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Applicability: Chemical Hygiene Program

Program

PURPOSE

The purpose of the Lehigh University Chemical Hygiene Plan is to help ensure that personnel working in laboratories are not overexposed to hazardous chemicals in the performance of their jobs. The Plan is designed to protect employees from recognizable health hazards associated with chemicals utilized in their laboratories. It has been designed to be in compliance with OSHA 1910.1450 "Occupational Exposures to Hazardous Chemicals in Laboratories."

The plan is general in nature and is intended to be used as a basic reference for controlling ordinary laboratory hazards. This document does not represent the final word on laboratory health and safety practices and should be used primarily as a source of information along with other materials when training employees. Furthermore, the dynamic nature of health and safety work, as well as the frequent changes in state and national health and safety regulations, predicate against the plan ever being complete.

At times, it may be necessary to deviate somewhat from this plan, but only if safety can be maintained and applicable laws or license provisions are not circumvented. Whenever special hazards are encountered, it will be necessary to search beyond this plan in the development and application of appropriate safety procedures. Environmental Health and Safety should be consulted before varying from the plan and during the establishment of procedures to control special hazards.

I. CHEMICAL HYGIENE RESPONSIBILITIES

A. INTRODUCTION

Development, implementation, and maintenance of a comprehensive health and safety program require the participation of many different people. This section identifies key personnel on whom the responsibility for this program rests and defines the nature of their responsibilities.

B. RESPONSIBILITIES

Responsibilities for chemical hygiene rest at all levels of the University and involve the following individuals and groups:

1. **University President**

   The President has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene.

2. **Provost Council**
   The Council shall oversee the University Laboratory Safety Committee and advise the President on chemical hygiene practices and compliance with the OSHA standards.

3. **University Laboratory Safety Committee**

   This committee shall consist of at least six (6) members and shall include, but not be limited to: the Director of Environmental Health and Safety, representative from LU Facilities, Director of Risk Management, and representatives from Departments, Centers, and Institutes with laboratories. This committee shall meet a minimum of four (4) times per year, more frequently if necessary, to conduct business pertaining to laboratory safety. In some cases, memos and/or correspondence may replace the yearly meeting. The University Laboratory Safety Committee shall report directly to the Provost.

   The duties of the University Laboratory Safety Committee shall include the following:

   a. Provide advice to the office of Environmental Health and Safety regarding the overall direction of the safety program.

   b. Review policies, rules and procedures issued by the office of Environmental Health and Safety.

   c. Help identify buildings, departments, centers and institutes requiring local safety committees. Assist these departments with guidance and support.

   d. Receive and hear reports from other environmental health and safety committees (Radiation Safety Committee, Biosafety Safety Committee, etc.) as needed.

   e. Review accident and incident reports from insurance companies, local safety committees and regulatory investigations.

   f. When it deems necessary, the Laboratory Safety Committee may, by a majority vote of members present at a committee meeting, initiate special safety investigations and make decisions on safety related issues.

   g. Keep minutes of committee meetings.

4. **Local Safety Committee**

   Because of their diversified activities and complex safety problems, certain departments, centers and institutes have been requested to maintain active safety committees within their organization. These committees are appointed by the Department Heads and/or Center/Institute Directors, whichever is applicable. The local committee shall consist of at least two members who will meet periodically to review and act on safety matters.

The duties of these committees include:

a. Conduct or commission safety inspections to identify hazardous conditions and implement corrections of unsafe conditions and practices within their operational unit(s).

b. Communicate and exchange information with the University Laboratory Safety Committee and Environmental Health and Safety.

c. Investigate accidents when necessary, implement safety training, and establish safety rules and procedures within their operational unit(s).

5. **Chemical Hygiene Officer (CHO)**

Each Department, Center and Institute with laboratory operations covered by the OSHA standard will have a functioning Chemical Hygiene Officer appointed by the Head of the Department, Center or Institute. The responsibility of the Chemical Hygiene Officer is to provide guidance for the implementation of the Chemical Hygiene Plan specific to his/her respective operational unit. The duties of the CHO are as follows:

a. Work with the local safety committee, researchers, administrators and other laboratory personnel to develop and implement appropriate chemical hygiene policies and practices specific to their operational unit.

b. Assist principal investigators to develop precautions and adequate facilities to conduct research.

c. Be familiar with current regulations concerning regulated substances and with the Department Head, Center and Institute Director, Safety Committee and Environmental Health and Safety ensure that action is taken to correct work practices and conditions that may result in overexposures and/or releases of toxic chemicals.

d. Monitor the safety performance of laboratory personnel to ensure that the required safety practices and techniques are being employed.

e. Seek ways to improve the chemical hygiene program.

6. **Principal Investigator/Center/Institute Director or Department Head**

This individual has primary responsibility for chemical hygiene in their operational unit.

7. **Laboratory Supervisor**

The Laboratory Supervisor has overall responsibility for chemical safety in the laboratory, which includes but is not limited to the following functions:

a. Ensure that laboratory personnel are informed of the contents of the OSHA Laboratory Standard and Lehigh's Chemical Hygiene Plan, and follow the chemical hygiene rules, that protective equipment is available, properly maintained and in working order, and that appropriate training has been provided concerning the hazards of all materials being used.

b. Conduct regular chemical hygiene and housekeeping inspections. A minimum of one inspection per semester.

c. Ensure the adequacy of facilities and training for use of any material/chemical being ordered. All lab personnel must be properly trained for the lab activities to be conducted and the training must be documented and available for review by EH&S and/or outside agencies.

d. Determine the type of protective apparel for use in the laboratory. Maintain all lab equipment (gas alarm systems, autoclaves, etc.) per manufacturer's recommendations including any and all preventative maintenance on the equipment.

e. Prepare, maintain and update chemical inventories, lab layouts and Standard Operating Procedures (SOPs) for the laboratory.

f. Become familiar with the operational unit Chemical Hygiene Officer and Lehigh University policies, written safety programs, safety training programs and University committees which may impact your research project.

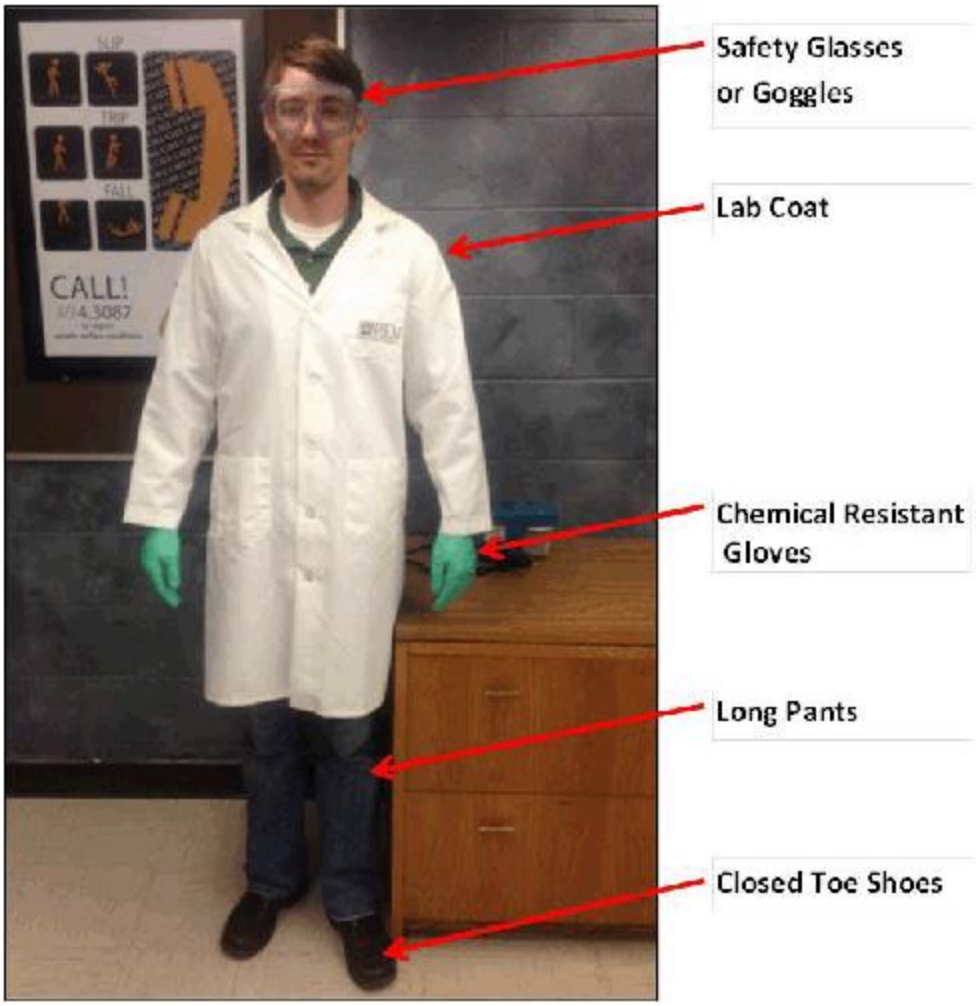
8. **Laboratory Worker**

Each worker is responsible for:

a. Planning and conducting each operation in accordance with institutional chemical hygiene procedures and specific policies and procedures for his/her laboratory and developing good personal hygiene habits.

b. Wearing the safety equipment and personal protective equipment necessary to perform each task they are assigned.

c. Reporting to the laboratory supervisor or the chemical hygiene officer all facts pertaining to every accident that results in exposure to toxic chemicals, and any action or condition that may exist that could result in an accident.



II. TOXICOLOGY

Individuals performing laboratory activities shall be aware of the toxicological characteristics of each chemical they are working with in their lab.

Factors to consider include:

- Type of Hazard (Physical and Health Hazards)
- Routes of Entry
- Signs and Symptoms of Overexposure
- Occupational Exposure Limits

Type of Hazard

Chemical hazards may be one of the following types: Physical Hazard, ad/or Health Hazard. Physical hazards act outside of the body to cause harm and may include flammables, explosives, oxidizers and reactants. Health hazards are defined by OSHA as a chemical which is classified as posing one of the following hazards: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization: germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard.

HCS-2012 complaint labels shall contain pictograms for each hazard associated with the chemical. The pictogram on the label is determined by the chemical hazard classification.

Routes of Entry

Knowing the routes of entry for a chemical is an important step in identifying proper controls and protective equipment necessary for the activity. Routes of entry will be designated by the SDS and/or the specific laboratory procedure (if developed).

