ESCUELA DE MEDICINA
San Juan Bautista

LABORATORY SAFETY MANUAL
CHEMICAL HYGIENE PLAN

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I. Introduction

Objective:

The objective of this Laboratory Safety Manual, previously known as the Chemical Hygiene Plan (CHP), is to provide Specific guidance to all the employees, students, and the faculty who are in contact with or use hazardous chemicals in the Institution. This plan fulfills the Federal OSHA Laboratory Standard (25 CFR 191O) requirements for laboratory workers. It sets forth safety procedures and describes how the San Juan Bautista School of Medicine employees, students, and faculty are informed about the potential chemical hazards in their working areas. With the information, they can avoid harmful exposure and safeguard the health. Generally,

communication of this plan will occur through training, and the plan will serve as a reference guide for that training.

Policy:

The San Juan Bautista School of Medicine's policy is to provide a safe and healthful environment for the employees, students, and faculty. It is also our policy to protect property from damage or loss caused by accident and to prevent harm to the public or the environment because of activities made here. A requirement of employment and a precondition for using laboratory facilities is that every employee, student, and faculty must be familiar with and carry out the institution's laboratory safety standards.

Accessibility:

This document is available to any employee, student, and faculty member engaged in the laboratory use of hazardous chemicals or their designated representative.

II. Laboratory Facilities:

It must provide a suitable workspace for the students, staff, and faculty working in the laboratories.

1. Design

a. Each laboratory where chemical substances are used must have adequate ventilation.

b. Air entrance and exits must be designed and located so that contaminated air does not re- circulate. Ventilation is needed to eliminate odors and vapors from the air, which might have the potential to adversely affect the health.

c. The floors should be easy to clean.

d. Working shelves must be made resistant to corrosive and solvent material as well as resistant to heat and made of a non-absorbent material.

e. Whenever necessary, the laboratory must have an adequate hood.

f. An area for storage of chemical products and garbage should be designated.

g. Safety equipment should be available.

h. Non-smoking signs must be located in the laboratory premises in a visible place.

2. Equipment Maintenance

Proper equipment maintenance is important for safe, efficient operation. Equipment should be inspected and maintained on a regular basis.

a. **Fire extinguishers:** Monthly inspections that consist of verifying general condition to assure that the security seal has not been

broken and that it is in proper condition.

b. **Smoke detectors:** inspected monthly to assure they areproperly functioning.

c. **Hoods:** all hoods are verified when they are first installed and on a yearly basis after that to assure adequate ventilation performance.

d. **Eyewash and showers:** should be flushed weekly for two or three minutes to assure that they are operating properly, and that the microbial contamination does not occur.

e. **A flammable liquid storage cabinet** should be used for the storage of flammable and combustibleliquids only.

f. **Acid storage cabinet:** should be used for the storage of acids.

3. Ventilation

The laboratory should have an air supply system that canprovide temperature and humidity control.

a. Hoods:

1. The extraction velocity recommended is from60 to 150 Fpm. The extractors are used to perform any work that may present exposition to vapors or toxic materials.
2. The filters of the extractors must be kept in optimal conditions and are change periodically or when the filtration capacity is reduced.

b. Biosafety Cabinets (laminar flow hoods)

1. Biosafety cabinets protect the laboratory from biological hazard agents that could cause laboratory-acquired infection.
2. The labs have class II cabinets. They are designed to protect the operator, environment, and experiment from contamination, includingmicroorganisms, using an inward flow of roomair through a front work opening, directional flow of HEPA filtered air through the work area, and HEPA filtration of exhausted air.
3. Maintenance areas should have appropriated ventilation; accumulation of vapor or gases isnot permitted.

III. Personnel Responsibilities

It is the responsibility of the Principal Investigator to ensure the safety of persons working or volunteering in his/her laboratories.

Department Directors shall:

- Ensure compliance with all safety requirements within their departments.
- Establish criteria and processes for Departmental review of hazard assessments/lab-specific Standard Operating Procedures for High-Risk Procedures.

