor

* limited use

Modified from Appendix C, Chapter 5 of DOE OSH Technical Reference "Glove Selection Material" at http://tis.eh.doe.gov/docs/osh_tr/ch5c.html July 8, 1998.

NOTE: performance varies with material thickness and duration of contact. ALWAYS choose protective material carefully, and wash and/or remove after chemical contact.

APPENDIX I
Glossary

ACGIH - The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals, physical agents, and biological exposure indices.

ACUTE - Severe, often dangerous, conditions in which relatively rapid changes occur.

ACUTE EXPOSURE - An intense exposure over a relatively short period of time.

AEROSOL - Liquid droplets or solid particles dispersed in air that are of fine enough size (less than 100 micrometers) to remain dispersed for a period of time.

ALIPHATIC - Open-chain carbon compounds and those cyclic carbon compounds that behave, chemically, like an open-chain compound. Examples include methane and ethane.

ANSI - The American National Standards Institute is a voluntary membership organization (run with private funding) that develops consensus standards nationally for a wide variety of devices and procedures.

AROMATIC - Relates to the structural characteristics of the chemical and not to the odor of the chemical. Many aromatic compounds contain one or more six-carbon rings. Examples include benzene, toluene, naphthalene, and xylene.

ASPHYXIANT - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

BOILING POINT - The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

"C" OR CEILING - A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value - Ceiling. (See also Threshold Limit Value)

CANCER - A malignant tumor characterized by proliferation (rapid growth) of abnormal cells.

CARCINOGEN - A cancer-producing substance or physical agent in animals or humans. A chemical is considered a **carcinogen** or **potential carcinogen** if it is so identified in any of the following:

- National Toxicology Program, "Annual Report of Carcinogens" (latest edition)
- International Agency for Research on Cancer, "Monographs" (latest edition)
- OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances

C.A.S. NUMBER - Chemical Abstracts Service; a Columbus, Ohio organization which indexes information published in "Chemical Abstracts" by the American Chemical

Society and provides index guides by which information about particular substances may be located in the "Abstracts" when needed. "C.A.S. Numbers" identify specific chemicals.

CFR - Code of Federal Regulations

CHEMICAL - Any element, chemical compound or mixture of elements and/or compounds.

CHEMICAL FAMILY - A group of single elements or compounds with a common general name. Example: acetone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK) are of the "ketone" family; acrolein, furfural and acetaldehyde are of the "aldehyde" family.

CHEMICAL HYGIENE OFFICER - An employee who is designated by the employer and who is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

CHEMICAL HYGIENE PLAN - A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that (1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (2) meets the requirements of OSHA regulation 29 CFR 1910.1450.

CHEMICAL MANUFACTURER - An employer in SIC Codes 20 through 39 with a workplace where chemicals are produced for user or distribution.

CHEMICAL NAME - The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature or a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation.

CHEMICAL REACTION - A change in the arrangement of atoms or molecules to yield substances of different composition and properties. (See Reactivity)

CHRONIC - Persistent, prolonged or repeated conditions.

CHRONIC EXPOSURE - A prolonged exposure occurring over a period of days, weeks, or years.

COMBUSTIBLE LIQUID - Any liquid having a flashpoint at or above 100^{o}F (37.8^{o}C) but below 200^{o}F (93.3^{o}C) except any mixture having components with flashpoints of 200^{o}F or higher, the total volume of which make up 99% or more of the total volume of the mixture.

COMMON NAME - Any designation or identification, such as code name, code number, trade name, brand name, or generic name used to identify a chemical other than by its chemical name.

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

CONCENTRATION - The relative amount of a material in a combination with another material. For example, 5 parts (of acetone) per million (of air).

CONTAINER - Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purpose of this document, pipes or piping systems are not considered to be containers.

CORROSIVE - A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

CUBIC METER (m^3) - A measure of volume in the metric system.

CUTANEOUS - Pertaining to or affecting the skin.

DECOMPOSITION - The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

DERMAL - Pertaining to or affecting the skin.

DESIGNATED AREA - An area which has been established and posted with signage for work involving hazards, e.g. "select carcinogens," reproductive toxins, or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.

DILUTION VENTILATION - See General Ventilation.

DOT - The United States Department of Transportation is the federal agency that regulates the labeling and transportation of hazardous materials.

DUSTS - Dusts are solid particles generated by handling, crushing, grinding or rapid impact of organic and inorganic materials such as rock, metal, coal, wood, and grain. Dust is a term to describe airborne solid particles that range in size from 0.1 to 25 micrometers.

DYSPNEA - Shortness of breath; difficult or labored breathing.

EMPLOYEE - An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments. The term "employee" includes students, visiting professors and scholars, trainees, and other individuals who are subject to the same exposures or working conditions as employees.