ROUTES OF ENTRY

Chemical and biological hazards can be transported into the human body by various agents, pathogens and other forms, through the four main routes of entry;

1. **Inhalation –** taken into the body through the lungs
2. **Absorption -** taken into the body through the skin
3. **Ingestion -** taken into the body orally
4. **Injection (direct entry) -** taken into the body through broken skin

Signs and Symptoms of Exposure

It is critically important that laboratory workers are aware of and recognize the signs and symptoms of chemical exposure. Prior to work, the SDS should be reviewed for associated signs and symptoms.

Signs and symptoms of chemical exposure may include (these symptoms may also be associated with conditions other than chemical exposure):

- Skin that has become dried, whitened, reddened, swelled, blistered, and itchy or exhibits a rash.
- A chemical odor. Many chemicals can be smelled at concentrations below harmful levels. Harmful levels may also be present for some chemicals without a detectable odor. Consult the SDS.
- A chemical taste.
- Tearing or burning of the eyes.
- Burning sensations of the skin, nose or throat.
- Cough, headache or dizziness.

Occupational Exposure Limits

The **occupational exposure limit** (OEL) represents the maximum airborne concentration of a toxic substance to which a worker can be exposed over a period of time without suffering any harmful consequences. These include: ACGIHs Threshold Limit Values, OSHAs Permissible Exposure Limits (PELs) or Action Levels, NIOSHs Recommended Exposure level (REL), Ceiling Values and Immediately Dangerous to Life and Health (IDLH) atmospheres.

III. RECOGNITION AND ANTICIPATION OF LABORATORY HAZARDS

A. INTRODUCTION

The initial step in the development of an overall laboratory health and safety program is to identify the chemical, biological, radiological and physical hazards that are present in the laboratory. The following section provides a framework for developing this component of the program and shows how to recognize hazards initially. Lehigh has instituted several programs and procedures which address recognition and anticipation of laboratory hazards. They are as follows:

- OSHA Hazard Communication Program
- Safety Data Sheet Availability
- Preliminary Hazard Assessment and Management of Change
- Hazardous Chemicals Lists
- Labels and Other Forms of Warnings
- Employee Safety and Health Training

B. OSHA HAZARD COMMUNICATION STANDARD

The Occupational Safety and Health Administration (OSHA) have issued a regulation which standardizes how chemical information about products used in the workplace will be made available to employees. This regulation is called the OSHA Hazard Communication Standard or, more commonly, the "Worker Right-To-Know". Lehigh's Hazard Communication Program and the procedures contained in it are available to all chemical users at the University.

This OSHA regulation requires employers such as Lehigh to establish a hazard communication program to inform workers of the potential danger of hazardous substances in their work areas. The key elements of the program are:

- Chemical information availability
- Employee training
- Container labeling

The Hazard Communication Program will be made available to all faculty, staff and students on the Environmental Health & Safety website:

https://facilities.lehigh.edu/environmental-health-safety

C. SAFETY DATA SHEETS

Safety data sheets (SDSs) pertaining to chemicals used in a particular department, building, laboratory or area are maintained at those locations and are available for your review. SDSs for hazardous chemicals can also be located on the manufacturers' website.

D. PRELIMINARY HAZARDS ASSESSMENT AND MANAGEMENT OF CHANGE

The Office of Research and Sponsored Programs has incorporated a Preliminary Hazards Assessment (PHA) Form into each researcher's grant application file.

This form is intended to alert responsible parties at the University to the potential hazards and possible impacts associated with the research. This process will aid in planning for adequate facilities and will assist in developing a program which is in compliance with Lehigh University safety guidelines and outside regulatory agencies. The Preliminary Hazards Assessment Form should be completed by the principal investigator before the proposal is submitted to the sponsoring agency.

When Environmental Health and Safety receives the completed PHA, it will be reviewed for potentially hazardous operations and assigned a Hazard Assessment number. The findings will be discussed with the principle investigator and other impacted University departments (Planning, LU Facilities, etc.).

If the PHA indicates that supplementary controls may be needed, Environmental Health and Safety will work with the principal investigator and other resource persons, committees and consultants to determine their necessity. If additional engineering controls, personal protective equipment and/or work practices are deemed necessary, the principal investigator will include them in the standard operating procedures for that laboratory.

At some point after the grant application has been approved, the principal investigator will be sent a Management of Change Form. This form should be completed if any changes are made in the research that would significantly alter the nature or degree of potential or existing hazards. All changes to the research project need to be documented and filed with Environmental Health and Safety. Copies of both the Preliminary Hazards Assessment and Management of Change forms can be found in the Appendix A.

E. HAZARDOUS CHEMICALS INVENTORY

The University maintains an inventory of the hazardous chemicals known to be present in the workplace. The Hazardous Chemical inventory is available at the following location:

Environmental Health and Safety
211 Warren Square
Contact: Director of Environmental Health and Safety

F. LABELS AND OTHER FORMS OF WARNINGS

Requirements for labeling of chemical containers come from the Occupational Safety and Health Administration (OSHA) Hazard Communication and Laboratory Safety standards. All hazardous chemicals are required to be properly labeled (full chemical name) unless they are exempted by this standard.

OSHA either exempts or does require labeling for certain chemicals that are covered under other regulations (they have their own labeling requirements). These chemicals include: pesticides; Toxic Substance Control Act chemicals; Food, Drug & Cosmetic Act chemicals; spirits; consumer products; chemicals regulated under the Department of Agriculture; hazardous waste; tobacco products, wood products; ionizing radiation; biological hazards. OSHA also exempts portable containers (stock solutions) that are intended for the immediate use by the employee performing the transfer.

If chemicals are not exempted or covered under other regulations as indicated above, OSHA then says labels are required for them if they are hazardous chemicals. OSHA defines a hazardous chemical as anything that is a physical or health hazard. Physical hazards are pretty straight forward. They include flammable and combustible liquids, compressed gasses, explosives, organic peroxides, oxidizers, pyrophorics, and water reactives. Health hazards are a little harder to determine, however OSHA indicates they include the following: carcinogens; reproductive toxins; sensitizers; irritants; corrosives; neurotoxins; hepatotoxins; nephrotoxins; agents that act on the hematopoietic system; and agents that damage the lungs, skin, eyes or mucus membranes.

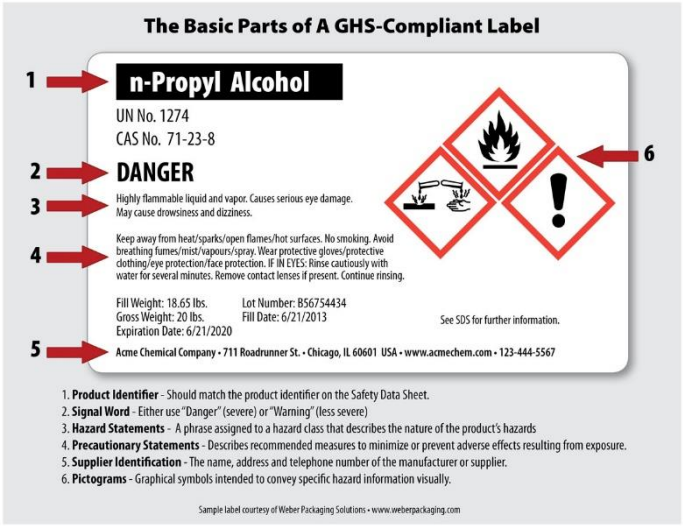
Dram vials and other small containers can be difficult to label because of their size. In this instance, we recommend that you place these items in test tube racks, boxes or other containers, and label these items instead. Labeling a shelf or draw where these chemicals are located is also possible, however any chemicals removed that do not have a full chemical name, must remain under your direct control and supervision.

Labels on purchased chemicals must include:

1. The common name of the chemical
2. The name, address and emergency phone number of the company responsible for the product
3. An appropriate hazard warning

The warning may be a single word – “danger,” “warning” and “caution” – or may identify the primary hazard, both physical (i.e., water reactive, flammable or explosive) and health (i.e., carcinogen, corrosive, or irritant). Most labels will provide you with additional safety information to help you protect yourself while working with substances. This includes protective measures to be used when handling the material, clothing that should be worn, first aid instructions, storage information and procedures to follow in the event of a fire, leak or spill. A good example of a label that meets OSHA requirements is included below.

Read the label each time you use a newly purchased chemical. It is possible the manufacturer may have added new hazard information or reformulated the product since your last purchase, and thus altered the potential hazards you face while working with the product.



G. EMPLOYEE SAFETY AND HEALTH TRAINING

Departmental supervisors, faculty, and designated faculty assistants may utilize SDSs and other available information to train new employees who are assigned to their work area. Work area supervisors and faculty train employees concerning methods and observations that the employee can use to detect the presence or release of a hazardous chemical in the work area. These techniques include use of monitoring devices and development of the ability to recognize the appearance and/or odor of hazardous chemicals. Supervisors and faculty also review the physical and health hazards of work area chemicals with new employees, as well as measures employees can take to protect themselves from hazards, including pertinent work practices, University emergency procedures, and personal protective equipment.

Environmental Health and Safety conducts regularly scheduled safety training programs which are available to all Lehigh faculty, staff and students. Online safety training programs (available 24/7) are on the EH&S website and include both a safety training module and proficiency quiz. Specialized safety training programs (Field Safety, Safe HF Use, etc.) are developed as requested or required.

Key elements of a successful safety and health training program include:

- General safety and health rules and procedures
- General chemical hazards
- Chemical labeling requirements
- Understanding safety data sheets
- Access to safety and health information
- Compliance with Lehigh University safety and health rules and procedures
- Summary of the OSHA Hazard Communication Standard and/or the Chemical Hygiene Plan
- Specific operations in work areas where hazardous chemicals are present
- The location and availability of the written Lehigh University Hazard Communication Program
- Lehigh University Chemical Hygiene Plan & Lab Safety Handbook

H. LAB DOOR POSTINGS - LAB LAYOUTS AND CHEMICAL INVENTORY FORMS

All laboratory doors must be posted with both an updated lab layout form and chemical inventory. The purpose of these forms is for emergency response. It is the responsibility of the principal investigator (PI) to update these forms a minimum of once per semester or on an as needed basis (if a student graduates, leaves their research team, professor is on sabbatical, etc.)

A copy of both forms can be found in Appendix B.