Principal Investigators shall:

- Ensure compliance with all safety requirements within the laboratory or laboratories.
- Provide direction and support to the Laboratory Coordinator.
- Perform a hazard assessment and develop/approve lab-specific Standard Operating Procedures for all high-risk procedures.
- Before allowing non-SJBSM employees to volunteer or work in the laboratory, submit and receive approval of the Research Center Director and the Laboratory Coordinator.
- Train laboratory employees and students when there is new laboratory-specific safety information or when a new employee or student is assigned to the laboratory.

Laboratory Coordinator shall:

- Work with the Principal Investigator to develop and document necessary laboratory-specific standard operating procedures.
- Read and be familiar with this section of the Laboratory Safety Manual.
- Document all training offered.

Laboratory Technician and Students shall:

- Plan and conduct laboratory operations in accordance with federal regulation and applicable SJBSM safety policies.
- Abide by all policies and procedures described in any department or laboratory-specific policies.
- Report all injuries, other incidents, and unsafe conditions to their supervisor and PI, and to the appropriate university support groups.

IV. Basic Rules and Procedures for working with chemicals

The following general safety principles should be observed when working with chemicals.

1. Use equipment only for its designed purpose.
2. Keep the working area clean and dear.
3. Limit the volume of volatile or flammable material to the minimum needed and for short operation periods only.
4. Obtain and read the Material Safety Data Sheets (MSDS) and other hazard information on all chemicals used to support the laboratory operations.
5. No smoking, eating, or drinking in the laboratory.
6. Wash your hands after the use of any chemical substance.
7. Any risk procedure must be realized on the hood.
8. Gas faucets must be kept closed if not in use.
9. Decontaminate the working area daily and clean the spills immediately.
10. Users should know how to use the emergency equipment such as showers, eye washers, and fire extinguishers and should be able to obtain additional help in an emergency.
11. . Never use mouth suction to pipet chemicals; use a pipet bulb or an aspirator to vacuum.
12. Do not store food or drink in the refrigerator. Cold room is used to store chemicals, biological reagents, or animal products.
13. Skin contact should be avoided. Proper protective equipment such as gloves, laboratory coats, and aprons

should always be worn when handling hazardous chemicals or microorganisms.

14. Safety glasses are required in all areas when **working** inthe laboratory.
15. Store equipment and chemicals properly.
16. Maintain access to exit and emergency control equipment.
17. When leaving a designated area, laboratory personnel should remove any protective equipment that has been used and thoroughly wash hands.
18. At the completion of each procedure, the hood work surfaces or containment area should be decontaminated.

STANDARD OPERATING PROCEDURE SOP#1

I. **Procedure Operation**

SOP for general laboratory procedures

II. **Hazardous Materials**

Chemicals and all reactive used

III. **Controls**

1. **Administrative:**

All Laboratory workers are trained in laboratory, safety procedures, handling of chemicals, and etiologic agents.

2. **Engineering:**

Require the use of fume hoods and biosafety cabinets.

3. **Personal Protective Equipment (PPE)**

Minimal PPE should include safety glasses, laboratorycoats, and protective gloves.

4. **Specific work practices:**

- Review Laboratory Safety Manual prior to performing any laboratory procedure

- Keep work area clean.
- Do all procedures in appropriate hood.
- Return Chemicals back to storage area when finishedusing and never leave chemicals in the hood.
- Do not conduct any procedure near open flames or excessive heat.

- Wash thoroughly before leaving lab area.
- Before leaving the lab, clean and decontaminate all working areas.

IV. **Medical Surveillance**

Refer to medical consultation anyone who reports symptoms of exposure.

V. **Spill response/decontamination**

- Identify the spill
- Wear appropriate PPE during clean-up
- Clean up using spill clean-up material and place waste in appropriate bags for disposal.

VI. **Waste Handling:**

All infectious liquids and biohazard waste are autoclaved prior to disposal. Then they are packed in biohazard labeled bags.

All chemical wastes are placed in appropriate chemical waste containers.

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STANDARD OPERATING PROCEDURE

SOP#2

I. **Procedure Operation**

Fixation of human brains

II. **Hazardous Materials**

Phenol, Glycerol

III. **Controls**

1. **Administrative:**

Store phenol in flammable cabinets. The users musthave Chemical Hygiene and Safety training.

2. **Engineering:**

Phenol solutions have to be dispensed in laboratory fume hood.

