CHAPTER 26 – LABORATORY SAFETY PLANS

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A. INTRODUCTION

1. This Chapter applies to all Smithsonian Institution (SI) laboratory operations, which are required by the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" to manage the risks associated with laboratory work through the development and implementation of a Laboratory Safety Plan (LSP).

2. "**Laboratory**", for the purposes of this Chapter, is any SI work area for testing, analysis, research, instruction, or similar activities:

   a. that involve the use of small quantities of multiple, hazardous chemicals on a non-production basis, and
   b. where such chemical processes operate on a scale that can easily and safely be done by one person, and
   c. where the added possibility of biohazards and radioactive hazards also exists, and
   d. that complies with NFPA 45, "Fire Protection for Laboratories Using Chemicals.

3. **The revised *SI Safety Manual*, along with this Chapter and its attached guidance documents, replace the former "Lab Safety Manual", issued January 28, 2005**.

4. All employees, visiting researchers (including those with short-term appointments or interagency agreements), volunteers, interns, or contractors assigned to laboratory work must be advised of the provisions of their LSP before working with chemicals or processes in the laboratory, and are expected to utilize the specified safe work practices.

B. CHAPTER-SPECIFIC ROLES AND RESPONSIBILITIES

1. **Directors** shall designate a Laboratory Safety Officer (LSO) to manage the development and implementation of the facility's site-specific LSPs, and to ensure that design and modification plans for laboratory space are transmitted for review through the SD 410 process. In facilities with multiple, complex laboratories, the Director shall also establish a Laboratory Safety Committee to assist the LSO.

2. **Department Chairs, or facility senior managers with authority for unit objectives and budget,** shall review and approve all LSPs within their

responsibility, ensuring that each LSP is provided with necessary resources and management support.

3. **Laboratory Safety Officers** (LSOs) and Laboratory Safety Committees, shall:

    a. Be knowledgeable, by formal training and practical experience, in chemical or biological laboratory protocols and the associated sciences.
    b. Provide technical guidance in developing and reviewing the facility LSPs, including suitability of physical location, and shall submit the final LSPs to the Safety Coordinator for final approval.
    c. Ensure that the facility LSPs are re-evaluated and approved annually, or more often as processes or LSOs change.

4. **Safety Coordinators** shall:

    a. Provide assistance, as needed, to the LSO and laboratory staff in the development of LSPs.
    b. Review and approve final LSPs as submitted by the LSO, ensuring that each LSP incorporates the requirements of this and other applicable chapters of this *Manual*, and ensure that LSPs are updated annually and/or upon change.
    c. Ensure that Laboratory Safety Training, as required by Section D of this Chapter, is conducted and documented.

5. **Principal Investigators and Supervisors** shall:

    a. Be responsible for the development and implementation of a site-specific LSP for laboratory work under their control, including training.
    b. Be knowledgeable of the potential health, safety, and environmental hazards associated with their work, including the means to control or eliminate such hazards, per the provisions of this *Manual.*
    c. Ensure that equipment and safety controls are routinely inspected, repaired or replaced as needed, to maintain them in good working condition.
    d. Ensure that employees and other researchers assigned to laboratory work are provided with, and trained on, the LSP prior to work.
    e. Review their LSPs at least annually with their staff and make changes as necessary. Submit annually-reviewed LSPs to their Departmental Chairs, LSOs and Safety Coordinator for approval.
    f. Refer to the Office of Safety, Health and Environmental Management (OSHEM) Occupational Health Services Division (OHSD) any employee who reports adverse health symptoms that may have resulted from laboratory work, or employees who report a change in personal health status that may necessitate a medical consultation on whether the health

condition would warrant additional safety precautions to prevent adverse occupational exposure.

6. **Employees** shall:

   a. Adhere to assigned LSPs and other precautions set forth by supervisory personnel.
   b. Report any unsafe conditions to their supervisor.
   c. Notify supervisors or OSHEM/OHSD if they experience any adverse health symptoms that may have resulted from laboratory work, or if they experience a significant change in health status that may necessitate a medical consultation on whether the health condition would warrant additional safety precautions to prevent adverse occupational exposure.

7. **Resident Building Managers** shall:

   a. Ensure prompt correction of mechanical and utility system deficiencies identified through annual maintenance, testing, or inspections, in accordance with Chapter 27, “Ventilation for Health-Hazard Control” and other applicable Chapters of this *Manual*.
   b. Coordinate work or scheduled outages of ventilation, electrical, and other building systems with laboratory supervisors prior to such outages or work, to prevent system users from being at risk from the outage.
   c. Ensure that all such work or scheduled outages must first receive approval from the laboratory supervisor prior to working on or around any lab utility or fixture.
   d. In coordination with laboratory supervisors and the LSO, ensure that building service and maintenance workers are trained as to the precautions to be taken when working in a laboratory environment and/or on laboratory equipment.

8. **Resident Security Managers** shall, in coordination with laboratory supervisors and the LSO:

   a. Ensure that security officers are trained as to the precautions to be taken when inspecting or working in a laboratory environment and/or on laboratory equipment.
   b. Ensure that security officers are trained as to the emergency response/first responder postings on laboratory doors, referenced in Section C of this Chapter.

9. **Office of Safety, Health and Environmental Management (OSHEM),** shall, upon request or as warranted, offer direction, medical consultation, and technical assistance in occupational safety, fire safety, industrial hygiene, environmental management, and occupational health, to Safety Coordinators and LSOs in implementing the requirements of this *Manual*.

C. REQUIREMENTS FOR A SITE-SPECIFIC LABORATORY SAFETY PLAN (LSP).

1. Every SI laboratory shall develop and implement an LSP to include the following sections.

    a. Cover page, with emergency response actions, and important safety points-of-contact.
    b. Management endorsement and approval signatures.
    c. Special approvals and work restrictions for highly hazardous activities.
    d. Job Hazard Analyses (JHAs) and control measures for laboratories.
    e. Maintenance and inspection of hazard controls.
    f. Hazardous waste disposal procedures.
    g. Record of training specific to the laboratory operations.

2. Requirements and detailed guidance for each section follow in the Attached Laboratory Safety Plan Guidance Manual. [hyperlink]

3. Training. Every laboratory supervisor shall provide, and maintain documentation of, staff training per the requirement of Section D of this Chapter.

4. Annual Update. Each LSP shall be updated and approved at least annually, or as often as tasks change, by the laboratory management and the LSO.

D. TRAINING

1. All laboratory employees are to receive Chemical Hazard Communication and Lab Safety Plan/Lab Safety Overview training (as listed in the OSHEM Training Catalogue) on the safe work practices of their specific Laboratory Safety Plan, and specific operational safety, health, fire safety or environmental protection training as applicable to their laboratory processes.

2. This training (D.1), is to be provided by the supervisor, with assistance from the safety coordinator, to all employees prior to actual lab work, and prior to assignments involving new potential exposures. Information is to include:

    a. The location and availability of the LSP, chemical inventory, Material Safety Data Sheets (MSDSs), applicable regulatory exposure limits, and other reference material regarding the safe handling, storage, and disposal of hazardous chemicals (or hazardous collections) in the lab.
    b. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory, as well as the health hazards themselves (reference the MSDS).

c. Methods that may be used to detect the presence or release of a hazardous chemical. This could include industrial hygiene monitoring, the use of continuous monitoring devices, visual appearance, or chemical odors.
d. Methods employees can take to protect themselves from hazards, including work practices, personal protective equipment and emergency procedures listed in the LSP. This should include a discussion of the proper use and limitations of engineering controls and safety devices, including chemical and biological hoods, emergency showers and eye washes.
e. Proper hazardous waste disposal methods and chemical spill response/awareness level training.
f. Emergency response plans established by each facility's Emergency/Disaster Response Plan, any medical or first aid response specifically recommended by OSHEM/OHSD (such as first response to hydrofluoric acid exposure), extinguishment of clothing fires (Stop, Drop, and Roll), and Chemical Spill Response Plans established by each facility

3. Laboratory employees are to receive <u>on-the-job refresher training</u> as the LSP is annually updated. Training/LSP review is also to be provided whenever processes or chemicals change resulting in a change in the LSP. The most effective way to reinforce good work practices is to involve all staff in regular, periodic reviews and updates of the LSP.

4. In addition, laboratory supervisors are to work with their safety coordinators to determine the <u>task-specific safety training courses</u> needed. These courses are listed in the OSHEM Training Catalogue and the operational topic chapters of this *Manual.*

5. The <u>training plan for the particular laboratory</u> is to be designated in the LSP. Laboratory supervisors or principal investigators are responsible for ensuring training is provided and documented per Chapter 6, "Training", of this *Manual*.

6. <u>All building service workers, maintenance workers, and security officers</u>, who have reason to enter labs in the course of their work duties are to be provided training for safe work in and around lab operations. Additional guidance is provided in Attachment 1, Appendix F, of this chapter
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E. REQUIRED INSPECTIONS and ASSESSMENTS

1.. Equipment and utilities in the laboratory shall be inspected and maintained in accordance with manufacturer's recommendations and the requirements of the applicable chapter(s) in this *Manual*.