I. MEDICAL MONITORING PROGRAM

Lehigh University will provide all personnel who work with hazardous chemicals an opportunity to receive medical attention, including follow-up examinations which the examining physician determines to be necessary, under the below circumstances. All required medical examinations and consultations will be provided to laboratory personnel at no cost, without loss of pay and at a reasonable time and place.

- Whenever an employee, visitor or student develops signs or symptoms associated with a hazardous chemical to which these personnel may have been exposed in the laboratory, the personnel shall be provided an opportunity to review an appropriate medical examination.

- Where exposure monitoring reveals an exposure level routinely above the action level (or the PEL, in the absence of an action level) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected personnel as prescribed by the particular standard.

- Whenever an event takes place in a work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected personnel shall be provided the opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

- Whenever significant work with chemicals of high chronic toxicity or select carcinogens occurs, Lehigh University shall provide the following information to the physician:

    - The identity of the hazardous chemical(s) to which the personnel may have been exposed.
    - A description of the conditions under which the exposure occurred including quantitative exposure data, if available.
    - A description of the signs and symptoms of exposure that the affected person is experiencing, if any.

For examinations and consultations required under this plan, Lehigh University will obtain a written opinion from the examining physician which shall include the following:

- Any recommendation for further medical follow-up.
- The result of the medial examination and associated tests.
- Any medical condition which may be revealed in the course of the examination which may place the person at increased risk of exposure to a hazardous chemical in the workplace.
- A statement that the person has been informed by the physician of the results of the consultation or medical examination and of any medial condition that may require further examination or treatment. The written opinion shall not reveal specific findings or diagnoses unrelated to occupational exposure.

In addition to the provisions stated above, personnel trained in first aid (Lehigh EMS Team) will

be available during normal working hours. All medical recordkeeping shall be in compliance with the requirements of the OSHA Medical Recordkeeping Standard codified at 29 CFR 1910.1020.

J. PLAN REVIEW AND UPDATES

The Chemical Hygiene Officer shall review the entire Chemical Hygiene Plan at least annually and shall make any revisions as deemed necessary to maintain compliance.

K. RECORDKEEPING

Lehigh University will maintain accurate and complete records relative to: Chemical Hygiene Plan reviews and updates; Medical examination and consultation records as applicable; Exposure monitoring reports; Personnel Training; Laboratory inspections; and, Accident reports. Records shall be maintained in accordance with 29 CFR 1910.1020(h) "Access to Employee Exposure and Medical Records."

L. LABORATORY SAFETY INSPECTIONS

Inspections of laboratory equipment and practices will be performed in accordance with the Laboratory Inspections SOP (Appendix C) to ensure all elements of this Plan are implemented.

M. PREGNANCY IN THE LAB

By using prudent work practices, most laboratory workers who are pregnant or planning pregnancy can work safely in research laboratories without exposing the fetus to potentially harmful chemicals.

Reproductive toxins are chemicals that can affect the reproductive system, including mutagens (chromosomal damage) and embryotoxins (harm the fertilized egg or fetus). Some chemicals may cross the placenta, exposing the fetus. A developing fetus may be more sensitive to some chemicals than its pregnant mother, particularly during the first twelve weeks of pregnancy, when the mother may not know she is pregnant. Proper handling of chemicals and use of protective equipment is especially important to reduce fetal exposure to chemicals.

Laboratory workers who are contemplating pregnancy or are pregnant should review the toxicity of the chemicals in their laboratory and may consult EH&S to determine whether any of the materials used in the laboratory pose additional risk during pregnancy. EH&S provides confidential counseling to help determine what actions are recommended.

For more information, contact EH&S at X84251.

IV. CONTROL OF CHEMICAL HAZARDS & GENERAL SAFETY PRACTICES

A. STANDARD OPERATING PROCEDURES (SOPS)

Each principal investigator/lab supervisor shall develop and have available for use by their laboratory personnel documents that provide detailed descriptions of standard methods or operations used in that laboratory. These documents, referred to as Standard Operating Procedures (SOPs), will be used by all employees. They should describe how to perform the method or operation in question. SOPs should be written clearly and precisely so that an individual responsible for a particular procedure or piece of equipment can easily understand them. In addition, each employee should read all SOPs associated with his/her particular area of responsibility and should acknowledge that the SOPs are understood.

B. DEVELOPMENT OF STANDARD OPERATING PROCEDURES

A good Standard Operating Procedure is one that is clearly stated and realistic in scope. Each principal investigator shall prepare SOPs for all their routine, repetitive and unique operations as well as for non-routine events (e.g., spills, shutdown procedures). Each principal investigator should take care to develop required and ancillary procedures in a consistent manner. The following general information, in conjunction with procedures, may be useful in establishing an accurate document.

- Photographs, graphs, or illustrations
- Flow charts, if applicable
- Appropriate forms
- Equipment used during a particular operation (cross-reference appropriate Equipment SOPs)
- Emergency contacts
- Published literature used as a supplement

The format of all SOPs should be consistent. A sample SOP along with a blank form is included in Appendix D. This SOP is a template which can be used by the principal investigator for a variety of laboratory operations. If another format is to be used, be sure that it contains all the information found in the sample SOP. In some cases, research protocols or grant applications can with some modification be used as SOPs. The decision to use another format for the SOP rests with the principal investigator.

C. VENTILATION

The quality and quantity of hood ventilation in each laboratory building will be monitored by a qualified ventilation firm. LU Facilities will do the selecting and screening of outside firms and will coordinate the schedule for yearly hood evaluations. In addition, all ventilation paperwork and reports will be maintained by LU Facilities. The hoods will be evaluated at least annually (or as needed) for the following factors:

- Adequate and appropriate captive velocities and airflow volume
- Adequate routine and preventative maintenance

Deficiencies found by the outside ventilation contractor will be reported to LU Facilities, along with suggested remedial actions. The contractor will also provide guidelines for restricted hood use until remedial actions are complete, or, where deficiencies cannot be corrected, for discontinued use of the hood. If any alterations of the ventilation system are considered, the system should be checked to ensure that worker protection to airborne toxic substances is not comprised.

D. GENERAL LABORATORY VENTILATION

General laboratory ventilation is intended primarily to increase the comfort of laboratory workers and to provide a supply of air that will be exhausted by a variety of auxiliary local ventilation devices (hoods, vented storage cabinets, etc.). This ventilation provides only very modest protection from toxic gases, vapors, aerosols and dusts, especially if they are released into the laboratory in any significant quantities. Simply stated, laboratory workers should regard the general laboratory atmosphere only as a source of air to breathe and a source of input air for auxiliary local ventilation devices.

E. LABORATORY HOODS

The following factors should be kept in mind whenever using hoods:

1. Conduct all operations that may generate irritating and/or hazardous air contaminants inside a fume hood.

2. Ensure that the hood is operating by looking at the flow indicator. If the hood is not operating, report this information to LU Facilities immediately. Do not use the hood!

3. Keep all apparatus and chemicals at least six inches (6") back from the face of the hood.

4. Minimize any obstruction of rear baffles by apparatus or containers.

5. Use equipment with legs, or raise it off the work surface with blocks to allow even airflow under equipment.

6. Minimize sources of turbulence at the hood face including foot traffic, ventilation supply diffusers, fans, or abrupt moving of arms in and out of the hood.

7. Do not lean into the hood or put your head in the hood when in use.

8. Do not permanently store chemicals or apparatus in the hood. Do not vent waste chemicals in the hood.

9. Keep the hood sash closed as much as possible. During use, position sash at or below the height indicated on the yellow hood certification sticker.

10. Do not place electrical receptacles or other ignition sources inside the hood when flammable liquids or gases are present. Permanent electrical receptacles are not permitted in the hood.

11. Face velocities should typically range from 80-120 linear feet per minute as measured by a standard airflow meter.

F. OTHER LOCAL VENTILATION DEVICES

In some cases, other local ventilation devices such as ventilated storage cabinets and snorkels may be required. If devices such as these are needed, the principal investigator should contact LU Facilities to discuss installation and operating requirements.

G. DESIGNATED WORK AREAS

All laboratory rooms are delineated as designated work areas by appropriate signage. Eating, drinking, application of cosmetics (including lip balm) and use of tobacco and vaping products are prohibited in these designated work areas. Additionally, activities involving certain classes of chemicals will require more stringent controls, additional signage and restrictions for the associated laboratory. These chemical classes may include: select Carcinogens; Allergens and Embryotoxins; chemicals designated as Moderate Chronic or High Acute Toxicity; and, chemicals designated as High Chronic Toxicity.

Examples of lab signage:

H. PROTECTIVE EQUIPMENT

Laboratory operations frequently involve a risk of clothing or skin contact with hazardous materials. While engineering and administrative controls and good work practices reduce this risk, it is often necessary to augment those measures with personal protective equipment.

The need for protective equipment in a laboratory depends on the type of work being done, the chemical, biological or physical agents being used and the potential for exposure. It is the responsibility of the principal investigator, with the assistance of Environmental Health and Safety, if necessary, to determine the type and level of protective equipment that is required. Lehigh University Laboratory Stores or an outside vendor can be used to purchase the equipment.

Attire Requirements and Body Protection

All laboratory personnel and any visitors are required to abide by the following attire requirements for any entry into a Lehigh University laboratory setting:

1. All loose hair and clothing must be confined.
2. Closed-toe shoes are required.
3. Contact lenses are prohibited.
4. Entry into a laboratory where active work is performed requires the use of a flame-resistant lab coat and goggles, at a minimum.
5. Footwear that is appropriate (minimizing slip/trip potential) for the laboratory setting shall be worn.

   Additional PPE may be required based on current lab activities. This may include: hand and face protection, respiratory protection, or the use of chemical-resistant aprons or coats.

Eye and Face Protection

Eye and face protection shall include the use of safety goggles or glasses at a minimum. Goggles are required for most activities and entry into active laboratories. Glasses shall be assigned for work with solid materials. For laboratory activities that involve increased chemical splash potential (such as pouring chemicals), vacuum work or flying particles, goggles/glasses shall be used in concert with face shields. The level of eye/face protection

shall be assigned and enforced by the Principal Investigator.

All safety glasses/goggles shall comply with the ANSI Occupational and Educational Eye and Face Protection Standard (Z87.1).

Hand Protection

Chemical-resistant gloves are required for any active laboratory activity. Further protection (such as double gloving, increased chemical resistance, or different glove material) may be assigned by the Principal Investigator.