3. **Personal Protective Equipment {PPE)**

Gloves, Lab coats and masks

4. Specific wo practices:

- Dispose human tissues and gloves in biohazards labeled waste containers.
- Dispose solutions waste in "waste" labeled containersfor liquids.
- Keep containers tightly closed and store in flammablecabinet.

IV. **Medical Surveillance**

Anyone who reports symptoms of exposure will be referred tomedical consultation.

V. **Spill response/decontamination**

Wear suitable personal protective equipment, contain the spill with absorb clean-up material and dispose waste in appropriate waste container.

VI. **Waste Handling:**

Dispose solution waste in a labeled waste container and closetightly.

STANDARD OPERATING PROCEDURE

SOP#3

I. **Procedure Operation**

Microorganism Culture and handling

II. **Hazardous Materials**

Microorganism to be cultured III.

Controls

1. **Administrative:**

Cultures have to be stored in refrigerators for this purpose. Personnel must be trained in the hazards associated with their work and in the proper microbiological techniques.

2. **Engineering:**

Microorganism cultures have to be done in a biosafety cabinet. The institution uses biosafety cabinet class II. All waste is decontaminated in an autoclave prior to disposal.

3. **Personal Protective Equipment (PPE)**

Gloves, Lab coats, eye and face protection.

4. **Specific work practices:**

- Do all processes involving microorganisms in a biosafety cabinet.
- In the event of an exposure, decontaminate all workingsurfaces, equipment, glassware, tubes, etc., as necessary. Decontaminate working surfaces before and after working with microorganisms.

IV. **Medical Surveillance**

Refer to medical consultation anyone who reports symptoms ofexposure.

V. **Spill response/decontamination**

- Use appropriate protection equipment. use absorbent clean-up material and decontaminate working area.

VI. **Waste Handling:**

All infectious liquid or solid wastes are decontaminated beforedisposal. They are placed in a biohazard labeled bag.

STANDARD OPERATING PROCEDURE

SOP#4

I. Procedure Operation

Spill response

II. **Hazardous Materials**

Apply to all hazardous chemicals and microbiological spills Ill. **Controls**

1. Administrative:

All laboratory workers are trained in Laboratory Safety Safety procedures, handling of hazardous chemicals and biohazards and microbiological techniques.

2. Engineering:

Use of fume hoods and biosafety cabinets are required.

3. Personal Protective Equipment (PPE)

If a spill occurs the people have to be evacuated from the

area and the person designated to clean up the spill will wear personal protective equipment.

4. Specific work practices:

- To clean up the spill, the technician will use absorbentclean-up material

IV. **Medical Surveillance**

People involved in the spill and reports symptoms will be referred to medical consultation.

V. **Spill response/decontamination**

- Evacuate people from the area

- Identify the spill

- Wear appropriate protection equipment
- Clean up and place waste in plastic bags for disposal.

VI. **Waste Handling:**

Dispose solution waste in a labeled waste container and close tightly. Biohazard waste will be placed in a biohazard labeled container.

STANDARD OPERATING PROCEDURE

SOP#5

I. **Procedure Operation**

Use of formaldehyde in human cadavers.

II. **Hazardous Materials**

Formaldehyde 10% solution and 37% (Formalin) Ill.

Hazard Analysis:

Exposures to formaldehyde will be kept as low as possible. The formaldehyde is only used for cadaver embalming. This procedure is performed at UPR Medical School.

IV. Controls

1. Administrative:

All users must have received training in the generation ofhazardous wastes, the generation of medical waste and safety procedures. Also must have Chemical Hygiene training.

2. Engineering:

Formalin solutions are to be used and dispensed in the laboratory fume hood to minimize worker exposure.

3. Personal Protective Equipment (PPE)

Protective eye wear, lab coats, gloves

4. Specific work practices:

- Decant waste in the hood to the appropriate wastecontainer

- Dispose gloves in dry waste container for hazard waste.

V. Medical Surveillance

Anyone who reports possible symptoms of over exposure will be referred for medical consultation.