EMPLOYER - The employer, for purposes of this document, means Purdue University.

EPA - U.S. Environmental Protection Agency; federal agency with environmental protection regulatory and enforcement authority. Administers Clean Air Act, Clean Water Act, FIFRA, RCRA, TSCA, and other Federal Environmental Laws.

EPA NUMBER - The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

EPIDEMIOLOGY - The study of disease in human populations.

ERYTHEMA - A reddening of the skin.

EVAPORATION RATE - The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

EXPLOSIVE - A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to a sudden shock, pressure, or high temperature.

EXPOSURE/EXPOSED - An employee is subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, injection or absorption), and includes potential exposure (i.e. accidental or possible).

^{O}F - Degrees, Fahrenheit; a temperature scale.

FLAMMABLE - A chemical that falls into one of the following categories:

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

ii) **flammable gas** - a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit.

iii) **flammable liquid** - any liquid having a flashpoint below 100^{O}F (37.8^{O}C), except any mixture having components with flashpoints of 100^{O}F (37.8^{O}C) or higher, the total of which make up 99% or more of the total volume of the mixture.

iv) **flammable solid** - a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a greater than one-tenth of an inch per second along its major axis.

FLASHPOINT - The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite in the presence of an ignition source or when tested as follows:

i) Tagliabue Closed Tester (See American National Standard Method of Test for Flashpoint by Tag Closed Tested, Z11.24-1979 (ASTM D-56-79)) for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100^{O}F (37.8^{O}C) or that contain suspended solids and do not have a tendency to form a surface film under test; or,

ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D-73-79)) for liquids with a viscosity equal to or greater than 45 SUS at 100^{O}F (37.8^{O}C), or that contain suspended solids, or that have a tendency to form a surface film under test; or,

iii) Setaflash Closed Tester (See American National Standard Method of Test for Flashpoint of Setaflash Closed Tester (ASTM D-3278-78)). Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any flashpoint determination methods specified above.

FORESEEABLE EMERGENCY - Any potential occurrence, such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

FORMULA - The scientific designation for a material (water is H_2O, sulfuric acid is H_2SO_4, sulfur dioxide is SO_2, etc.)

FUME - Small solid particles that have condensed in the air resulting from the heating of a solid body. Gases and vapors are not fumes, although the terms are often mistakenly used interchangeably.

g - Gram; a metric unit of weight. One U.S. ounce (avoirdupois) is about 28.4 grams.

g/kg - Grams per kilogram; an expression of dose used in oral and dermal toxicology testing to indicate the grams of substance dosed per kilogram of animal body weight. (Also see "kg" (kilogram))

GAS - A form of matter that is neither solid nor liquid. In its normal state (at room temperature and atmospheric pressure) it can expand indefinitely to fill a container completely. A gas can be changed to the liquid or solid state under the right temperature and pressure conditions.

GENERAL VENTILATION - Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition. (See Local Exhaust Ventilation)

HAZARD ASSESSMENT - A formal procedure undertaken by the supervisor in which occupational hazards for all employees are described per procedure or task, and by affected body part(s) or organ(s), and which is documented and posted in the workplace with all personal protective equipment requirements.

HAZARD WARNING - Any words, pictures, symbols or combination thereof appearing on a label or other appropriate form of warning which convey the hazards of the chemical(s) in the container(s).

HAZARDOUS MATERIAL - Any material which is a potential/actual physical or health hazard to humans.

HAZARDOUS MATERIAL (DOT) - A substance or material capable of posing an unreasonable risk to health, safety, and property when transported including, but not limited to, compressed gas, combustible liquid, corrosive material, cryogenic liquid, flammable solid, irritating material, material poisonous by inhalation, magnetic material, organic peroxide, oxidizer, poisonous material, pyrophoric liquid, radioactive material, spontaneously combustible material, an water-reactive material.

HAZARDOUS CHEMICAL - 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. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system,

and agents which damage the lungs, skin, eyes or mucous membranes. A chemical is considered **hazardous** if it is listed in any of the following:

- OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances
- "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment," ACGIH (latest edition)
- "The Registry of Toxic Effects of Chemical Substances," NIOSH (latest edition)

IARC - see International Agency for Research on Cancer

IDENTITY - Any chemical or common name which is indicated on the Material Safety Data Sheet (MSDS) for the chemical. The identity used shall permit cross-references to be made among the required list of hazardous chemicals, the label and the MSDS.

IGNITABLE - A solid, liquid or compressed gas waste that has a flashpoint of less than 140^{o}F. Ignitable material may be regulated by the EPA as a hazardous waste as well.

IMMEDIATE USE - The hazardous chemical will be under the control of, and used only by, the person who transfers it from a labeled container and only within the work shift in which it is transferred.