1. Gloves are to be inspected prior to, and throughout use.
2. Gloves are to be removed prior to leaving the laboratory using the one-hand technique.
3. Laboratory personnel shall wash hands immediately after glove use.
4. Care should be taken regarding handling of objects (pens, phones, doorknobs) that were handled while donning gloves.

Foot Protection

Wear closed-toe shoes at all times in buildings where chemicals are stored or used. Do not wear perforated shoes, sandals or cloth sneakers in laboratories or where mechanical work is conducted. These shoes offer no barrier between you and chemical and physical hazards.

Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup). Leather shoes tend to absorb chemicals and may have to be discarded if contaminated with a hazardous material.

Although generally not required in most laboratories, steel-toed safety shoes may be necessary when there is a risk of heavy objects falling or rolling onto the feet, such as in bottle-washing operations or animal care facilities.

These are some examples of footwear that is **NOT** appropriate lab work:

I. RESPIRATORY PROTECTION

Lehigh University has developed a written Respiratory Protection Program which establishes guidelines for the use of respirators. It is the University's policy to control employee exposures to air contaminants through the use of engineering controls, ventilation technologies, and the substitution of less toxic materials.

This Program has been developed to meet OSHA requirements specified at 29 CFR 1910.134. These requirements include: Appropriate selection of respirators, Medical pre-qualification, Training, Fit Testing, Proper use, Inspection and Maintenance of the respirator.

Respirators are required when these control measures are not feasible, are being installed, in emergencies and when the exposure to air contaminants is likely to exceed an OSHA permissible

exposure level and/or action level.

If it is suspected that a respirator may be required to control personal exposures to contaminants, contact Environmental Health and Safety at X84251 for an evaluation. Copies of the Respirator Protection Program can be obtained by contacting Environmental Health and Safety at X84251 .

J. CHEMICAL EXPOSURE EVALUATION MONITORING AND SAMPLING

Operations that are typically conducted in laboratories may create a variety of exposure risks. The laboratory supervisor's role for minimizing exposures to personnel is to ensure that his/her personnel are adequately trained, use proper protection equipment (ventilated fume hoods, gloves, respirators, etc.) and that he/she is familiar with safety precautions and emergency procedures before undertaking any laboratory work.

If after all the above precautions have been taken and chemicals are still thought to be released into the laboratory environment, exposure monitoring may be appropriate and Environmental Health and Safety should be informed by the laboratory supervisor or the affected individual.

Exposure monitoring will consist of identifying and evaluating sources of exposures, then measuring chemical concentrations via a wide range of sampling techniques. The sampling logic diagram (Appendix E) is one approach that will be used for determining whether chemical sampling is required. If necessary, Environmental Health and Safety will request that a representative from the University Laboratory Safety Committee be involved with the preliminary walk-through survey of the laboratory in question to identify operations and chemicals that present the greatest potential health risk. After identification of these operations, chemicals, and the personnel potentially exposed, a sampling plan will be developed.

When the sampling has been completed, the results will be reviewed by Environmental Health and Safety, and if necessary, the University Laboratory Safety Committee or other outside consultant. The employee will be notified of the sampling results, and, if necessary, exposure control measures will be initiated. Control techniques may include upgrading hood ventilation, induction into Lehigh University's Respiratory Protection Program, work practice modifications, etc. The use of microscale laboratory experiments is encouraged to reduce chemical exposures, hazardous waste and spill potential.

V. GENERAL PRINCIPLES FOR WORK WITH LABORATORY CHEMICALS

A. INTRODUCTION

People who work in scientific laboratories are exposed to many kinds of hazards. The hazards of handling chemicals in the laboratory may be classified broadly as physical or chemical. Physical hazards include those of fire, explosion and electric shock, which are extremely serious and not unfamiliar in most laboratories. Other physical hazards arise from means of containment, such as cylinders of compressed gases, cryogenic equipment, furnaces, refrigerators and glass apparatus.

Chemical hazards are associated with their toxic effects and may be subclassified as acute or chronic. Acute hazards are those capable of producing prompt or only slightly delayed effects (such as serious burns, inflammation, allergic responses, or damage to the eyes, lungs, or nervous system). Some chemicals are extremely dangerous in this respect and small amounts can cause death or severe injury very quickly.

Other toxicological effects of chemicals may be delayed or develop only after exposure over long periods of time and are referred to as chronic. These effects may involve cumulative damage to many different organs or parts of the body. Some are reversed on elimination of exposure to the chemical, but some are nearly irreversible, especially after much damage has occurred.

Carcinogenic effects are usually chronic.

B. RECOMMENDATIONS FOR SAFE PRACTICES IN LABORATORIES

EVERYONE involved in laboratory operations must be safety minded. Each laboratory worker should develop good personal safety habits which include the following:

- **Eye protection should be worn at all times**
- **Exposure to chemicals should be kept to a minimum (wear PPE at all times)**
- **Smoking, eating and drinking should be avoided in areas where chemicals are present**
- **Safety carriers should always be used when transporting chemicals**

Advance planning is one of the best ways to avoid serious incidents. Before performing any chemical operation, the laboratory worker should consider "What would happen if....?" and be prepared to take proper emergency actions.

Over familiarity with a particular laboratory operation may result in overlooking or underrating its hazards. This attitude can lead to a false sense of security, which frequently results in carelessness. Every laboratory worker has a basic responsibility to themselves and colleagues to plan and execute laboratory operations in a safe manner.

Some general chemical safety guidelines are presented on the next few pages. Additional laboratory safety information is available in the Lehigh University Laboratory Safety Handbook which can be obtained by contacting Environmental Health and Safety at X84251.

C. GENERAL GUIDELINES

The following guidelines represent the basic Standard Operating Procedures that all laboratory workers should follow. These procedures should be supplemented by the Standard Operating Procedures that each laboratory supervisor has developed for his/her particular laboratory.

1. Know the safety rules and procedures that apply to the work that is being done. Determine the potential hazards (chemical, biological) and appropriate safety precautions before beginning any new operation.

2. Know the location of and how to use the emergency equipment in your area, as well as how to obtain additional help in an emergency, and be familiar with emergency procedures.

3. Know the types of protective equipment available and use the proper type for each job.

4. Be alert to unsafe conditions and actions and call attention to them so that corrections can be made as soon as possible. Someone else's accident can be as dangerous to you as any you might have.

5. Avoid consuming food or beverages or smoking in areas where chemicals are being used or stored.

6. Follow Lehigh University waste disposal procedures.

7. Be certain all chemicals are correctly and clearly labeled. Post warning signs when unusual hazards, such as radiation, laser operations, flammable materials, biological hazards, or other special problems exist.

8. Avoid distracting or startling any other worker. Practical jokes or horseplay cannot be tolerated at any time.

9. Use equipment only for its designated purpose.

10. Think, act, and encourage safety until it becomes a habit.

D. 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? Is the material toxic, and if so, how can one be exposed to the material (inhalation, skin or eye contact, accidental ingestion, accidental puncture)?

2. What kind of ventilation does one need for protection? What kind of personal protective equipment (i.e. gloves, respirator, and goggles) does one need for protection?

3. Will the process generate other toxic compounds, or could it result in a fire, explosion, etc.?

4. Are the proposed storage facilities appropriate for the type of materials required? How can incompatible materials be segregated?

5. What possible accidents can occur and what steps should be taken to minimize the likelihood and impact of an accident?

6. What are the proper procedures for disposal of the chemicals(s)?

Once the potential hazards associated with the chemical(s) have been evaluated and the process has been evaluated, one can design the process and work procedures to minimize or eliminate the hazards.

E. HEALTH AND HYGIENE

Laboratory workers should observe the following health practices:

1. Wear appropriate eye protection at all times.

2. Use protective apparel, including face shields, gloves, and other special clothing or footwear as needed.

3. Confine long hair and loose clothing when in the laboratory.

4. Do not use mouth suction to pipette chemicals or to start a siphon; a pipette bulb or an aspirator should be used to provide vacuum.

5. Wash well before leaving the laboratory area. However, avoid the use of solvents for washing the skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent might facilitate absorption of a toxic chemical.

F. FOOD HANDLING

Contamination of food, drink and smoking materials is a potential route for exposure to toxic substances. Food should be stored, handled and consumed in an area free of hazardous substances.

1. Well-defined areas should be established for storage and consumption of food and beverages. No food should be stored or consumed outside of this area.

2. Areas where food is permitted should be prominently marked and a warning sign (e.g., EATING AREA-NO CHEMICALS) posted. No chemicals or chemical equipment should be allowed in such areas.

3. Consumption of food or beverages and smoking should not be permitted in areas where laboratory operations are being carried out.

12. Glassware or utensils that have been used for food storage should be dedicated to that use and prominently labeled.

G. HOUSEKEEPING

There is a definite relationship between safety performance and orderliness in the laboratory. When housekeeping standards fall, safety performance inevitably deteriorates. The work area should be kept clean, and chemicals and equipment should be properly labeled and stored.

1. Work areas should be kept clean and free from obstructions. Cleanup should follow the completion of any operation or at the end of each day.

2. Wastes should be deposited in appropriate receptacles.

3. Spilled chemicals should be cleaned up immediately and disposed of properly.

4. Stairways and hallways should not be used as storage areas.

5. Access to exits, emergency equipment, controls, and the like should never be blocked.

6. Equipment and chemicals should be stored properly; clutter should be minimized.

H. WARNING SIGNS AND LABELS

Laboratory areas that have special or unusual hazards should be posted with warning signs. Standard signs and symbols have been established for a number of special situations, such as radioactivity hazards, biological hazards, fire hazards and laser operations. It is the responsibility of the principal investigator to obtain and post these special warning signs. Other signs related to the activity of facility equipment should be posted to show the locations of safety showers, eyewash stations, exits, and fire extinguishers. Extinguishers should be labeled to show the type of fire for which they are intended. Waste containers should be labeled for the type of waste that can be safely deposited.

I. UNATTENDED OPERATIONS

Frequently, laboratory operations are carried out continuously or overnight. It is essential to plan for interruptions in utility services such as electricity, water and inert gas. Operations should be designed to be safe, and plans should be made to avoid hazards in case of failure. Wherever possible, arrangements for routine inspection of the operation should be made and, in all cases, an appropriate sign should be placed on the door. The principal investigator is responsible for

posting the appropriate signs and if necessary, arranging for routine inspections.