VI. Spill response/decontamination

- Wear suitable personal protective equipment
- Contain the spill with absorbent clean-up material
- Dispose waste in hazardous waste can.
-

VII. Waste Handling:

Label the Formalin can with "Waste-formaldehyde - flammable"

V. Chemical Procurement and Storage:

1. **Procurement**

Laboratory personnel responsible for ordering chemicalsmust be aware of the following requirements:

a. Material Safety Data Sheets (MSDS) must be acquired for the work area in which the chemical will be used unless the MSDS are already on file.

b. Containers must not be accepted without an adequate identifying label that contains chemical identity, hazard warnings, and manufactures nameand address.

c. Chemical purchases must be kept to the minimum volume required to sustain laboratory operations without incurring significant operational interruptionto avoid high waste disposal costs later.

2. **Storage**

The separation of chemicals during storage is necessaryto reduce the potential for unwanted reactions by

. accidental mixing. The following storage rules apply to all laboratory facilities:

a. All chemicals will be classified prior to storage by compatibility. This is made to avoid adverse reactions.

b. Limit the amount of chemicals permitted for storage to amounts that are as small as practical.

3. Avoid exposure of chemicals to heat or directsunlight.

4. Do not use fume hoods as storage areas for chemicals.

VI. Environmental monitoring

Environmental monitoring refers to testing the air for the presence of Specific chemicals or types of chemicals. The kind of monitoring used istime-integrated sampling. This monitoring allows the industrial hygienist to establish the average air concentration of the chemical over a specific period of exposure. Results of time-integrated exposure monitoring can be compared to permissible exposure limits. The institution's policy is to keep employee, faculty, and students exposure to chemicalsubstances below the OSHA exposure limits established in CFR 1910 subpart 2.

The OSHA industrial hygienist must measure an employee exposure to any substance regulated by an OSHA standard. The initial monitoring must be followed by periodic monitoring if the resultof the initial monitoring indicates exposure at or above the permissible action levels.

Faculty exposure monitoring is sometimes used during an initial evaluation of an operation to determine if controls are needed. Thisis performed on a test basis during the initial phase of operation. Environmental monitoring may also be performed if needed after theoperation has been implemented to verify that exposure levels are safe.

Results from the faculty exposure monitoring are used to determine whether any additional controls are needed, mainly because of the use of formaldehyde on the anatomy laboratory. Every year at the beginning of the semester, at the anatomy course,the OSHA Industrial hygienist make monitoring exposure tests on formaldehyde.

If air-monitoring results indicate that exposure are **above** the limits prescribed in the substance specific standard, medical monitoring is provided.

VI. Housekeeping, Maintenance, and Inspections

There is a definite relationship between safety performance and orderliness in the laboratory. Work areas should be kept cleanand free from obstructions. Clean up should follow the completion of any operation or at the end of each day.

1. Laboratory Personnel is responsible for the following duties:
    a. Disinfection of equipment, disinfect **working** table and

specialized areas.

b. Clean up of little spills of chemical substances.

c. Disposition of broken glassware and hazardouswaste.

2. Maintenance Personnel

a. Clean up of floors, except in the case of spills

b. Disposition of non-hazardous waste

c. Clean up the walls and windows

3. Chemical substances that are not been used must bekept in the storage room.

4. Maintain access to exits, emergency equipment and other control equipment.

5. Store equipment properly.

6. Use careful handling and storage procedures to avoid damaging glassware.

7. Prevention inspections will be performed in a regular basis to the security equipment such as showers, fire extinguishers and others.

8. Cleaning of the equipment will be performed periodicallyas a preventive tool.

9. Janitors and other personnel will be trained in the laboratory preventive and safety rules.

10. In case of an accident the supervisor will be advised immediately.

Periodical evaluation of the laboratory premises will be performed inwhich the several aspects of chemical order are evaluated which includes the areas to be cleaned. The laboratory must comply with the regulations of the Laboratory Safety Plan for Chemicals. The result of the inspection realized must be informed to the personnel and take corrective measures if necessary.