2. Lab Spaces Slated for Renovation or Demolition.

   a. A risk assessment evaluation of a research space slated for renovation or demolition must be conducted prior to construction work to identify and develop remediation plans for hazardous chemical contamination of the space and hazardous waste disposal provisions per Chapter 29, Hazardous Waste Disposal, of this *Manual*.

   b. The risk assessment process includes hazardous materials surveys and abatement plans as mandatory parts of all SI construction and renovation projects, as specified in the SI Construction Specifications.

   c. OSHEM is to be contacted for assistance in managing this process.

F. RECORDS and REPORTS

1. Refer to Chapter 25, "Hazard Communication Program", of this *Manual* for requirements on chemical inventories and MSDSs.

2. Documentation of training is to be maintained by the laboratory supervisor, as well as reported to the Safety Coordinator.

3. All documents generated during the hazardous material risk assessment process, per Section E of this Chapter, will be maintained by the Resident Building Manager for as long as such documents need to be relied upon.

G. REFERENCES AND RESOURCES

1. General Sources of Information

FREE ON LINE: Major Text Resource for Laboratory Safety

Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Revised Edition (2011)
http://dels.nas.edu/Report/Prudent-Practices-Laboratory-Handling/12654
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SI Libraries Safety Texts
SIL, particularly the Museum Support Center branch, have many occupational safety-related texts and references. Consult with librarians.

Collections-Based Hazards
A compendium of collections-based hazards can be found in Chapter 24 of the SI *Safety Manual*

Information from your Material Safety Data Sheets (MSDS)
U.S. manufacturers are required by law to produce an MSDS on every chemical and hazardous material they produce. The MSDS is the lab's initial source of details on health effects, fire ratings, reactivity and storage precautions, personal protective and control recommendations, first aid and medical response, and disposal. MSDSs are often sent with chemical shipments, and are often available on manufacturer's web sites.

Information from your Container Labels
The chemical warning label affixed by the manufacturer to each container also contains details similar to the MSDS and should never be removed or changed while chemical remains in the container (NOTE: the external Department of Transportation (DOT) shipping label is NOT as specific and only lists the most urgent information).

NOAA CAMEO software http://www.cameochemicals.noaa.gov/. Information on this site is intended for first responders and safety professionals. To start using the software you simply enter the name of your chemical(s). After which you can:

- View generic **chemical datasheets**
- **Predict reactivity** if two or more substances are mixed together.
- Generate a **report** (with reactivity predictions and datasheet information). These reactivity sheets provide more information than found in a typical incompatibility chart.

  NOAA National Oceanic and Atmospheric Administration CAMEO is an acronym for "Computer-Aided Management of Emergency Operations"

2. University / Professional / Consensus-Standard Organizations with useful websites for laboratories

American Chemical Society Division of Chemical Health &Safety
http://membership.acs.org/c/chas/

American Conference of Governmental Industrial Hygienists
http://www.acgih.org

American Industrial Hygiene Association (AIHA)
http://www.aiha.org

AIHA Lab Safety & Health Committee:
http://www.aiha.org/insideaiha/volunteergroups/labHandScommittee/Pages/default.aspx/htmljavascript.htm

American Institute for Conservation, Health & Safety Committee webpage
http://aic.stanford.edu

American National Standards Institute
http://ansi.org

Arts, Crafts, and Theater Safety
http://www.artscraftstheatersafety.org/

Health Physics Society
http://www.hps.org/

The Laboratory Safety Institute
http://www.labsafetyinstitute.org/

Laser Institute of America
http://www.laserinstitute.org/

Michigan State Univ Office of Radiological, Chemical and Biological Safety:
http://www.orcbs.msu.edu/chemical/resources_links/chemical_compatibility/compatinfo.htm

National Fire Protection Association
http://www.nfpa.org

National Safety Council
http://www.nsc.org

University of California Davis Safety Services:
http://safetyservices.ucdavis.edu/

University of California Davis Safety Nets List
http://safetyservices.ucdavis.edu/quick-links/safetynets-1

University of New Hampshire Env Health & Safety
http://www.unh.edu/research/support-units/environmental-health-safety

3. Regulatory Agencies with useful web sites for laboratories

Occupational Safety and Health Administration (OSHA) 29 CFR 1910 Standards, particularly 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories.
http://www.osha.gov

OSHA's new educational materials on laboratory safety provide information for laboratory managers on protecting their workers from exposure to chemical, biological and physical hazards. The new materials include the *Laboratory Safety Guidance** document,

U.S. Environmental Protection Agency (EPA)
http://epa.gov

U. S. Department of Transportation, Office of Hazardous Materials Safety
Promulgates and enforces national transportation regulations, including shipment of hazardous materials. http://www.phmsa.dot.gov/hazmat

4. Hazardous Substances Databases, especially toxicological information

Agency for Toxic Substance and Disease Registry (ATSDR)
http://www.atsdr.cdc.gov; Agency helps prevent exposure to hazardous substances from waste sites on the U.S. Environmental Protection Agency's National Priorities List, and develops toxicological profiles of chemicals found at these sites. Fact sheets on various substances.

Centers for Disease Control and Prevention
http://www.cdc.gov; Working with states and other partners, CDC provides a system of health surveillance to monitor and prevent disease outbreaks (including bioterrorism), implement disease prevention strategies, and maintain national health statistics.

CDC: National Center for Environmental Health
http://www.cdc.gov/nceh/ Research on environmental-public health issues.

CDC: National Institute for Occupational Safety and Health (NIOSH)
http://www.cdc.gov/niosh/homepage.html;
Conducts research and training in occupational safety and health issues; certifies respirators; issues health hazard alerts and other publications; conducts health hazard evaluations upon employer or employee request; maintains extensive databases of literature including NIOSHTIC. Funds Educational Research

Centers located at many universities across the country, providing training courses and information to employees and employers.

Special link: NIOSH Chemical Protective Clothing
http://www.cdc.gov/niosh/npptl/topics/protclothing/

Special link: NIOSH Pocket Guide to Chemical Hazard
http://www.cdc.gov/niosh/npg/npg.html, on-line, includes many additional databases and literature citations not included in the printed version

National Toxicology Program; http://ntp-server.niehs.nih.gov/ Conducts long-term research studies on chemicals of concern; indicator of emerging hazard issues.

National Institute of Environmental Health Sciences
Information on adverse effects of environmental factors on human health. *Environmental Health Perspectives* (*EHP*) is a monthly journal of peer-reviewed research and news on the impact of the environment on human health.
http://www.ehponline.org/

National Library of Medicine
http://sis.nlm.nih.gov/ The Specialized Information Services Division is responsible for information resources and services in toxicology, environmental health, chemistry, HIV/AIDS, and specialized topics in minority health. Manages databases such as :

TOXNET http://www.nlm.nih.gov/pubs/factsheets/toxnetfs.html, and The Household Products Data Base http://hpd.nlm.nih.gov/

IRIS: Integrated Risk Information System, of the US Environmental Protection Agency http://www.nlm.nih.gov/pubs/factsheets/irisfs.html

Kodak Environmental Services
http://www.kodak.com/US/en/corp/environment/kes/pubs/index.jhtml

5. Carcinogens, Biosafety

(latest) Report on Carcinogens
U.S. Department of Health & Human Services, National Toxicology Program
http://ntp.niehs.nih.gov/index.cfm?objectid=72016262-BDB7-CEBA-FA60E922B18C2540

International Agency for Research on Cancer, http://www.iarc.fr
Monograph series on individual chemicals and carcinogenic agents,

National Cancer Institute, http://www.nci.nih.gov

Biosafety in Microbiological and Biomedical Laboratories , National Institutes of Health http://www.cdc.gov/od/ohs/biosfty/biosfty.htm

6. Fire Safety References

NFPA 10 - *Standard for Portable Fire Extinguishers*
NFPA 30 - *Flammable and Combustible Liquids Code*
NFPA 45 - *Standard on Fire Protection for Laboratories Using Chemicals*
NFPA 55 - *Storage and Use of Liquefied and Compressed Gases in Portable Cylinders*
NFPA 70 - *The National Electrical Code*
NFPA 101 - *The Life Safety Code*
OSHA 29CFR1910, Subparts E-Means of Egress, L-Fire Protection, and H-Hazardous Materials
International Building Code (IBC) – Most recent edition.
International Code Council (ICC) Performance Code for Buildings and Facilities - Most recent edition.

"**Fire Protection for Laboratories Using Chemicals**", National Fire Protection Association (NFPA), 1982.