One particular hazard frequently encountered is failure of cooling water supplies. A variety of commercial or homemade devices can be used that (a) automatically regulate water pressure to avoid surges that might rupture the water lines or (b) monitor the water flow so that its failure will automatically turn off electrical connections and water supply valves.

J. SPECIAL PRECAUTIONS FOR WORKING WITH FLAMMABLES AND COMBUSTIBLES

Flammable/Combustible Liquids are materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. 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 a more rapid vaporization. In addition, flammable and combustible materials react with oxidizers which can result in a fire.

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 flammables shall be explosion proof or lab safe.

6. Assure 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. Assure bonding and grounding is checked periodically.

7. Assure appropriate sprinkler system and/or fire extinguishers are in the area.

K. SPECIAL PRECAUTIONS FOR WORKING WITH OXIDIZERS

Oxidizers are materials which react with other substances by accepting electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. Oxidation reactions are the most frequent cause of chemical accidents.

1. Know the reactivity of the materials involved in the experiment or process. Assure there are not 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 reducers.

L. WATER REACTIVE MATERIALS

Water reactive materials react with water to produce a flammable or toxic gas, or other hazardous condition. Special precautions for safe handling of water reactive materials will depend on the specific materials, and the conditions of use and storage. Contact your PI or Environmental Health and Safety for information on the safe use of a specific material. Examples of water reactives include alkali metals, acid anhydrides, and acid chlorides.

M. PYROPHORIC MATERIALS

Pyrophoric materials are materials which ignite spontaneously upon contact with air. Often the flame is invisible. Examples of pyrophoric materials are silane, silicon tetrachloride, white or yellow phosphorous. Pyrophorics should be used and stored in inert environments.

N. SPECIAL PRECAUTIONS FOR WORKING WITH PEROXIDIZABLES

Peroxidizables are materials which react with oxygen to form peroxides which can explode with impact, heat or friction such as removing a lid. Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened. Examples of peroxidizables include ethyl ether, tetrahydrofuran, isopropyl ether, liquid paraffins (alkanes) and olefins (alkenes).

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 the date of receipt or 3 months from the date of opening.

2. Do not open any container which has obvious crystal formation around the lid. Call EH&S (X84251) immediately for advice.

3. Other special precautions are similar to those used for flammables.

O. SPECIAL PRECAUTIONS FOR WORKING WITH LIGHT-SENSITIVE MATERIALS

Light-sensitive materials are materials which react 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.

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 materials after one year if unopened or 6 months if opened.

P. SPECIAL PRECAUTIONS FOR WORKING WITH SHOCK-SENSITIVE OR EXPLOSIVE MATERIALS

Shock-sensitive/Explosive materials are compounds which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), and azides.

1. Contact Environmental Health and Safety 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 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.

Q. SECURITY OF HAZARDOUS MATERIALS

Laboratories need to take specific actions in order to provide security against theft of highly hazardous materials, and to ensure compliance with new regulations. EH&S urges each unit (college, department, research group) to review and develop procedures to ensure the security of all hazardous materials in their area of responsibility.

Many laboratories already implement various means of security, including locking up controlled substances, syringes and needles, and radioactive materials. EH&S asks you to review and assess the hazardous materials in your laboratory and consider security issues. The intent is to minimize the risk of theft, especially targeting the five-minute window when the lab is left unattended. **One easy was to increase security is to make sure your laboratory door is locked whenever the lab is left unattended, even for a few minutes.** You may wish to implement some of the following suggestions.

Follow these guidelines to minimize opportunities for intentional removal of any hazardous materials from your laboratory:

1. Recognize that laboratory security is related to but different from laboratory safety. Security is preventing intrusion into the laboratory and the theft of equipment or materials from the lab.

2. Develop a site-specific policy.

   - Make an assessment of your laboratory area for hazardous materials and particular security issues.
   - Develop and implement lab security procedures for your lab group.
   - Train lab group members on security procedures and assign responsibilities.

3. Control access to areas where hazardous chemicals are used and stored.

   - Limit laboratory access to only those individuals who need to be in the lab.
   - Restrict off-hours access to individuals authorized by the principal investigator.
   - Lock freezers, refrigerators, storage cabinets, and other containers where stocks of biological agents, hazardous chemicals, or radioactive materials are stored when they are not in direct view of workers (for example, when located in unattended storage areas).
   - Do not leave hazardous materials unattended or unsecured at any time.
   - **Close and lock laboratory doors when no one is present even for a short period of time**.

4. Know who is in the laboratory area.

   - Know who is in the laboratory area at any given time.
   - Approach any people you don't recognize who appear to be wandering in laboratory areas and ask them if you can help direct them.

5. Secure your highly hazardous materials.

   - Use a log to sign highly hazardous materials in and out of secure storage.
   - Take a periodic inventory of all highly hazardous chemicals, biological agents/ toxins, radioactive materials, and controlled substances. **This could be as simple as frequently looking at your chemical containers to ensure none are missing.**
   - Track the use and disposal of hazardous materials. Immediately report any missing inventory to University Police (X84200) and EH&S (X84251).
   - Know what materials are being ordered and being brought into the laboratory area. Visually screen packages before bringing them to the lab. Packages containing potentially infectious materials should be opened in a biological safety cabinet or other appropriate containment device.
   - Know what materials are being removed from the laboratory area.

6. Develop an emergency plan specific to your laboratory.

   - Control of access to laboratory areas can make an emergency response more challenging. This must be considered when emergency plans are developed.
   - Have a protocol for reporting incidents. The PI should have policies and procedures in place for the reporting and investigation of incidents or possible incidents, such as undocumented visitors, missing chemicals, or unusual or threatening phone calls.
   - Review and update the lab's layout contact information located on your laboratory door.

Look out for these important areas of concern:

- ***Open labs***
- ***Unrestricted access to chemicals***
- ***Unlocked support/core rooms***
- ***Toxic gas security***
- ***Biological materials not secured***
- ***Access to controlled substances***
- ***Changes in chemical inventory***
- ***Storeroom security***
- ***Chemical waste collection areas***
- ***Unusual activities***

Additional information:

- Call EH&S for assistance (X84251) and/or visit the EH&S website for additional information.
- Review laboratory product catalogs for information about various locks, lock boxes, and other security devices for chemical storage in laboratories.
- Consult with University Police (X84200).

R. LABORATORY CLOSE OUT AND DECOMMISSIONING PROCEDURES

Research scientists and science instructors at Lehigh University are responsible for the safe operation of their laboratories. If you are relocating, renovating, or vacating your laboratory, you are also responsible for leaving your laboratory in a state suitable for re-occupancy or renovation.

Increased public concern over environmental issues has led to a major expansion of federal and state environmental laws in recent years. Aggressive enforcement of these laws by regulatory agencies has also increased. This enforcement follows “cradle to grave” accountability for hazardous chemicals, biohazards, infectious waste, and radioactive material.

To this end, researchers are required to properly “decommission” areas where these materials are used or stored. Chemical, biological, and radioactive materials are used and stored within designated areas for teaching and research purposes throughout Lehigh. These designated areas can become contaminated with residues over a period of time and use. Contamination typically results from spills, splashes, failed containers, uncontrolled chemical reactions, storage of incompatible chemicals next to each other, and simply using the areas for their intended purposes.

All decontamination and decommissioning work shall be completed in accordance with all University policy and procedures. Chemical, biological, and radioactive waste will be disposed through Environmental Health and Safety.

Laboratories for the purpose of this procedure are defined as entire rooms or as designated areas within rooms such as fume hoods and associated ductwork, photographic darkrooms, glove-boxes, sinks, biosafety cabinets, storage cabinets and shelves, closets, refrigerators and freezers, and lab equipment where chemical, biological, and radiological materials are used and stored.

- ***Call EH&S for assistance (X84251) regarding closing out or decommissioning your laboratory.***

S. WORKING ALONE

Generally, it is prudent to avoid working in a laboratory building alone. Under normal working conditions, arrangements should be made between individuals working in separate laboratories outside of working hours to crosscheck periodically. Experiments known to be hazardous should not be undertaken by a worker who is alone in a laboratory.

Under unusual conditions, special rules may be necessary. The principal investigator has the responsibility for determining whether the work requires special safety precautions, such as having two (2) persons in the same room during a particular operation.

VI. CONTINGENCY PLANNING AND RESPONSE

All laboratories are equipped with various fire detection, notification and suppression equipment. This includes detectors, pull stations, alarms, and extinguishers. Fire extinguishers are strategically placed in each lab building. Additionally, Lehigh University has developed and implemented various emergency response plans, developed a list of building monitors and a building monitor training program, and emergency evacuation plans and maps that are either available for review or posted in applicable areas. All laboratory personnel shall be aware of the location of equipment and procedures for responding, alarming or evacuating. Additional question regarding contingency planning and response should be directed to the Office of Risk Management at X8399.

You may be asked to evacuate a campus building due to an emergency event such as a building fire alarm, chemical spill, gas leak, etc. Faculty, Staff and Students should be familiar with these procedures so you are better prepared for an emergency evacuation:

- All fire alarms should be treated as an actual emergency situation and all appropriate protocols should be followed by everyone ***without exception***.
- When the fire alarm sounds, evacuation of the building is **mandatory.**
- Do not use elevators.
- Contain fire by closing doors and windows prior to exiting the building.
- Take personal belongings (keys, cellphones, purses, etc.) and weather appropriate clothing with you as you leave the building.
- If time permits, secure any hazardous, sensitive or confidential materials, prior to leaving your area.
- Go to the nearest emergency exit of the building and proceed to the rally point. **KNOW THE PRIMARY & SECONDARY RALLY SITE FOR EACH BUILDING YOU FREQUENT DURING THE WORK DAY.**
- All rally sites should be located a minimum of 150 feet from your building and must **NOT** impede the movement of emergency vehicles/responders at the site of the incident.
- If you frequent several buildings on campus and do not know where each rally site is located, **please do one (1) of the following to be prepared**: Speak with the building monitor in that building to identify the location of the rally sites, contact Environmental Health & Safety at X84251 or bap2, follow the suggestion listed above *(move 150 feet away from the building to a location that does not impede the progress of emergency vehicles or responders)*.

- Do not re-enter the building until an **"ALL CLEAR"** is given to building occupants by **either** emergency responders or the individuals conducting the proactive emergency drill.
- With everyone's full cooperation and timely execution of an emergency drill, the **"ALL CLEAR"** will be given ASAP and everything can return to normal.