INCOMPATIBLE - The term applies to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

INGESTION - Taking a substance into the body through the mouth as food, drink, medicine, or unknowingly as on contaminated hands or cigarettes, etc.

INHALATION - The breathing in of an airborne substance that may be in the form of gases, fume mists, vapors, dusts, or aerosols.

INHIBITOR - A substance that is added to another to prevent or slow down an unwanted reaction or change.

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC) - An agency of the World Health Organization (WHO) whose mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control.

IRRITANT - A substance which, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or reaction of the eye, skin, nose or respiratory system. The contact may be a single exposure or multiple exposures. Some primary irritants: chromic acid, nitric acid, sodium hydroxide, calcium chloride, amines, metallic salts, chlorinated hydrocarbons, ketones and alcohols.

L - Liter; a measure of volume. One quart equals .9 liter.

LC_{50} - See Lethal Concentration**50**.

LD_{50} - See Lethal Dose**50**.

LABEL - Any written, printed or graphic material displayed on or affixed to containers of chemicals, both hazardous and non-hazardous.

LABORATORY - A facility where the "laboratory use of chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

LABORATORY SCALE - Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and

safely manipulated by one person. "Laboratory Scale" excludes those workplaces whose function is to produce commercial quantities of materials.

LABORATORY USE OF HAZARDOUS CHEMICALS - Handling or use of such chemicals in which all of the following conditions are met:

1. Chemical manipulations are carried out on a "laboratory scale";
2. Multiple chemical procedures or chemicals are used;
3. The procedures involved are not part of a production process nor in any way simulate a production process; and
4. "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

LEL - See Lower Explosive Limit.

LETHAL CONCENTRATION$_{50}$ - The concentration of an air contaminant (LC_{50}) that will kill 50% of the test animals in a group during a single exposure.

LETHAL DOSE$_{50}$ - The dose of a substance or chemical (LD_{50}) that will kill 50% of the test animals in a group within the first 30 days following exposure.

LFL - See Lower Explosive Limit.

LOCAL EXHAUST VENTILATION (Also known as exhaust ventilation) - A ventilation system that captures and removes the contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan, and possibly an air-cleaning device. Advantages of local exhaust ventilation over general ventilation include: it removes the contaminant rather than dilutes it, requires less airflow and, thus, is more economical over the long term; and the system can be used to conserve or reclaim valuable materials; however, the system must be properly designed with the correctly shaped and placed hoods, and correctly sized fans and ductwork.

LOWER EXPLOSIVE LIMIT (LEL - Also known as LFL) - The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in a percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn. (See also UEL)

m^3 - See Cubic Meter.

MATERIAL SAFETY DATA SHEET (MSDS) - Written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of 29 CFR 1910.1200.

MELTING POINT - The temperature at which a solid changes to a liquid. A melting range may be given for mixtures.

mg- See Milligram.

mg/kg - See Milligrams Per Kilogram.

mg/m^3 - See Milligrams Per Cubic Meter.

MILLIGRAM (mg) - A unit of weight in the metric system. One thousand milligrams equal one gram.

MILLIGRAMS PER CUBIC METER (mg/m^3) - Units used to measure air concentrations of dusts, gases, mists, and fumes.

MILLIGRAMS PER KILOGRAM (mg/kg) - This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 milligrams (of substance) per kilogram of body weight (of the experimental animal).

MILLILITER (ml) - A metric unit used to measure volume. One milliliter equals one cubic centimeter. One thousand milliliters equal one liter.

MIST - Small suspended droplets of liquid generated by condensation of liquids from the vapor back to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing. Some examples are paint spray mist in painting operations and the condensation of water to form a fog or rain.

MIXTURE - Any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.

ml - See Milliliter.

MSHA - The Mine Safety Health Administration; a federal agency that regulates the mining industry in the safety and health area.

MUTAGEN - Anything that can cause a change (or mutation) in the genetic material of a living cell.

NARCOSIS - Stupor or unconsciousness caused by exposure to a chemical.

NATIONAL TOXICOLOGY PROGRAM (NTP) - A collaborative program including the National Institute of Environmental Health Sciences (NIH/NIEHS), the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (CDC/ NIOSH), and the Food and Drug Administration's National Center for Toxicological Research (FDA/NCTR). Classifications published by the Report On Carcinogens are used by OSHA regulations as part of the definition of "select carcinogen."

NFPA - The National Fire Protection Association; a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 705, "Identification of the Fire Hazards of Materials". This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

NIOSH - The National Institute for Occupational Safety and Health; a federal agency that among its various responsibilities trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

NTP - see NATIONAL TOXICOLOGY PROGRAM

ODOR THRESHOLD - The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

ORAL - Having to do with the mouth

ORGANIC PEROXIDE - An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen

peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

OSHA - The Occupational Safety and Health Administration; a federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

OXIDATION - The process of combining oxygen with some other substance or a chemical change in which an atom loses electrons.