7. Controls: Ventilation and Personal Protective Equipment (see your safety coordinator or OSHEM for more resources

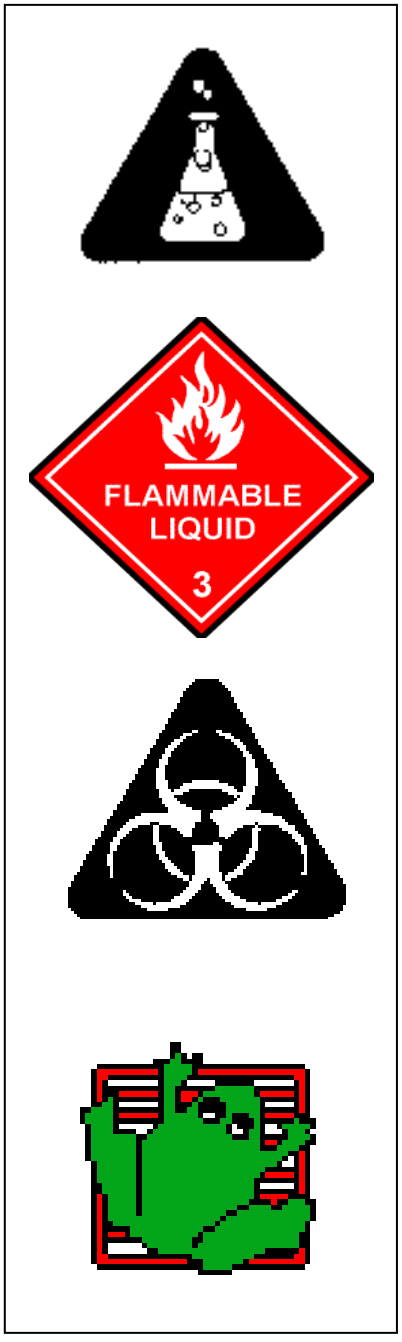
Guidelines for Laboratory Design: Health and Safety Considerations, latest ed Louis DiBerardinis, et al, John Wiley & Sons.

ACGIH Industrial Ventilation: A Manual of Recommended Practice, latest Ed.

Safety in Academic Chemical Laboratories, 6th Ed. ACS Committee on Chemical Safety, American Chemical Society, Washington DC 1995.

Laboratory Ventilation, ANSI/AIHA Z9.5-2003, American National Standards Institute, 2003.

Attachment 1 of Chapter 26,
"Laboratory Safety Plans", SI Safety Manual



Laboratory Safety Plan Guidance Manual

"There are no safe chemicals or safe equipment; the people and their work practices make a laboratory safe."

Adapted from the American Chemical Society

Supersedes SI Lab Safety Manual, issued: 1-28-05

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Laboratory Safety Plan Guidance Manual

Laboratory protocols include a wide variety of processes and chemicals that are not always routine and repetitive. Laboratory safety is largely dependent on the human factors of safe work practices and a well-trained lab staff.

The most effective way to reinforce safe work practices is to involve every lab worker in the writing and review of their Lab Safety Plan (LSP). A template is included as Appendix A. There are many practical ways to organize this information:

a. A facility with 5 or less laboratories may find it easier to write a separate LSP for each one.

b. A large department within a facility, each having multiple labs, might want to create a broader departmental LSP, with individual attachments for each research project.

c. The LSP can be written in whatever format is most practical for your laboratory (c.f.: using the attached template or just inserting safety warning text boxes into the protocol itself)

This Manual contains, as a technical compliment to Chapter 26:

1. Individual Section C.1 requirements for each section of a LSP.
2. Appendix A: LSP Template that you can download and use.
3. Appendix B & B1: Interactive NFPA diamond [hyperlink] with codes
4. Appendix C: Job Hazard Analysis for Laboratories
5. Appendix D: Technical Guidance on Hazard Identification and Control
6. Appendix E. Practical Tips for Safe Operation of Fume Hoods
7. Appendix F: Guidelines for Building Service Workers, Maintenance Workers, and Security Officers

Ch 26 Section C.1.a
EMERGENCY RESPONSE ACTIONS and POINTS OF CONTACT

1. Warning Signs: First Responder Information and Specialized Entry Precautions

    a. All entrances to laboratory work areas in which highly hazardous materials and/or activities are present shall be posted with warning signs indicating any specialized entry precautions and/or instructions for securing the laboratory and shutting-down equipment in case of an emergency.

    b. The warning signs shall also include the names and phone numbers of the Principal Investigator and the emergency contact per the facility's own plans for emergency response and disaster management.

2. Additional Warning Information: A National Fire Protection Association (NFPA) 704-style sign is strongly recommended to be posted at the entrance to each laboratory containing hazardous materials (i.e., the "NFPA Diamond"). An NFPA signage template, with instructions, is included in Appendices B & B1 of this Attachment.

3. In case of a fire, medical emergency, chemical spill or other emergencies/disaster, laboratory occupants are to follow the **facility's emergency response or disaster management plan**, as appropriate, which lists the phone numbers to call to report an incident, and actions to take.

4. Building security officers, building emergency first responders, and building safety coordinators are to have immediate access to Material Safety Data Sheets (MSDSs) and Lab Safety Plans for all laboratory work areas in which highly hazardous materials and/or activities are present.

4. **In the event of a chemical spill or fire**, **IF SAFE TO DO SO**:

    a. turn off any reaction apparatus, especially heat sources,
    b. turn off local exhaust ventilation (and close the sash on a chemical fume hood),
    c. notify supervisors immediately and
    d. follow the response steps in your **facility's emergency response or disaster management plan, including procedures for chemical emergency spill control.**

5. **In the event of a radioactive material spill**, the area shall be restricted and decontamination shall begin promptly. The extent of contamination and potential hazard shall be determined by the supervisor with assistance from the facility Radiation Safety Coordinator. Procedures for responding to and decontaminating a radioactive material spill shall follow OSHEM guidelines in Chapter 32, Ionizing Radiation, of this *Manual*.

6. **If an exhaust hood flow alarm triggers or if the hood is not working properly**:

   a. turn off any reaction apparatus, especially heat sources, or stop chemical reaction,
   b. close the sash on a chemical fume hood,
   c. leave the lab, close the lab door and notify supervisors immediately,
   d. place a call to the proper building authorities and
   e. do not use the hood until the problem is identified and repaired.

7. Lab Safety Plans are to be reviewed to determine the need for any **specialized medical antidote treatment** needed upon exposure and on the way to seeking emergency medical help (for example, exposure to hydrofluoric acid or cyanide). OSHEM/OHSD is to be contacted for advice and training.

8. Emergency Showers and Eye Washes. Whenever there is a possibility that the eyes or body can be injured by corrosive, irritant or otherwise harmful chemicals, in a manner that overwhelms the primary protective devices, facilities for the emergency treatment of injured workers must be provided in accordance with Chapter 9, General Workplace Safety, of this *Manual*.

Ch 26 Section C.1.b

MANAGEMENT APPROVAL. As a demonstration of management commitment to safety, and resource support for implementing the controls and training required by the LSP, each LSP is to be reviewed and approved at least annually or as the Plan is changed, whichever occurs first, by the:

1. Department Chair or Division/Section senior manager.
2. LSO
3. Safety Coordinator

Ch 26 Section C.1.c
SPECIAL APPROVALS and WORK RESTRICTIONS FOR HIGHLY HAZARDOUS ACTIVITIES

1. The LSP is to state which activities or materials:

    a. require special approvals each time prior to the work,
    b. have special restrictions or controls due their highly hazardous nature,
    c. are prohibited to conduct or use when working alone, under any circumstances.

2. Highly Hazardous Materials and/or Activities. "**Highly hazardous**" materials and their safe handling and use, are described in Chapter 19, Chemical Handling and Storage, of this Manual, and are based on the OSHA standard 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories. Technical guidance on defining materials and activities is provided through OSHEM, and in *Section M and Attachment 2* of this Chapter.

    a. "Highly hazardous" refers to:

        i. Chemical carcinogens
        ii. Reproductive toxins, including teratogens and mutagens
        iii. Acutely toxic substances, and
        iv. Highly reactive materials

    b. Modifications to LSPs involving highly hazardous materials must not be made without re-approval by the department senior manager, safety coordinator and LSO.

3. Working Alone. Individuals using highly hazardous chemicals, which could cause immediate serious injury or incapacitation as a result of an accident, shall not work alone. Another individual capable of coming to the aid of the worker should be in visual or audio contact. This requirement shall be stated in the LSP.

4. Extended Duration Experiments

    a. Laboratory operations involving hazardous substances that must be carried out continuously or overnight must be supervised or designed to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas. Controls

must be approved by the LSO and safety coordinator and stated in the LSP.

b. Heat-producing operations that must be carried out continuously or overnight must be supervised or designed with controls to prevent a fire or explosion. Controls must be approved by the LSO and safety coordinator and stated in the LSP.

c. Office of Protection Services (or resident security) shall to be notified of unattended experiments involving hazardous substances and/or heat-producing operations and provided with necessary points of contact and response instructions per the facility emergency response and/ or disaster management plan and in accordance with *Section D* of this Chapter.

d. Laboratory lights should be left on, and signs must be posted identifying the nature of the experiment, the hazardous substances in use, and the emergency contact information for the responsible individual.

Ch 26 Section C.1.d
JOB HAZARD ANALYSIS and CONTROL

1. Job Hazard Analysis.

   a. Supervisors are responsible for assessing the safety risks of their laboratory operations, by identifying hazards and implementing controls to eliminate or reduce health and safety risks to an acceptable level. Appendix C includes a step-by-step spreadsheet for this analysis.

   b. The assessment should address the hazards associated with the properties and reactivity of chemicals and materials being used and potential end products, hazards associated with the operation of equipment, and hazards with proposed reactions.

   c. Control measures and training are to be implemented for identified hazards, in priority order, and in consultation with the facility safety coordinator and OSHEM.

2. Environmental and Personal Exposure Assessments.

   a. Exposure monitoring may be needed to determine the actual health risk from a chemical or process. The OSHEM Environmental Management Division is responsible for conducting environmental and

personal exposure assessments (see Chapter 39 of this *Manual* for details).

b. Staff working with the OSHA regulated substances or hazards identified in Chapter 39, *MUST* arrange for exposure monitoring as required by OSHA standards.

c. Affected staff should contact their Safety Coordinator who will make arrangements for monitoring with the OSHEM IH technical liaison.