VII. SAFETY RESOURCES

Environmental Health and Safety as well as various academic departments have programs which are available to the Lehigh community. The development of programs is an ongoing process and therefore additions will be periodically made to this list.

Structured programs available to date are as follows:

- Bloodborne Pathogens
- Chemical Hygiene
- Compressed Gas Safety
- Confined Space
- Emergency Preparedness, Prevention, and Contingency Plan (EPPC)
- Fall Protection
- Fire Safety
- Fume Hood Guidelines
- Hazard Communication (Worker Right-To-Know)
- Hearing Conservation
- Laser Safety
- Lockout/Tagout
- Radiation Safety
- Respiratory Protection
- Waste Disposal

For a complete list of the EH&S online training programs please go to our website at:

https://facilities.lehigh.edu/environmental-health-safety

Finally, several University Committees are available that deal with laboratory safety:

- Animal Care Committee
- BioSafety Committee
- Radiation Safety Committee
- University Laboratory Safety Committee

Further information regarding any of these programs, training sessions or committees can be obtained by contacting Environmental Health and Safety at X84251.

VIII. MEDICAL SURVEILLANCE

Arrangements have been made with the Occupational Health Department at St. Luke's Hospital, Bethlehem, PA to provide medical surveillance and consultations when:

1. An employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.

2. 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 will be established for the

affected employee as prescribed by the particular standard.

3. If 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 consultation shall be for the purpose of determining the need for a medical examination and further treatment.

IX. ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

The purpose of this procedure is to provide employees and their designated representatives with access to employee exposure and medical records as required by OSHA 1910.20. All employee exposure and medical records and analyses thereof derived because of the employee's exposure to toxic substances or harmful physical agents can be accessed by the affected employee or his/her designated representative by contacting:

Environmental Health and Safety
211 Warren Square
X84251

X. WASTE MANAGEMENT

The Lehigh University waste management program has three basic goals:

1. To dispose of laboratory waste in compliance with all applicable federal, state, and local regulations.

2. To manage the wastes generated in a manner that protects employees, the citizenry, and the environment.

3. To reduce the volume and toxicity of waste generated to the degree practicable.

To achieve these goals, Lehigh University has developed a set of waste disposal guidelines which detail procedures for Chemical, Biological and Radioactive waste disposal. Copies of these documents should be easily accessible in each department and should be periodically reviewed by the principal investigator. Copies of the document can be obtained by calling Environmental Health & Safety at X84251.

XI. EMERGENCY PLANNING – EPPC PLAN

An Emergency Preparedness Prevention Plan (EPPC) has been developed by Environmental Health and Safety to promote the safe, effective handling of a hazardous material incident. The purpose of the plan is to minimize hazards to human health or the environment from fires, explosions, or any unplanned, sudden, or non-sudden release of hazardous waste, hazardous materials, or radioactive materials to air, soil, or water. Copies of the Plan can be obtained by contacting Environmental Health and Safety at X84251.

XII. RECORDKEEPING

Lehigh University's Environmental Health and Safety office maintains documentation on health and safety programs. Examples of the types of documentation that are maintained are:

- Chemical Hygiene Plan
- Copies of various Lehigh University's health and safety programs
- Health and Safety training sign-off sheets and training materials

- Archival information such as employee medical surveillance logs, biological monitoring results, air sampling results, waste disposal records, respirator fit-testing program, accident incident reports, radiation surveys and exposure information
- DEP License
- Process Hazard Assessment and Management of Change forms

If you have questions concerning document access, please contact EH&S at X84251.

APPENDIX A

HAZARDS ASSESSMENT

1.0 Purpose

To provide guidelines for the following:

- To assess hazards associated with operations and equipment used at Lehigh University
- To conduct formal hazard review in laboratories, and
- To involve the Office of Environmental Health & Safety (EH&S) in laboratory operations

2.0 Definitions

2.1 Hazard: A situation with the potential for the following undesired events: (1) threat of harm to employees, the public or related facilities; (2) injury, illness or death to employees or the public; (3) damage to facility and/or equipment, or the environment.

2.2 Hazard Review: A comprehensive review designed to identify potential hazards and to generate recommendations that will reduce the probability of their occurrence and/or their consequences.

2.3 Hazard Classification: The basis for hazard classification is the severity of the work case consequence of the hazard's occurrence regardless of the probability that the hazard will occur.

3.0 Guideline

The project director shall make the initial hazard assessment and the proper hazard classification. The hazard classifications are:

(1) Class A - These are high risk operations involving significant hazards such as:
- toxic, reactive, flammable, hazardous chemicals
- chemical carcinogens regulated by state or federal agencies
- radioactive materials

Class A hazardous operations require a formal hazard review in which Environmental Health & Safety must be involved. Examples of Class A projects include any complex, experimental set-up involving hazardous materials, or any unknown reaction conducted at high pressure or high temperature. The hazard review on the Class A may require extraordinary control measures (e.g., controlled access area).

(2) Class B - These are medium risk operations that are defined as experiments where the risk to the person, property or environment is minimized through the use of "Routine" laboratory or engineering safeguards. Operations with this classification require a preliminary hazards assessment and possibly a hazard review if Environmental Health & Safety feels it is necessary for safe operation. Examples of Class B projects include small laboratory hood type experiments that involve hazardous materials and deviate from standard practice

(3) Class C - These are low risk operations that entail no significant or appreciable hazard to life, property or environment under conceivable circumstances including upsets and emergency conditions. This level of hazard requires, at a minimum, the preliminary hazards assessment form. The project director is responsible for document preparation.

LEHIGH UNIVERSITY

LUFacilities
Environmental Health and Safety
211 Warren Street
Bethlehem, PA 18015-1755
T: 610.758.4251

PRELIMINARY HAZARDS ASSESSMENT

Principal Investigator: _____ Date: _____

Chairperson or Director (Department, Center, or Institute): _____

Title & Description of Project:

Facilities: Building: _____ Lab #: _____ Location: _____

Operating Conditions (Attach Optional Flow Sheet)

Temperature Range: _____ Pressure Range: _____

Run Duration: _____ Overnight: _____

Expected Lifetime: _____ Chemical Capacity: _____

Materials of Construction: (Note: Materials compatability should be considered in this section as well as the appropriateness of the material to be used.)

Hazardous Chemical/Quantity Special Hazards Associated With Chemicals

Listing of Major Hazards: (Radiation, Biohazard, etc.)

Special Requirements: (Ventilation, Exhaust, etc.)

Waste Products:

Risk Classification: High _____ A Medium _____ B Low _____ C

Principal Investigator: _____ Date: _____

Environmental Health & Safety: _____ Date: _____ Hazard Assessment #: ____

RETURN TO: Environmental Health & Safety
211 Warren Square

(Hazard. Asm)

LEHIGH UNIVERSITY

LUFacilities
Environmental Health and Safety
211 Warren Street
Bethlehem, PA 18015-1755
T: 610.758.4251

MANAGEMENT OF CHANGE

PURPOSE

To insure that significant changes to operating techniques, equipment, processes, or exposures have been Adequately evaluated so as not to compromise the safety of the laboratory.

DEFINITION

Operational or equipment changes include all changes to procedures or equipment that lie outside the scope of the original research protocol, process hazard review, or standard operating procedures. This includes changes in raw materials, operating procedures, equipment, etc.

RESPONSIBILITIES

The researcher is responsible for implementing this management of change guideline for reevaluating equipment and operational changes in their areas.

I. Change is being made to: **(check all that apply)**

A. _____	Raw Materials	G. _____	Fire Fighting Techniques
B. _____	Operating Procedures	H. _____	Operating Personnel
C. _____	Apparatus/Equipment	I. _____	Experiment Location
D. _____	Exposure Hazards	J. _____	Safety Devices
E. _____	Waste Disposal	K. _____	Risk Classification
F. _____	Emergency Shut-Down	L. _____	Other

II. Briefly describe changes from Section I **(use attachment if necessary)**

Date change will be in effect: _____

Date reviewed: _____

Researcher: _____

Environmental Health & Safety: _____ Assessment #: _____

RETURN TO: ENVIRONMENTAL HEALTH & SAFETY
211 WARREN SQUARE
DR. BARBRA A. PLOHOCKI

(MGMTCHNG)

APPENDIX B

LEHIGH UNIVERSITY

LUFacilities
Environmental Health and Safety
211 Warren Street
Bethlehem, PA 18015-1755
T: 610.758.4251

EMERGENCY INFORMATION

Building:	**Room #**
Supervisor:	**Telephone #**
Emergency Contact:	**Telephone #**

Legend:

FH – Fume Hood

CYL – Cylinder(s)

REF – Refrigerator

CHEM – Chemical Storage

WST – Chemical Waste

RAD – Radioactivity

BIO – Biohazards

_____

_____

_____

_____

_____

_____

Processes/Experiments:

_____

_____

_____

_____

_____

_____

_____

_____

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LUFacilities
Environmental Health and Safety
211 Warren Street
Bethlehem, PA 18015-1755
T: 610.758.4251

Building:	Lab #
Laboratory Supervisor:	
Date of Inventory	

Chemical Name	*Approximate Quantity*	*Liquid (L), Solid (S), Gas(G)*

APPENDIX C

LUFacilities
Environmental Health and Safety
211 Warren Street
Bethlehem, PA 18015-1755
T: 610.758.4251

Lehigh University Lab Inspection – Standard Operating Procedure
Issue Date: August 2019
Issuing Department: Environmental Health & Safety

CONTENTS:

1. PURPOSE

The purpose of this procedure is to outline the process used for conducting laboratory inspections at Lehigh University.

2. SCOPE

This procedure applies to all laboratories at Lehigh University.

3. DEFINITIONS

3.1 Deficiency: An issue identified during an inspection that must be corrected.

3.2 PI: Principal Investigator

3.3 Laboratories: All labs belonging to Lehigh University including those that contain biological, chemical, physical, or radiological hazards.

3.4 Building Monitor (BM): A representative of the building or department that assists With the safety inspection and has emergency preparedness responsibilities.

3.5 Inspection Team: The person or persons inspecting a lab.

4. RESPONSIBILITIES:

4.1 Lehigh University Department Heads

4.1.1 Communicate the importance of following safety policies and procedures Identified in the Lehigh University Laboratory Safety Manual, Biological Safety Manual, Radiation Safety Manual and Hazardous Waste Management Plan.