OXIDIZER - Is a substance that gives up oxygen easily to stimulate combustion of organic material.

OXYGEN DEFICIENCY - An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.

PEL - See Permissible Exposure Limit.

PERMISSIBLE EXPOSURE LIMIT (PEL) - An exposure, inhalation or dermal permissible exposure limit specified in 29 CFR Part 1910, subpart Z. PELs may be either a time-weighted average (TWA) exposure limit (8-hour), a 15-minute short-term limit (STEL), or a ceiling (C). The PELs are found in OSHA regulations part 1910, subpart Z. (See also TLV)

PERSONAL PROTECTIVE EQUIPMENT - Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles

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

POLYMERIZATION - A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

PPM - Parts (of vapor or gas) per million (parts of air) by volume.

PRODUCE - To manufacture, process, formulate, or repackage.

PROTECTIVE LABORATORY PRACTICES AND EQUIPMENT - Those laboratory procedures, practices and equipment accepted by the Chemical Hygiene Officer as effective in minimizing the potential for employee exposure to hazardous chemicals.

PUBLISHED EXPOSURE LIMITS - The exposure limits published in "NIOSH Recommendations for Occupational Health Standards" (current edition), or if none is specified, the exposure limits published in the standards specified by the American Conference of Governmental Industrial Hygienists in their publication "Threshold Limit Values and Biological Exposure Indices" (current edition).

PYROPHORIC - A chemical that will spontaneously ignite in the air at a temperature of 130^{o}F (54.4^{o}C) or below.

REACTIVITY - A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on an MSDS.

REPRODUCTIVE TOXINS - Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

RESPIRATOR - A device which is designed to protect the wearer from inhaling harmful contaminants.

RESPIRATORY HAZARD - A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some body function impairment.

RESPONSIBLE PARTY - Someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

SELECT CARCINOGENS - Any substance which meets one of the following:

1. It is regulated by OSHA as a carcinogen; or
2. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
3. It is listed under Group 1 ("carcinogen to humans") by the International Agency for Research on Cancer Monographs (IARC)(latest editions); or
4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP.

SENSITIZER - A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

SHORT-TERM EXPOSURE LIMIT - Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also the daily TLV-TWA must not be exceeded.

"SKIN" - This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes; thus, a protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not exceeded.

SPECIFIC CHEMICAL IDENTITY - The chemical name, Chemical Abstract Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

SOLVENT - A substance, commonly water, but in industry often an organic compound, which dissolves another substance.

STEL - Short-Term Exposure Limit

SUBSTANCE - A chemical element or compound; can also refer to a mixture.

SUPPORT SERVICES - The non-academic areas of University operations. This includes, but is not limited to, Physical Plant, Printing Services, Residence Halls, Mackey Arena, Purdue University Computing Center, Engineering Computer Network, Purdue Memorial Union, and Individual Department Print Shops.

SYNONYM - Another name by which the same chemical may be known.

SYSTEMIC - Spread throughout the body; affecting many or all body systems or organs; not localized in one spot or area.

TERATOGEN - An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

THRESHOLD LIMIT VALUE (TLV) - Airborne concentration of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLVs: Time-Weighted Average (TLV-TWA), Short-Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL).

TIME-WEIGHTED AVERAGE - The average time, over a given work period (e.g., 8-hour work day), of a person's exposure to a chemical or agent. The average is determined by sampling for the contaminant throughout the time period.

TLV - See Threshold Limit Value

TOXICITY - A relative property of a material to exert a poisonous effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

TRADE NAME - The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending upon the manufacturers or distributors involved.

TRADE SECRET - Any confidential formula, pattern, device, information or compilation of information (including chemical name or other unique chemical identifier) that is used in an employer's business and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.

TWA - See Time-Weighted Average

UEL - See Upper Explosive Limit

UFL - See Upper Explosive Limit

UNSTABLE (REACTIVE) - A chemical which, in the pure state or as a produced or transported, will vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, or temperature.

UNIVERSITY - The Purdue University system of campuses for which the main campus has health and safety authority. This includes the main campus, Calumet, Ft. Wayne, and North Central campuses.

UPPER EXPLOSIVE LIMIT (Also known as upper flammable limit) - The highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1 ppm and the UEL is 5 ppm, then the explosive range of the chemical is 1 ppm to 5 ppm. (Also see LEL)

USE - To package, handle, react, or transfer

VAPOR - The gaseous form of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with lower boiling points will evaporate faster.

WATER-REACTIVE - A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

WORK AREA - The department or office in which an employee may work. Maintenance, Building Services, Department of Aviation Technology, the Office of the Registrar, and Environmental Control and Abatement are examples of work areas.

WORK LOCATION - The site on campus and/or University property where the actual job occurs.