3. Medical Surveillance**.** OSHEM/OHSD will provide medical consultations and examinations to affected employees:

a. Whenever an employee develops signs or symptoms of exposure to a hazardous chemical or biological agent to which the employee may have been exposed in the laboratory.

b. Whenever a spill, leak, explosion, or other occurrence results in the likelihood of a serious exposure to a hazardous chemical or biological agent.

c. When an employee requests a medical consultation due to health concerns related to assigned tasks and/or change in personal medical history, such as pregnancy, special medications, or diagnosed hypersensitivities or other illnesses.

d. When exposure monitoring results trigger medical surveillance requirements under a particular OSHA standard (see Chapter 39 of this *Manual*), when other regulations mandate medical consultations, such as for the use of respiratory protection, or for animal handlers.

4. General Lab Safe Work Practices

a. Technical Guidance on safety and health hazard controls for most prevalent laboratory operations are included in Appendix D, and in each of the operational chapters of this *Manual*.

b. Special controls for highly toxic/carcinogenic substances are discussed in Chapter 19, “Chemical Handling and Storage”, of this *Manual.*

c. Specific guidance on ventilation for health hazard control is summarized in Appendix D, Appendix E, and in detail in Chapter 27, “Ventilation for Health-Hazard Control” ,of this *Manual*.

d. Specific requirements for approved quantities (storage and use) of

flammable and combustible liquids, including collections fluid preservatives, is addressed in Appendix D, which also lists specific operational chapters of this *Manual*, and is to be determined with the facility safety coordinator.

e. It is the responsibility of each supervisor to match the proper type of personal protective equipment to the hazard(s) involved with each laboratory operation. See Chapter 17 "Personal Protective Equipment" of this *Manual* for a detailed discussion of PPE selection and use, including:

   i. Safety glasses and goggles for impact and chemical splash protection.
   ii. Other face protection such as face shields, welding goggles, and laser eyewear.
   iii. Foot and head protection.
   iv. Hearing protection, fall protection, and respirators
   v. Electrical protective wear.

5. Decontamination of Equipment. Any equipment must be properly cleaned and decontaminated of any residual hazard prior to disposal or surplus. All surplused equipment that has been decontaminated must have a statement taped to the unit and included in the LSP, listing the decontamination method and verification.

Ch 26 Section C.1.e
MAINTENANCE and INSPECTION of HAZARD CONTROLS

1. Supervisors are responsible for ensuring that equipment and safety controls are routinely inspected, repaired or replaced as needed, to maintain them in good working condition and in accordance with manufacturer's specifications and the specific inspection and condition requirements of individual operational chapters in this *Manual* that apply to that equipment.

2. Maintenance, security and/or building service workers must first receive approval from the laboratory supervisor prior to working on or around any lab utility or fixture. **Lab hoods, electrical power, equipment, or other lab equipment or operations must never be turned off or disturbed without first receiving this approval.**

3. Personal protective equipment is to be inspected by the user before and after

each use for signs of wear that could compromise safety, such as: cracks or other structural damage; loosened or worn elastic straps; pinhole leaks or abraded/thinning sections on chemical-protective clothing.

4. Users are to be trained in the warning signs of equipment or control failures and instructed to stop using same if the equipment or controls are not performing properly.

5. Preventive maintenance and repair of ventilation systems is the responsibility of the resident Building Manager, in accordance with Chapter 27, “Ventilation for Health-Hazard Control” of this *Manual*.

6. OSHEM/EMD shall conduct annual testing of exhaust ventilation systems designed for health hazard control to ensure that adequate exhaust velocity is provided to capture and contain hazardous chemicals, in accordance with Chapter 27, “Ventilation for Health-Hazard Control” of this *Manual*.

7. Biological safety cabinets require a more extensive certification of the effectiveness of the internal filtration, in accordance with NSF/ANSI Standard 49, and are to be inspected and certified annually by an accredited Biological Cabinet Field Certifier. Contact OSHEM for a list a local contractors.

Ch 26 Section C.1.f.
HAZARDOUS WASTE DISPOSAL PROCEDURES

1. Every SI facility has a Hazardous Waste Coordinator (HWC) and a specific hazardous waste disposal protocol based on the regulations of the state or local government in which the facility is located. The facility HWC is to be consulted on procedures to follow within that facility, or to assist in classifying a material as hazardous waste. **Pouring hazardous waste chemicals down the drain, adding them to regular trash, or evaporating them in a local exhaust hood are illegal actions !** Details on SI regulations can also be found in Chapter 29, “Hazardous Waste Management”, of this *Manual*.

2. Each container of hazardous waste is to be labeled according to requirements of its jurisdiction, and according to the direction provided by the facility HWC. If a reagent container label has been removed or becomes illegible, and the identity of the contents is unknown, the container must be disposed as soon as possible by arrangement with the facility hazardous waste coordinator.

3. Prior to the departure of staff or visiting scientists, chemicals for which that

person was responsible are to be inventoried and discarded or returned to storage.

LABORATORY SAFETY PLAN TEMPLATE

Use This Template to Create or Update Your Lab Safety Plan

- Review your current LSPs against these requirements of Chapter 26 and update as needed.

- Old LSP formats are still valid, HOWEVER,

- Your annual updates should incorporate important new aspects in the new template, that will better organize your information, such as the:
  - Management Approval page
  - Job Hazard Analysis for Laboratories
  - Training Requirements for this laboratory operation, to be included in your Job/Lab hazard analysis sheet.

LABORATORY SAFETY PLAN

[Department / Laboratory Name & Room No. if applicable]

Prepared by Lab Supervisor _____ Date _____

FACILITY EMERGENCY PROCEDURES:

In case of fire, medical emergency, chemical or radioactive material spill or other disaster, follow [facility name] EMERGENCY RESPONSE PLAN and call:

Then if you can do so safely:

- **Turn off any reaction apparatus, especially heat sources.**
- **Turn off any local exhaust ventilation and close the sash on chemical fume hoods.**
- **Exit the lab, close the door and notify your supervisor.**

WARNING: IN CASE OF EMERGENCY ENTRY!!

THESE HIGHLY HAZARDOUS MATERIALS ARE USED/STORED IN THIS ROOM :

(if applicable) MEDICAL ANTIDOTE FOR EXPOSURE TO [ ] STORED IN [ ].

IMPORTANT CONTACTS: [insert name & phone number for each below]

Principal Investigator or Responsible Supervisor:

Facility Laboratory Safety Officer/Committee:

Facility Safety Coordinator:

Facility Hazardous Waste Coordinator:

(If applicable) Facility Radiation Safety Coordinator:

[Department] Safety Committee member:

Occupational Health Services Clinic / OSHEM: 202-633-7990

CHEMICAL INVENTORY / MATERIAL SAFETY DATA SHEETS CAN BE FOUND IN :

MANAGEMENT APPROVAL

This Laboratory Safety Plan (LSP) describes safe work practices, personal protective equipment, and other control measures necessary for the safe use of chemicals and other hazardous materials and procedures for this laboratory.

All employees, visiting researchers (including those with short-term appointments or interagency agreements), volunteers, interns, or contractors assigned to laboratory work must be advised of the provisions of their LSP before working with chemicals or processes in the laboratory, and are expected to utilize the specified safe work practices.

As protocols change, or on an annual basis (whichever comes first), this Plan is to be reviewed by all members of the laboratory team and updated as needed to heighten safety awareness. Additional technical guidance can be found:

- In the SI Safety Manual ***(located on PRISM, Safety link, or http://ofeo.si.edu/safety_health/OSHEMhome.asp)***
- In our Material Safety Data Sheets ***(located in …….)***
- From your Supervisor or laboratory Principal Investigator (PI).

The requirement for a site-specific LSP is based on SI policy (Chapter 26, SI Safety Manual) and the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories.* This Plan is to be used in conjunction with the SI Safety Manual), for a full understanding of the principles and practices involved with safe work in your lab.

In my capacity as the person principally responsible for this lab and the safety of its users, I approve this Lab Safety Plan and expect all personnel using this lab to integrate its requirements in their daily work, for their safety and that of their co-workers. The mission of this Lab can readily be accomplished without compromising safety or the environment.

_____*(signature/title of Dept. Chair or Senior Manager)*

_____*(date)*

Rev and approved:
(Lab Safety Officer signature and date)_____

Rev and approved:
(Safety Coordinator signature and date)_____

SPECIAL WORK RESTRICTIONS FOR HIGHLY HAZARDOUS ACTIVITIES

The following work conditions, activities and/or procedures shall require special permission from [insert name] prior to conducting:

The following procedures should never run unattended:

The following procedures cannot be conducted while working alone:

unless the following special arrangements are approved in writing by [insert name]:

[See Ch 19, SI Safety Manual, and Ch. 26 resource list]**The following highly hazardous materials (i.e., carcinogens, reproductive hazards, radioactive, acutely toxic or reactive) are stored and used in this lab, and require the following special handling procedures:**

Restricted work area has been established and labeled in (describe):
Special storage area is established in (describe)
(If required): Special decontamination procedures include (describe):
(If required): Special waste disposal procedures include (describe):

JOB HAZARD ANALYSIS & CONTROL MEASURES

Recommended Option: Use Att. 1, App B spreadsheet of this Chapter.