4.1.2 Encourage and support laboratories to conduct periodic self-inspections using the self-inspection checklist (attached).

4.1.3 Encourage Principal Investigators to correct deficiencies noted by the Inspection Team.

4.2 Lehigh University Principal Investigators and Lab Managers

4.2.1 Understand and follow safety policies and procedures identified in the Lehigh University Laboratory Safety Manual and Lab Safety Handbook, Biological Safety Manual, Radiation Safety Manual, Hazardous Waste Management Plan and all other Lehigh Safety Publications that apply to your lab.

4.2.2 Be aware of the self-inspection checklist and use it to prepare for lab inspections.

4.2.3 Ensure all deficiencies found during lab inspections are corrected by the appropriate deadline.

5. LABORATORY INSPECTION SCHEDULING

5.1 Steps for Scheduling Laboratory Inspections

5.1.1 Contact the appropriate departmental personnel (BM, Chairperson, etc.) to Discuss a planned start date and time for the inspection.

5.1.2 The following should be decided prior to the initial inspection:

- Will it be an announced or unannounced inspection?
- Who will be on the inspection team?
- Will a re-inspection be conducted? Is it needed?

5.1.3 Complete the inspections per the agreed upon schedule.

6. LABORATORY REPRESENTATION DURING INSPECTION

6.1 The PI or his/her designee should be present during the lab inspection. The lab representative should be knowledgeable of the daily operations of the lab and familiar with specific lab protocols and procedures.

6.2 If the PI refuses or does not have lab representation for the inspection, conduct the inspection with the inspection team.

7. INSPECTION PROCESS

7.1 Prior to an announced inspection, the PI in charge of the lab should have the lab users examine the inspection template to review items that will be checked. ***Correcting deficiencies prior to the inspection is allowed and encouraged.***

7.2 A representative of the lab should meet the Inspection/Inspection Team outside of the lab to ensure the Inspection Team is apprised of the hazards in the lab and the appropriate Personal Protective Equipment is worn.

7.3 The lab representative should stay with the Inspection Team to answer any questions the Inspector/Inspection Team may have.

7.4 There may be equipment present in the lab (biosafety cabinets, etc.) or procedures being conducted that are not documented on the Lab Inspection Form. Any issues or deficiencies that are not documented on the form will be written in the "NOTES" section. The notes section will also be used for comments about the lab, follow-up questions and any further actions that may be required to bring the lab into compliance.

7.5 Immediately notify (during the inspection) the PI or lab representative if critical deficiencies are found that may result in suspension of lab activities.

7.6 An EH&S representative will draft an inspection report within seven (7) days outlining

the results of the inspection and recommended actions for correcting noted deficiencies. Photographs may be used to document lab conditions.

This report will be sent to members of the Inspection Team for review and comment prior to being distributed to the department. A more detailed report may follow at a later time if further information is needed or is requested.

7.7 Complete a re-inspection (if needed or requested) of the labs with deficiencies peer the agreed upon schedule.

8. BUILDING/DEPARTMENT INSPECTION SCHEDULE

The building/department inspection schedule for campus buildings will be based on the activities (lab and non-lab) conducted in each building. This schedule may be altered based on the types and quantity of labs, lab activities and hazards in each of the buildings. In addition, safety inspections can be requested on an as needed basis.

8.1 Campus Buildings/Departments Inspected Once (1) Per Year or As Needed

- Whitaker Lab
- STEPS
- ATLSS (or more frequently based on requests by ATLSS)
- Iacocca Hall including the Animal Facility
- Mudd
- Powerhouses
- Optics Lab

8.2 Buildings/Departments Inspected Every Two (2) Years or As Needed

- Transportation Department
- Academic and Administrative Campus Buildings
- Physics
- Sherman Fairchild
- Mohler Lab
- Sinclair
- Building C
- Fritz Lab

9. DEFICIENCIES

Deficiencies will be classified as critical and non-compliant.

9.1 Critical Deficiencies

Deficiencies found that are immediately Dangerous to Life and Health (IDLH) can result in immediate suspension of laboratory activities. In such a deficiency is identified, the Inspection Team will do the following:

1. Contact the PI responsible for the lab to discuss an immediate resolution.

2. If the deficiency cannot be corrected immediately, the PI refuses to correct this deficiency or the PI or another lab representative cannot be reached:

   A. Contact the Department Head to discuss the situation.

   B. If the lab/area is going to be shut down, notify all appropriate individuals (Dean, PI, Associated VP/University Architect LU Facilities, etc.) of the shutdown. Verify emergency contact information on the lab door. Post signage on the door stating "Restricted Access. Do Not Enter."

   C. Contact the appropriate personnel to communicate the suspension of the lab activities. Ensure the custodial staff who service the lab are also informed of the situation.

   D. The lab will remain closed until the critical deficiency is correct.

9.2 Non-Compliance Deficiencies

1. If a deficiency is non-compliant, a timeframe must be established by the PI for correction of the deficiency.

2. A re-inspection (if needed or requested) will be conducted by the inspection team to ensure all non-compliant deficiencies have been corrected.

9.3 Correction of Deficiencies

1. Whether or not a re-inspection occurs, it is the responsibility of the PI to ensure that ***ALL*** deficiencies are corrected.

2. Correction of deficiencies, can, in some cases, be evidenced to the Inspection Team by an email documenting the corrective action or photograph.

Continued failure to correct deficiencies to an acceptable level will result in an escalation process described in the next section.

10. ESCALATION PROCESS

10.1 Unless the deficiencies found are sufficiently critical to the life and health of the lab workers or the regulatory status of the laboratory, laboratories will be given a minimum of two (2) weeks to correct deficiencies.

10.2 If the deficiencies remain unresolved an email will be sent reminding the PI in charge of the lab as to the status of the lab. An additional seven (7) days will be given to bring the lab into compliance.

10.3 If after these seven (7) days the lab is still non-compliant, another email will be sent to the PI and the Department Chairperson will be copied. Based on the severity of the deficiency, the Dean may also be involved.

A representative of EH&S will also brief the Vice President and Associate Provost for Research and Graduate Studies and the Associate VP/University Architect LU Facilities about the situation. An additional seven (7) days will be given to bring the laboratory into compliance.

10.4 At this point, the PI has had a minimum of 28 days to bring the lab into compliance. If the lab is still not in compliance, a meeting will be set up with the PI and University Administration to discuss the issue and the next step in the escalation process.

10.5 Failure to bring a lab into compliance after 28 days may result in the suspension of lab activities.

10.6 Extensions to any of these periods may be granted at the discretion of Environmental Health & Safety. A request for an extension should be requested via email to the Inspector/Inspection Team.

10.7 The escalation process will **NOT** be used for lab inspection findings that are out of the control of the PI.

11. REFERENCE DOCUMENTS FOR LAB INSPECTION

11.1 Laboratory Safety Inspection Form

11.2 Lab Layout Form

11.3 Chemical Inventory Form

APPENDIX D

SAMPLE

STANDARD OPERATING PROCEDURE

No. 3

Job: Filling a closed end mercury manometer

Building: Mountaintop, Bldg. A **Lab:** C332

Prepared By: Barbra A. Plohocki **Date:** 11/02/89 **Revised:** 12/13/90

Signature: _____

Required Protective Equipment: Safety glasses, laboratory gloves, mercury spill test

Job Steps in Sequence	Potential Hazards	Recommended Safety Procedures
1. Fill mercury reservoir and assemble manometer system.	Personal contact with mercury.	Use proper protective equipment. Make all connections tight. Work over spill tray.
2. Evacuate the system with a high-vacuum (see page 2).	Glass breakage from defective glass tubing or connections.	Inspect glass equipment prior to use. Follow SOP for vacuum pump use.
3. Tilt the mercury reservoir.		Work over spill tray.
4. Gradually allow pressure in reservoir to rise by bleeding in air at vacuum pump bleed valve. Mercury from mercury is forced into manometer tube.	Rapid pressure rise may force mercury in manometer at too rapid a rate and cause tube breakage.	Open bleed valve slowly. Work over spill tray.
5. If closed end of tube is not completely filled (air bubble present) tilt manometer tube to fill closed end and repeat steps 2-4.	Mercury spillage and personal contact.	Work over spill tray.

STANDARD OPERATING PROCEDURE (cont'd).

Job: Filling a closed end mercury manometer

Job Steps in Sequence	Potential Hazards	Recommended Safety Procedures
6. Upon successful filling, return reservoir to upright position and bleed air into system. Disconnect mercury reservoir and return to suitable container.	Mercury spillage and personal contact.	Work over spill tray.
7. Clean up any mercury spills immediately and dispose of properly.	Mercury is a toxic substance and must be disposed of properly.	Read and follow Lehigh University Waste Disposal procedures.