OR: Create your own table of the major steps in your protocols. Either way, include the following information based on references in this Chapter:

(1) List the major/critical steps in your lab protocol.

(2) List the lab/experimental equipment used per step.

(3) List the chemicals (or other hazardous materials) to be used per step.

(4) Based on 1-3, summarize the Potential Hazards (safety, health, fire or environmental) that could possibly cause injury, illness, fire, or pollution.

a. Start by listing the intuitive hazards

b. Then, refer to Appendix D Technical Guidance of this Chapter, and the pertinent operational Chapters of the Safety Manual that apply to either the operational step, the equipment and/or the chemicals, to really understand what could go wrong and how to prevent it.

(5) How severe is the risk associated with these hazards?
Not sure if the chemicals will cause overexposure? Call your safety coordinator for advice, or to arrange for OSHEM IH exposure assessments, to help you design the proper controls, and select the proper personal protective equipment.

(6) Develop a plan for reducing risk and controlling exposures. Double-check the operational chapters applicable to each step, equipment and chemical to be sure you are using best-practices and complying with regulatory requirements.

(7) Check Chapter 19, Chemical Handling and Storage, and note any special precautions necessary in each step.

Be sure to include instructions on storage and use (and approved quantities) of flammable/combustible liquids, including fluid preservatives and fluid-preserved specimens.

(8) Check with your safety coordinator, with OSHEM technical assistance and with the attachments to this chapter, for specific highly hazardous materials controls.

(9) Select and list the appropriate personal protective equipment. Be specific; saying exactly what needs to be done, such as: “Wear blue nitrile gloves (found in PPE storage drawer) and non-vented safety goggles”, instead of “Wear gloves and eye protection”.

(10) Training course required (see Section D of the Chapter and the OSHEM Training Catalogue.

ROUTINE MAINTENANCE and INSPECTION of LABORATORY EQUIPMENT and SAFETY CONTROLS

ROUTINE PREVENTIVE MAINTENANCE REQUIRED FOR EQUIPMENT AND SAFETY CONTROLS

Lab staff [insert names] are responsible for performing routine maintenance on the following equipment and on the following schedule, to ensure good working order:

Building management will conduct preventive maintenance and inspection on the following equipment and on the following schedule, to ensure good working order for the safety of the lab:

[insert any other organizations who routinely inspect/maintain lab equipment or safety equipment, such as fire extinguishers and safety eyewashes]

ROUTINE INSPECTION OF EQUIPMENT, PPE AND SAFETY CONTROLS

Prior to using [list each specific mechanical apparatus or instrument] *check*
[give specific instructions here] *to be sure it is working properly.*
[repeat this line for each critical piece of equipment or safety control]

Turn on lab fume hood and check the hood flow monitor for proper hood exhaust flow before opening chemical bottles or conducting hazardous work inside hood.

Before putting on gloves, check for holes and leaks (fill chemical gloves with water or air)

SIGNS OF CONTROL FAILURE

Stop work and notify your supervisor [add building mgr number for utility malfunctions if appropriate to your facility] ***if you notice anything out of the ordinary or signs of failure in safety controls or protective equipment, such as*** [be specific from your Hazard Analysis & Control sheet] :

- Lab exhaust systems not working properly (visual clues, odor noticed).
- Fume hood monitor indicates low flow and/or in alarm mode.
- Moisture felt on inside of gloves
- Chemical burns or redness on skin/hands without any obvious signs of safety glove failure
- Eyes irritated even though safety goggles worn
- Machinery sounds different/wrong upon start-up.
- Chemical leaks found around stored containers, or precipitation/corrosion noted on bottles, shelves.

HAZARDOUS WASTE DISPOSAL AND SPILL CONTROL

[NAME of hazardous waste coordinator] is to be consulted on hazardous waste disposal procedures, or to assist in classifying a material as hazardous waste. Details on SI regulations can also be found in the SI Safety Manual, Chapter 29.

If radioactive or biological waste is generated in this laboratory, specify special disposal instructions per your LSO or Rad Safety Officer:

Each container of hazardous waste is to be labeled with the following legends. Pre-printed labels are also available through **[NAME].**

"HAZARDOUS WASTE"

CONTENTS [be specific as to chemical and quantity of each: ex. 500 mL 10% ethanol]

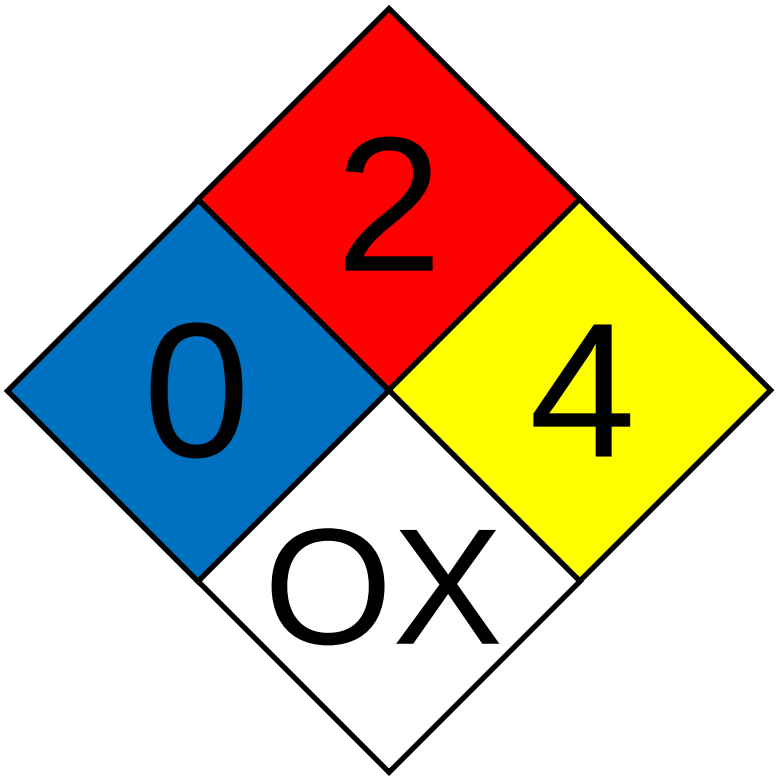
ACCUMULATION START DATE:

If a reagent container label has been removed or becomes illegible, and the identity of the contents is unknown, the container must be disposed as soon as possible by arrangement with the facility hazardous waste coordinator.

Prior to the departure of staff or visiting scientist, chemicals for which that person was responsible are to be inventoried and discarded or returned to storage.

Pouring hazardous waste chemicals down the drain, adding them to regular trash, or evaporating them in a local exhaust hood are illegal actions !

SPECIAL INSTRUCTION: *Attach your facility's* "Hazardous Chemicals Emergency Spill And Leak Control Procedures, Reporting Person's Check List" *from facility spill plans.*



Special Entry Precautions:

Wear safety goggles

Edit Diamond

Laboratory entries should be posted with the NFPA diamond. **Att 1 App B provides you with an INTERACTIVE template.** You can change the number automatically in each diamond section, or print out and write in, based on the codes listed on the template. Simply print out, enclose in a plastic sleeve and post on your door!

HEALTH	FLAMMABILITY
4 - Can be lethal	**4** - Materials that rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and burn readily.
3 – Can cause serious or permanent injury	**3** - Liquids and solids that can be ignited under almost all ambient temperature conditions.
2 - Can cause temporary incapacitation or residual injury	**2** - Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.
1 - Can cause significant irritation	**1** - Materials that must be preheated before ignition can occur
0 – Would offer no hazard beyond that of ordinary combustible materials	**0** - Materials that will not burn under typical fire conditions.
EXPLOSION	**SPECIAL HAZARDS**
4 - Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures	• Materials that react violently or explosively with water (i.e., water reactivity rating 2 or 3) shall be identified by the letter "W" with a horizontal line through the center (W). • Materials that possess oxidizing properties shall be identified by the letters "OX." • For chemicals requiring both "special hazard" symbols (i.e., W and OX), the W shall be displayed inside the special hazards quadrant, and the OX shall be displayed directly below or adjacent to the special hazards quadrant. • Materials that are simple asphyxiant gases shall be permitted to be identified with the letters "SA" and shall be limited to the following gases: nitrogen, helium, neon, argon, krypton, and xenon.
3 - Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction but that require a strong initiating source or must be heated under confinement before initiation	
2 - Materials that readily undergo violent chemical change at elevated temperatures and pressures	
1 - Materials that in themselves are normally stable but that can become unstable at elevated temperatures and pressures	
0 - Materials that in themselves are normally stable, even under fire conditions	

HEALTH HAZARDS

Toxicity is the potential of a substance to cause injury to the body. To properly evaluate the degree of toxicity, you need to know the quantity demonstrated to be toxic (usually expressed in terms of Lethal Dose or Lethal Concentration) in experimental studies, whether the effect is acute or chronic, the routes of entry into the body (ingestion, inhalation, absorption, or injection), and symptoms and target organs of over-exposure.

OSHA Hazard Communication Standard 29 CFR 1910.1200 Appendix A includes a good summary of definition, including these two highly hazardous substances:

"**Carcinogen**:" A chemical is considered to be a carcinogen if:

(a) It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or

(b) It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or,

(c) It is regulated by OSHA as a carcinogen.

"**Highly toxic**:" A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD(50)) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD(50)) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC(50)) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

The degrees of health hazard shall be ranked according to the probable severity of the effects of exposure to emergency response personnel:

4 - Materials that, under emergency conditions, can be lethal

3 - Materials that, under emergency conditions, can cause serious or permanent injury

2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury

1 - Materials that, under emergency conditions, can cause significant irritation

0 - Materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials

FLAMMABILITY HAZARD

Flammability is one of the most common chemical hazards. To handle a flammable material safely, you must know its flammability characteristics: flash point, upper and lower limits of flammability, and ignition temperatures. **This information appears on each chemical's Material Safety Data Sheet (MSDS).** Also, **hot work** requires permitting and other controls to prevent a fire hazard.

The degrees of flammability hazard shall be ranked according to the susceptibility of materials to burning:

4 - Materials that rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and burn readily

3 - Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions.

2 - Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air.

1 - Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur.

0 - Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand

EXPLOSION AND REACTIVE HAZARDS

There are substances that are explosive in response to heat, light, friction, static discharge, mechanical shock, or contact with a catalyst. With some substances, very tiny amounts of impurity are sufficient to begin a reaction that can quickly transition to detonation. Hazards include old, degraded chemicals and peroxide-forming agents like picric acid.

A laboratory work area is considered to contain an explosion hazard if any of the following apply:

- ✓ Materials stored have a National Fire Protection Association (NFPA) reactivity rating of 4.
- ✓ Use or formation of materials with an NFPA reactivity hazard rating of 4.
- ✓ Presence of highly exothermic reactions such as polymerizations, oxidations, nitrations, peroxidations, hydrogenations, or organo-metallic reactions.

The degrees of hazard shall be ranked according to ease, rate, and quantity of energy release of the material in pure or commercial form:

4 - Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures

3 - Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction but that require a strong initiating source or must be heated under confinement before initiation

2 - Materials that readily undergo violent chemical change at elevated temperatures and pressures

1 - Materials that in themselves are normally stable but that can become unstable at elevated temperatures and pressures

0 - Materials that in themselves are normally stable, even under fire conditions

SPECIAL HAZARDS

Special hazards denote water reactivity and oxidizing properties of the materials that cause special problems or require special fire-fighting techniques. Certain chemicals, when mixed, produce new and volatile or toxic chemicals, usually rapidly and violently leading to fire or explosion. Examples include water-reactive chemicals (elemental sodium or potassium), oxidizers (perchloric acid, ammonium nitrate), and reducing agents (ammonia, metals)

Special hazards shall be represented by a spatial arrangement denoted by symbols always at the six o'clock position.

- Materials that react violently or explosively with water (i.e., water reactivity rating 2 or 3) shall be identified by the letter “W” with a horizontal line through the center ().
- Materials that possess oxidizing properties shall be identified by the letters “OX.”
- For chemicals requiring both “special hazard” symbols (i.e.,  and OX), the  shall be displayed inside the special hazards quadrant, and the OX shall be displayed directly below or adjacent to the special hazards quadrant.
- Materials that are simple asphyxiant gases shall be permitted to be identified with the letters “SA” and shall be limited to the following gases: nitrogen, helium, neon, argon, krypton, and xenon.

JOB HAZARD ANALYSIS FOR LABORATORIES

Lab Protocol/Experiment Title:

Date Created/Revised:

Lab supervisor:

WORK LOCATION (ROOM NO.):

DEPARTMENT:

Task Description (summarize from, or cross-reference to, the lab protocol	Equipment Used (note frequency/duration)	Chemicals/Hazardous Materials Used	POTENTIAL HAZARDS	RISK (High-Medium-Low)	REQUIRED CONTROLS/WORK PRACTICES	PPE	Special Notes on Highly Hazardous Material Storage, Handling	REQUIRED TRAINING

TECHNICAL GUIDANCE on HAZARD IDENTIFICATION and CONTROL

IDENTIFICATION

Identifying all the health and safety hazards in a research or conservation lab is more challenging than for an industrial process because of the variety of chemicals in use, in storage, or as part of the collections themselves. The assessment should address the hazards associated with the properties and reactivity of materials being used and potential end products, hazards associated with the operation of equipment, and hazards with proposed reactions.

CONTROLS AND SAFE WORK PROCEDURES

The estimated health and safety risks inherent to the laboratory operation, as determined through exposure assessments and job hazard analyses, will dictate the most effective control measures needed to eliminate those risks or, at least, reduce them to acceptable levels. The three general control methods are:

1. Re-design of methods or equipment, substitution of least hazardous chemicals, and mechanical engineering controls such as ventilation, guards, instrument interlocks
2. Good laboratory work practices and regular training and drills.
3. Personal protective equipment (respirators, gloves, eye protection, safety eyewash/showers)

This Appendix contains summaries of these topics (refer to their *Safety Manual* Chapters for more details):

- General Lab Safety
- Selection & Use of Ventilation Controls
- Special Chemical Handling and Storage Instructions
- Electrical Hazards
- Physical/Mechanical Hazards
- Compressed or Liquified Gases
- Cryogenic Safety
- Radiation/Lasers
- Blood-borne Pathogens and Zoonoses

GENERAL LAB SAFETY

- Before beginning any new operation, reduce the potential for accidents by obtaining information from reference materials regarding hazards, instituting appropriate protective procedures, and planning the proper positioning of equipment.

- Chemicals shall not be brought into a laboratory work area unless the design, construction, and fire protection of the facility are suitable for the quantities and hazards of chemicals being introduced. CHECK WITH YOUR SAFETY COORDINATOR.

- Portable fire extinguishers shall be installed, located, and maintained throughout all laboratory units in accordance with NFPA 10 – *Standard for Portable Fire Extinguishers* and NFPA 45 - *Standard on Fire Protection for Laboratories Using Chemicals*.

- All heating of flammable and combustible liquids shall be conducted so as to minimize fire hazards.

- To the extent feasible, operations are not to be left unattended. In the event operations must be left unattended, leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances.

- Any work involving an apparatus which may release toxic chemicals (vacuum pumps, distillation columns, etc.) should be conducted in a hood or vented into a local exhaust device.

- Chemicals and apparatus are to be placed back from edges of tables or benches.

- Access must be kept clear to safety showers and eye washes; exits and emergency equipment must not be blocked; and stairwells and hallways must not be used to store material.

- Equipment is to be used only for its designed purpose. Only authorized personnel are allowed to make repairs or adjustments on equipment.

- Damaged glassware is not to be used. Extra care is to be used with Dewar flasks and other evacuated glass apparatus, which should be shielded or wrapped to contain chemicals and fragments should implosion occur.

- Ensure all employees are educated on “Stop, Drop, and Roll” should their clothing catch on fire.

- Ensure gas shut-off valves are properly marked and readily accessible.

- Hands and areas of exposed skin are to be washed well and often while in the lab and before leaving. All food, beverages, cosmetics, and medications are to be stored outside the laboratory. Lab sink areas are not to be used for washing/storing food and beverage utensils, coffee makers, microwaves, etc. The lab sink and eye wash station water supply are not to be used for drinking water due to the potential for chemical contamination.

- Skin that could be exposed to chemical splash is to be covered. Shoes must cover the entire foot. Long hair and loose clothing are to be secured to prevent them from coming in contact with contaminated materials or moving equipment parts. Hanging jewelry or absorbent watch straps should not be worn.

SELECTION AND USE OF VENTILATION CONTROLS

Chapter 17, SI *Safety Manual*
(Suggestion: Print and Post App E Fume Hood Safety)

- ***General (dilution) ventilation is primarily used to control employee comfort*** (for example, temperature and humidity). Dilution ventilation may be used to reduce airborne concentrations of contaminants of low toxicity when they are generated at relatively low rates from diffuse sources. Dilution ventilation rates shall be determined using ANSI/ASHRAE Standard 62.1-2007, "Ventilation for Acceptable Indoor Air Quality."

- All work with hazardous materials must be conducted under properly designed and functioning ***local exhaust ventilation***.

- Application and installation of any local exhaust system must be reviewed and approved by OSHEM with respect to its intended use**.**

- **Enclosure** hoods, such as a chemical fume hood, glove box, biosafety cabinet, or toxic gas cabinet which completely contains the contaminant source, are the most effective local exhaust system.

- **Capture** hoods (such as "snorkel/elephant trunk" types), slot hoods, or downdraft tables are designed to provide a strong exhaust velocity at a certain distance from the source and can be used for control of materials with low-to-moderate toxicity, or for situations where point source control of hazardous materials cannot be achieved easily in an enclosure and the exposure risk has been assessed to be low-to-moderate.

- **The acceptable working distance for a capture hood is a critical variable** in the formula which must be provided to lab designers in order to provide a safe system for your needs. Conversely, for existing capture hoods, the OSHEM hood test sticker should be noted, which will indicate the maximum distance the hood can be placed away from a source and still exhaust effectively (typically 80 lfm; with effective smoke test capture).

- **Canopy-type receiving hoods** are **never** to be used for control of chemical hazards, since they could pull contaminants through a worker's breathing zone and cause illness or injury.