STANDARD OPERATING PROCEDURE

No. _____

Page _ of _

Job: _____

Building: _____ Lab: _____

Prepared By: _____ Date: _____ Revised: _____

Signature: _____

Required Protective Equipment: _____

_____

_____

Job Steps in Sequence	Potential Hazards	Recommended Safety Procedures

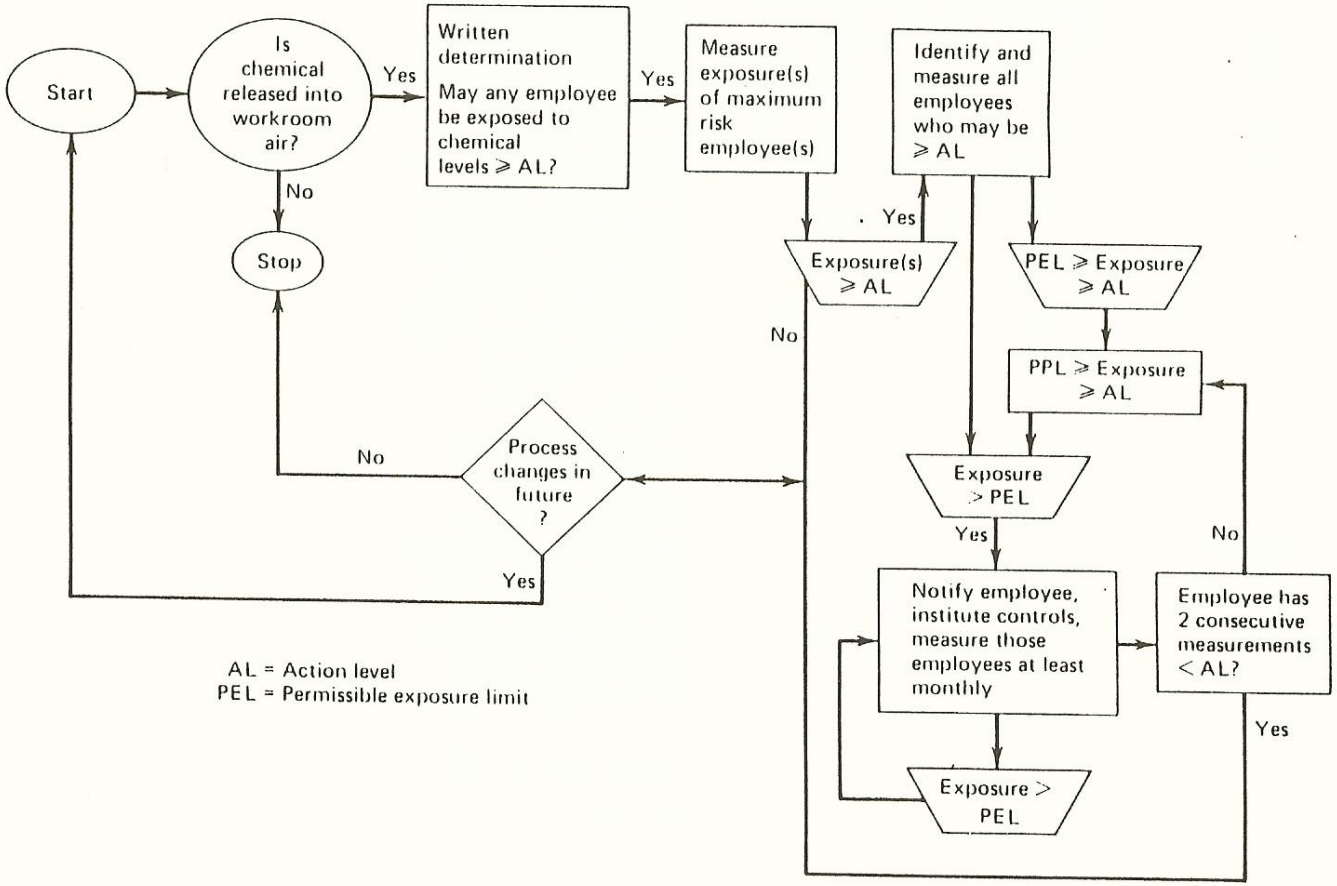
STANDARD OPERATING PROCEDURE (cont'd).

No. _____

Page _ of _

Job: _____

Job Steps in Sequence	Potential Hazards	Recommended Safety Procedures



NIOSH-recommended employee exposure determination and measurement strategy.

GLOSSARY OF TERMS

Absorption	A mode of entry of a toxic substance into the body in which the substance enters through the unbroken skin.
ACGIH	American Conference of Governmental Industrial Hygienists
Action Level	A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8) hour time-weighted average, which initiated certain required activities such as exposure monitoring and medical surveillance.
Adequate Ventilation	Ventilation that will keep the exposures to a material below the Threshold Limit Value.
Asphyxiation	Smothering. A toxic material may cause asphyxiation by diluting the amount of oxygen in the air, paralyzing the lungs, or interfering with the body's ability to transport oxygen to the cells.
Carcinogen	A material that can cause cancer.
Chemical Hygiene Plan	A written program developed and implemented by the employer which sets forth practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace.
Chronic	A toxic effect that occurs only after exposure to a material for a long time, usually months or years. The amount of exposure is usually very low, and often symptoms are not immediately noticeable.
Combustible Liquid	Any liquid having a flashpoint at or above 100EF (37.8EC), but below 200EF (93.3EC), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.
Compressed Gas	(1) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70EF (21.1EC); or (ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130EF (54.4EC) regardless of the pressure at 70EF (21.1EC); or (iii) A liquid having a vapor pressure exceeding 40 psi at 100EF (37.8EC) as determined by ASTM D-323-72.
Concentration	The amount of materials in the air, e.g., 50 parts per million. May also refer to the amount of a substance in a mixture, e.g., 10% ammonia in water.
Control	A method of limiting or eliminating exposure of workers to a hazardous substance.

Cumulative Effect	An effect of a toxic materials that takes place only after a quantity of the material is taken into the body, or when damage is caused by the substance over a period of time at a rate faster than the body can repair the damage.
Decompose	Breaking down of a chemical under heat, shock, or mixing with other chemicals. The resulting products of decomposition may be more toxic or hazardous than the original substance.
Dose	The amount of a substance that enters the body. The amount depends on the rate at which the substance enters the body and the length of time the substance continues to enter the body, e.g., a worker may inhale 10 milligrams of dust per day for 10 days. The total dose is 100 milligrams. Not all of the substance may remain in the body; some is eliminated, possibly as fast as it enters.
DOT	Department of Transportation. A Federal Agency which specifies a labeling system for the interstate transport of hazardous materials, among other duties.
Dust	Relatively large particles of solid material in the air, generated by grinding or crushing.
Engineering Control	A change in equipment, materials or process, e.g., ventilation, that reduces reduces the hazard from the substance.
Evaluation	The process used by a Safety of Health Professional to determine the extent of hazard presented by the use of a toxic material. It often involves taking air samples to determine total dose.
Explosive	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock pressure or high temperature.
Exposure	Similar to dose. The combination of concentration of a substance in air and the amount of time a worker is exposed to that concentration gives the total exposure or dose.
Flammable Limits	The range of concentrations in air of flammable vapors of a substance between which the vapors will ignite and continue to burn; possibly resulting in an explosion. The lower limit is the **L**ower **F**lammable (or explosive) **L**imit, UFL. Below the LFL, there is not enough vapor to support combustion. Above the UFL there is too much vapor. The mixture is too much to burn. **NOTE**: The MSDS uses Explosive Limit, but the preferred term is Flammable Limit. The terms are synonymous.
Flash Point	The temperature at which enough vapor is produced from a flammable liquid reach a concentration equal to the LFL, see Flammable Limits. A substance with a high flash point is less hazardous than one with a low flash point.

Fume	A term used by health professionals to mean solid particles in air, usually much smaller than dust, and generated by heating a solid material, eg., a welding rod.
Gas	A substance like air. Nitrogen, oxygen, and carbon dioxide are gases.
Hazard	A term that combines the ability or potential of a substance or process to cause a problem with the probability that the substance actually will cause a problem, e.g., gasoline is a flammable substance. If small amounts are kept in sturdy, sealed containers with no ignition sources nearby, the hazard is small. If gasoline is kept in large, open buckets and smoking and welding are done nearby, the hazard is great.
Individual Susceptibility	The difference in reaction to a given dose of a toxic material by different individuals. Some persons may show a stronger or more noticeable effect from the same dose than others. Such individuals may be allergic or hypersensitive to the material.
Incompatible	Two or more chemicals that will produce an undesirable reaction when mixed, e.g., mixing any acid with sodium cyanide will produce highly toxic hydrogen cyanide gas.
Infrared	A type of radiation given off by a hot stove or the sun, sensed as heat.
Ingestion	Swallowing. One of the ways a toxic substance can enter the body.
Inhalation	Breathing in. The most common way for toxic substances to enter the body.
Laboratory	A facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a nonproduction basis.
LFL or LEL	Lower Flammable Limit or Lower Explosive Limit
Medical Consultation	A consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.
Microorganism	Germs, bacteria, viruses, yeasts, molds, and fungi capable of causing disease. These are biological hazards.
Mist	Liquid droplets in the air.
MSDS	Material Safety Data Sheet
Nonionizing Radiation	Forms of radiation, e.g., infrared, radio, and microwaves. These are considered to be less hazardous than ionizing radiation, e.g., x-rays and radiation.

Permissible Exposure Limit, PEL	OSHA's number that tells the concentration of a chemical in air that a worker may breathe for a given period of time, without experiencing adverse effects, see TLV.
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.
Reactive	A chemical that will undergo undesirable changes or reactions when heated, shocked, exposed to air, or mixed with other substances, see **I**ncompatible.
Recognition	The process of identifying potential hazards. The process of evaluation then assesses the degree of actual hazard.
Reproductive Toxins	Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).
Respirator	A device worn over the face and used to either mechanically filter dirty air or supply fresh air to the wearer.
Solvent	A liquid used to dissolve or clean materials. Water is a solvent; but materials like alcohol, trichloroethylene, or methyl ethyl ketone are usually referred to as solvents or organic solvents. These materials usually evaporate into the air and can be inhaled into the body.
Specific Gravity	The density of a liquid when compared to water which has a specific gravity of 1.0. A liquid with a specific gravity of less than 1 will float on water; while on with a specific gravity of more than 1 will sink in water.
Substitution	A control method in which a less hazardous substance replaces a hazardous one; e.g., soap and water to clean floors in place of a solvent like acetone.
Systemic Poisoning	A toxic effect on the body in which one or more organs are damaged by a substance, e.g. lead entering the body by inhalation can damage the nervous system, the kidneys, the bone marrow, or the intestines.
Threshold Limit Value TLV	A number that tells the concentration of a chemical in air that a worker may breathe for a given period of time (a dose) without experiencing adverse effects. The **A**merican **C**onference of **G**overnmental **I**ndustrial **H**ygienists, ACGIH, publishes TLVs for about 500 substances. OSHA uses similar limits called Permissible Exposure Limit, PEL.
Toxic	Capable of causing damage to the body. A substance is more toxic if a small amount can cause the damage. The degree of a substance depends partly on how toxic it is.
UFL or UEL	Upper Flammable Limit or Upper Explosive Limit.

Unstable	A chemical that will decompose or react very easily. Nitroglycerine is unstable because it will explode when shocked by dropping a container.
Vapor	A substance in air similar to a gas, but produced by the evaporation of a liquid into the air. Solvents usually enter the body in the form of a liquid.
Vapor Density	A measure of how heavy the vapor of a liquid is, compared to air which has a vapor density of 1.0. When the vapor density is high, the vapors will tend to collect in low spots.
Vapor Pressure	A measure of the volatility of ease with which a liquid will evaporate to become a vapor. A high vapor pressure means the liquid evaporates quickly.
Water-Reactive	A chemical that reacts with water to release a gas that is either flammable of presents a health hazard.