- ***Ventilation Design Requirements for Specific Processes***. For certain processes, federal regulations mandate defined ventilation system designs, and/ or minimum ventilation rates. Some of these process specific requirements are detailed in Attachment 1 of Chapter 17," Ventilation for Health-Hazard Control", of the *SI Safety Manual*. The Safety Coordinator and OSHEM should be consulted for processes that are not listed, but may generate uncontrolled airborne contaminants.

- **Radioisotope work** is to be conducted in fume hoods dedicated to this purpose and under work conditions specifically approved through the OSHEM Radiation Protection Program and applicable Nuclear Regulatory Commission license provisions.

SPECIAL CHEMICAL HANDLING AND STORAGE INSTRUCTIONS for chemicals and hazardous materials will follow the direction, and reference lists, in **Chapter 19 "Chemical Handling and Storage"** of the *SI Safety Manual*:

- Inventory Control
- Labeling
- Safe work practices
- Secondary containment and spill response
- Compatible storage by chemical class
- Storage in appropriate cabinets, refrigerators or freezers
- Special controls of highly hazardous materials

ELECTRICAL HAZARDS

Chapter 9 (General Workplace Safety) and Chapter 12 (Lock-out/Tag-out) of the *SI Safety Manual*

Electrical shock or similar injuries can occur from contact with energized circuits or equipment. Serious injury is possible when appropriate attention is not given to the engineering and maintenance of electrical equipment and personal work practices around such equipment. In addition, equipment malfunctions can lead to electrical fires. By taking reasonable precautions, electrical hazards in the laboratory can be dramatically minimized.

- All electrical installations, including wiring, apparatus, lighting, etc., shall comply with the requirements of NFPA 70 - *The National Electrical Code (NEC).*

- Electrical receptacles, switches, and controls shall be located so as not to be subject to liquid spills.

- All 125 volt receptacles installed within 6 feet of a sink will be provided with Ground Fault Circuit Interrupter (GFCI) protection. Exception: In industrial laboratories, receptacles used to supply equipment where removal of power would introduce a greater hazard shall be permitted to be installed without GFCI protection.

- Flammable liquids should be kept away from electrical equipment.

- Laboratory personnel should know the location of electrical shut-off switches and/or circuit breakers in or near the laboratory so that power can be quickly terminated in the event of a fire or accident.

- All electrical equipment should be periodically inspected to ensure that cords and plugs are in good condition. Frayed wires and wires with eroded or cracked insulation should be repaired immediately by a qualified electrician, especially on electrical equipment located in wet areas such as cold rooms or near cooling baths. Insulation on wires can easily be eroded by corrosive chemicals and organic solvents.

- All electrical equipment should have three-pronged, grounded connectors. The only exception to this rule is instruments entirely encases in plastic (i.e., electric pipetters and some types of microscopes) and Glas-Col heating mantels. If equipment does not have a three-pronged plug, tag the equipment out of service and have a qualified electrician replace the plug.

- Extension cords should be avoided. They should be used only on a temporary basis. They should have three-pronged, grounded connectors and be positioned or secured so they do not create a tripping hazard.

- Do not use electrical equipment while standing on a wet surface or when hands are wet.

- Electrical panels in the laboratory must be easily accessible. Do not store materials on the floor in front of panels.

- Avoid working on live circuits. Connect power only to perform necessary tests and disconnect when finished.

- When building new equipment or repairing the 115 volt alternating current (AC) portion of an existing chassis, cover the bare connections with insulation or install a protective shield.

- Completely de-energize a system before conducting any electrical work with exposed circuits or contacts having a potential to ground of greater than 30 volt alternating current (AC) or 6 volt direct current (DC). Adequate safeguards must be in place to prevent the system from accidentally being re-energized.

- Replacement parts should have the same or higher voltage/current ratings as originals.

- Safety interlocks are not to be bypassed unless necessary to service equipment. When necessary, care should be taken to avoid voltage hazards and to remove the bypass when finished.

- Laboratory work areas, laboratory units, and laboratory hood interiors generally shall be considered as “unclassified” electrically, with respect to Article 500 of NFPA 70 – the NEC. It may, however, be necessary under special conditions to classify a portion or all of a laboratory work area as a hazardous location.

- Only trained personnel may repair and maintain electrical equipment. High voltage electrical work shall be performed by qualified electricians only.

- All electrical shocks, no matter how minor, should be immediately reported to the supervisor. All faulty electrical equipment shall be immediately tagged out of service until repaired by a qualified electrician.

- Electrical outlets, wiring, and equipment within a laboratory or building should only be repaired by qualified electricians.

PHYSICAL/MECHANICAL HAZARDS

SI Safety Manual Chapters: 9 (General Workplace Safety); 11 (Machinery and Tools); 13 (Materials Handling/Storage); 20 (Compressed, liquefied, cryogenic gases); 24 (Collections)

Physical injury and property damage is a risk from poor control of a wide variety of lab processes, equipment and hazardous materials. Practically every operational chapter in the SI Safety Manual could apply, but the following are the ones that apply to most laboratories and should be consulted FIRST:

MECHANICAL AND EXPERIMENTAL APPARATUS

- Inspect all equipment before use. Ensure that defective equipment is tagged out of service and is not left for someone else to use.

- All mechanical equipment, including refrigerators and freezers, shall be installed in accordance with National Fire Protection Association (NFPA) and National Electric Code (NEC) requirements, properly grounded, and Underwriter Laboratories (UL) listed. The power supply shall be properly fused and protected. Three-prong to two-prong adapters shall not be used.

- In general, all mechanical equipment shall be furnished with adequate safety guards that prevent access to electrical connections and moving parts. Laboratory personnel shall receive training in the safe use of this equipment.

- Electric power failure or shutdown may cause exhaust hoods to cease functioning. When this occurs, cylinders of toxic or flammable gas must be turned off, reactions producing toxic fumes must be shut down, bacteriological or virological techniques producing pathogenic aerosols must be stopped, and associated systems sealed off insofar as is possible and safe.

- Reactions shall not be carried out under pressure in closed containers unless the container has been tested and certified as able to withstand the pressure. Pressurized apparatus must have appropriate relief devices.

- Safety shielding shall be used for any operation having the potential for explosion, such as when a reaction is carried out for the first time or under non-routine, non-ambient conditions. Shielding must be adequate to protect all personnel in the area.

- Pressure vessels should not be opened until the internal and atmospheric pressures have been equalized.

COMPRESSED or LIQUIFIED GASES and CRYOGENS

- Compressed gas cylinders are manufactured and charged under regulations set by the Department of Transportation. These cylinders must not be filled or altered in any way except as specified by the cylinder manufacturer. Compressed gas cylinders should be handled as high-energy sources and therefore as potential explosives and projectiles.

- The handling, storage, and use of oxygen, fuel, or any compressed or liquefied gas cylinder shall be in accordance with the policy specified in the SI *Safety Manual*, Chapter 20, Compressed Gases.

- All cylinders should be checked for damage upon receipt and prior to use. The Receiving Cylinder Checklist, Attachment 1 in Chapter 20, SI *Safety Manual,* should be used.

- Cylinder storage areas must be conspicuously placarded with the names of gases being stored.

- Know the contents of a cylinder and be familiar with the properties of that gas. Never use a cylinder which cannot be positively identified; cylinder color coding varies among gas vendors and is an unreliable identifier of cylinder contents. Do not rely on color codes for identification of gas; use the tag or decal.

- Each experimental apparatus employing compressed gas cylinders should be checked for proper pressure relief with the facility/department supervisor. The cylinder regulator maximum discharge pressure should not exceed the pressure rating of the downstream apparatus. Be sure all downstream apparatus is at zero guage pressure before disassembly.

- Federal regulations require that cylinders of oxidizing gas be separated from cylinders of flammables by a minimum of 20 feet or by a five foot high 30 minute rate fire rated barrier.

- Storage of compressed or liquefied gas cylinders in a laboratory shall be limited to those cylinders needed for the experiment in progress. When stored or in use at a laboratory, the maximum quantity of flammable or oxidizing gases within a laboratory unit shall be per NFPA 45. For laboratory work areas of 500 $ft.^2$ or less, the maximum cylinder volume shall not exceed 6.0 $ft.^3$ of flammable or oxidizing gases. Cylinders must be secured in an upright position with an approved strap and bracket or chain device, and protective caps in place when stored.

- Cylinders must be transported securely on carts. Cylinders must be capped when they are being moved or not in use.

- A compressed gas cylinder is considered to be in use if:
  a) It is connected through a regulator to deliver gas to a laboratory operation.
  b) It is connected to a manifold being used to deliver gas to a laboratory operation.
  c) It is a single reserve cylinder secured alongside the cylinder in item (a).

- Do not drop cylinders or allow them to strike against each other.

- Cylinders and other containers of compressed gases must be kept below 125^{o}F. Contact with a direct flame is not permitted under any circumstances. Direct sunlight must be avoided.

- Do not rely on color codes for identification of gas; use the tag or decal.

- Stand away from the face of regulator when opening the valve. Free gases should be turned on slowly and fully. Liquefied gases should be turned on partially.

- Toxic gases shall be ordered in the smallest quantity possible for the nature of the experiment. Use of cylinders shall only be under a laboratory hood, vented gas cabinet or with special safety-vented regulators connected to a local exhaust system for direct discharge to the atmosphere. Consult with OSHEM before starting use.

- Only personnel experienced/trained in the use of compressed gases may handle toxic or explosive gases.

- Use special safety vented regulators for highly-toxic and hazardous gases, with the vent piped to a hood or other local exhaust system for direct discharge to the atmosphere in the event of a leaking regulator.

- Oily gauges should **never** be used with oxygen. Gauges used with oxygen should bear the warning: **"Oxygen - Use No Oil".**

CRYOGENIC SAFETY

- **Cryogenic Fluids.** Be aware that there is a possibility of explosion, spilling, frostbite, and an escape of asphyxiating gases when using cryogenic fluids.

- In all cases of low temperature operations, the names of persons knowledgeable of the operation of the equipment are to be posted in an easily visible location near the equipment.

- When handling liquefied gases, the eyes must be protected with a full face shield and goggles. Insulating cryogen gloves must be worn when handling anything that is, or that may have come into contact with, the liquid. Gloves must be loose-fitting to facilitate quick removal. Impervious apron or coat, long pants, and high topped shoes should also be worn. Leg wear must not be tucked inside foot wear when liquids are poured from or used in open containers.

- Only authorized personnel are to be allowed to repair or make adjustments to cryogenic systems.

- All cryogenic storage vessels shall be chosen to withstand the weights and pressures of the material used, and shall have adequate venting to prevent pressure buildup.

- Cryogenic fluids are to be used in equipment and systems that are free from contaminating materials that could create a hazardous condition upon contact with the cryogen. Mixtures of gases and fluids must be closely controlled to prevent the formation of flammable or explosive mixtures.

- Evacuated glassware (commonly Dewar flasks) must be shielded against implosion.

- Work and storage areas should be well ventilated.

- Transfers or pouring of cryogenic liquid should be done very slowly to minimize boiling and splashing.

RADIATION HAZARD (INCLUDING LASERS)

***SI Safety Manual Chapters*: 32 (Ionizing); 33 (Non-Ionizing); 34 (Laser Safety)**

Ionizing, non-ionizing, or laser radiation sources are used as tools for research, and, in some cases, can be a byproduct of the research. Acute exposure to radiation at high levels can rapidly cause serious health effects, even death. Chronic exposures can lead to delayed health effects, including possible cancers.

IONIZING RADIATION SAFETY

The use, storage, and display of radioactive materials and lasers must be in compliance with the SI's Radiation Protection Program. The Program ensures compliance with U.S. Nuclear Regulatory Commission regulations and licenses, as well as all applicable State agreements.

All users of radioactive materials must be in contact with the respective facility's assigned Radiation Safety Coordinator (RSC), who is responsible for:

- conducting routine health physics surveys of all laboratories and storage areas,
- supervising radioactive waste disposal,
- maintaining an inventory of all radioactive materials,
- authorizing procurement, receipt, and distribution of all radioisotopes, and
- distributing, receiving, and processing personnel monitoring devices.

The RSC and PI's work closely with the **SI Radiation Safety Officer in OSHEM**, who provides oversight, training (see Chapter 32 of this *Manual*), and exposure monitoring; approves all protocols and LSPs involving radioactive materials; and prepares all licensing documents for submission to the Nuclear Regulatory Commission and applicable state agencies.

NON-IONIZING RADIATION SAFETY

Work with non-ionizing sources, such as UV light, radiowaves, microwaves, or electromagnetic fields must follow the exposure controls and regulations required by Chapter 33 of the SI *Safety Manual*. Consult your facility safety coordinator or facility radiation safety coordinator for technical assistance and include these sources in your LSP.

LASER SAFETY

All work with lasers, of any Class, or with instruments and equipment containing embedded laser systems, must follow the requirements of the SI Laser Safety Program, as described in Chapter 34 of the SI *Safety Manual*. All laser use, safe work practices, and LSPs involving lasers, are to be approved by the facility safety coordinator or facility radiation safety coordinator. The respective facilities are to maintain a laser inventory of class and parameters, use, principal operator, and location of both setup/use and non-use storage. The act of servicing and maintenance of normally inaccessible embedded laser systems will need to be evaluated for safety risks. Laser safety training is available for all laser operators. Safety training is required for operators of Class 3b and 4 lasers. Contact OSHEM (202-633-2530) for scheduling.

BLOOD-BORNE PATHOGEN OR ZOONOTIC BIOHAZARDS

SI Safety Manual Chapters: **40 (Blood-borne pathogen); 44 (Zoonoses)**

Biohazards include organisms (viral, fungal, and bacterial) or products of those organisms that present a risk to humans, including human blood-borne pathogens and zoonotic hazards of animal-to-human transmission (including viral, bacterial, protozoan and other parasitic infections which can be transmitted from live animals and post-mortem specimens to humans).

- Individuals working with **human tissue, blood, or body fluid** are to be enrolled in the SI **Blood-Borne Pathogen Program** through OSHEM/OHSD and offered the necessary immunizations, and develop specific safe work practices, disinfection, and biohazard waste disposal programs for their lab.

- **No work shall be conducted at the SI exceeding Biosafety Level (BSL) 2, due to the serious health risks associated with BSL 3 & 4 organisms, and the lack of BSL 3 or 4 containment facilities within the SI.**

- It is the policy of the SI to provide appropriate inoculations, medical testing and surveillance and to implement safe work practice controls to **reduce the risk of employees contracting a zoonotic disease** during field collection, specimen preparation, or collection handling.

- Individual facility-specific **zoonosis control programs,** formulated with OSHEM, will be incorporated into those facilities' LSPs and general safe work procedures. Elements of BSL-2 containment controls will be implemented, as a minimum, although more stringent controls may be needed depending on discovered pathogens in infected live animals, or suspected or tested pathogens in post-mortem specimens.

Practical Tips for Safe Operation of Fume Hoods

#1: Your fume hood is not a storage area. Keeping equipment and chemicals unnecessarily in the hood may block airflow.

#2: Do not allow blockage of air baffle openings at the back of the hood. Place large and bulky equipment (e.g., ovens), on blocks to allow air to flow beneath and maintain an unobstructed path to the baffles. Do not leave paper towels inside the hood, or else they will be exhausted and block ductwork and fans.

#3: Work about 6 inches inside the hood, from its front edge, to prevent vapors or particles being caught in turbulence and swept back out the front of the hood. A stripe on the hood bench surface is a good reminder. Ensure that arms/hands placed inside the hood are protected with gloves or skin protection to avoid unnecessary exposure.

#4: Always position the sash between you and your work. Never place your head inside a fume hood!

#5: Open and close the sash slowly, move your hands slowly inside, and avoid rapid movements in front of the hood, which may increase turbulence and reduce the effectiveness of fume hood containment.

#6: When the hood is being used, keep the hood sash closed as much as possible *unless the fume hood sticker states a particular height for the sash to maintain proper airflow*. (This will be the case for older conventional hoods without a bypass which do not adjust air volume at the face to compensate for changes in face opening area). Proper sash height will minimize energy usage and protect you from dangerous reactions,

#7: Keep lab doors and windows closed to ensure negative room pressure to the corridor and proper air flow into the hood. Look around to be sure that no other air stream is interfering with normal hood exhaust. Prevent cross drafts from open windows, open doors, fans, or air conditioners. Minimize foot traffic in front of hood.

#8: Electrical receptacles must always be mounted on the exterior of the hood. If outlets are inside the hood, they must be taken out of service and a new receptacle be installed outside of the hood.

#9: The hood air flow must be fully operational before starting any spark-producing equipment (e.g., burners) inside a hood used for flammable liquids or gases.

#10: Do not use the hood as a waste disposal mechanism (e.g., for evaporation of chemicals).

GUIDELINES FOR BUILDING SERVICE WORKERS, MAINTENANCE WORKERS and SECURITY OFFICERS

- Your supervisor and the facility LSO should be providing you with an overview of lab safety in the zones to which you are assigned. If you have any questions or concerns about the safety of working in your assigned areas, ask your supervisor and the scientists/occupants of the laboratory space for more information.

- Any container (box, bottle, beaker, etc.) that holds a chemical must be clearly labeled as to content and appropriate warnings. Do not touch, move, or handle containers of chemicals in a lab.

- If chemicals or equipment needs to be moved for you to perform your work in the lab, have your supervisor and the laboratory supervisor arrange for this to be done first.

- If this cannot be done, or there is still a chance that you may contact hazardous chemicals in the course of your work, wear appropriate personal protective equipment as assigned by your supervisor (gloves, goggles, etc.).

- If the contents of any container are spilled, do not touch or clean up! Leave the area at once, close the door, and notify your supervisor and fellow lab occupants immediately (who should then follow the facility Spill Response Plan).

- Always wear barrier gloves when emptying trash containers! Be cautious for broken glass. If you see chemical containers, needles, or any objects that you are in doubt about handling, leave them in the laboratory and notify your supervisor.

- Maintenance personnel: Before working in a laboratory or chemical fume hood, notify the laboratory supervisor or lab occupant about the work to be performed.

- **NEVER turn off the hood, electrical power, equipment, or disturb any lab operations without first getting approval from the laboratory supervisor or principal occupant!!!**

- **Do NOT work in or on a fume hood used for perchloric acid or radioactive materials without first contacting OSHEM for safe work practices.**