VIII. Medical Consultation

1. Every employee, student and faculty should obtain medical consult and examination in the following situations:

- When they develop symptoms that appear to be associated with exposures to hazardous chemicals.
- When they are involved in responding to a spill, leak, explosion, or other release that results in exposures to hazardous chemicals.
- When air monitoring has demonstrated exposures at or above permissible exposure limits.
- When required by substance specific OSHA regulations. The chemical that has substance specific regulations in our school is: formaldehyde.
- When they have been exposed to any chemical, the

The Institution will provide the physician with the following information:

- Identify of the hazardous chemicals.
- Description of the condition of exposure.
- Description of signs and symptoms developedby the employee, student, or faculty.

The examining physician should provide the institution a written opinion that includes recommendation for follow up, results of the medical examination and a statement that the employee, student, or faculty has been informed of the results of the examination.

IX. Personal Protective Equipment

1. Wear adequate clothing, use a laboratory coat to protect against chemical splashes or spills, use protective apparel, including face shields and gloves.
2. Do not wear open toed shoes or sandals.
3. Wear safety glasses whenever chemical are in use.The safety glasses should be impact resistant with side shields.
4. Wear goggles or face shields when there is danger ofsplashed chemicals or flying particles.
5. Wear contact lenses alone are prohibited when handling corrosive

chemicals.

X. Record Keeping

The San Juan Bautista School of Medicine follows the norms and regulations of Occupational Exposition to Chemical agents by keeping records of the following:

1. Results of the Environmental Monitoring Tests realized to decide if there has been any exposition of the employees,students, or faculty to any chemical agent.
2. Medical records of employees that have been subject to medical examination.
3. Record and investigation of accidents.
4. Inventory of high-risk material or substances that includesthe amount available and when used, the amount used; record include name of the user, quantity, and date of use.

XI. Signs and Labels

- Signs
  a. The personnel and students that enter the laboratory premises must be aware of the risk and safety rules in case of an emergency. Signs and labels identifying the different places and equipment are necessary. The following signs and labels are available at the laboratory premises:
     1. Hazard signs
        a. Flammable material
        b. Toxic
        c. Biological waste
     2. Access control
        a. Authorized personnel only
        b. Explosives: Keep **away**
     3. Emergency signs and security information
        a. Emergency telephone numbers

b. Emergency showers

C. Eye bath

d. Fire extinguishers

e. Safety glasses are required

f. Warning ultraviolet light

g. Refrigerator not for food storage

- Container labeling

  Hazard warning labels or tags are required in the original shipping containers and any container subsequently usedfor storage. Labels must show the name of the material, provide hazard warning information appropriate for employee protection and be legible and prominently displayed. Labels on shipping containers provided by the manufacturer are required to provide all the appropriate information and must not be removed.

Other containers like glassware, safety cans, plastic squeeze bottles, etc. must have labels that identify the chemical content and information on the hazard associated with the use of the chemical.

XII. Spills and accidents

The amounts of chemicals used in the laboratories are small. However, spills and accidents may occur. The following action should be taken when responding to chemical spills.

- Evacuate people form the area.
- Identify the spill. Use the **MSDS** if necessary.
- If the material is flammable, turn off ignition and heatsources.
- Wear appropriate protection equipment during clean up.
- Clean up and place waste in plastic bags for disposal.
- Decontaminate the area after gross spill, clean up if necessary.

XIII. Training and Information

Employees and students must be provided with training on thehazards to

which they *may* be exposed and the means to avoid these hazards.

Collectively, the training must minimally include discussion of the following:

- Potential chemical, physical and biological hazards.
- Operations involve hazardous material.
- Applicable health standards.
- Location and content of the Laboratory Safety Plan .
- Use and location of material Safety Data Sheets.
- Spill and emergency response.
- Personnel protection measures.
- Labeling requirements.
- Safe working practices.
- Purpose and use of control measures.
- The warning properties of chemical release.

New Employees shall be informed about the OSHA Laboratory Standard and the Institution compliance program. At the time of initial assignment-a new employee will receive the required training.

XIV. Waste Disposal

The dispositions for garbage management are the following:

a. Garbage must be segregated into different types:
Hazardous, medicine/biohazard, trash

b. Management of chemical disposal must follow thefollowing procedures:

i. Incompatible chemicals must not be mixed.

ii. Chemical containers must be separated in compatiblegroups.

iii. Containers must be labeled with content, amount andphysical state.

c. Sharp material is disposed in special puncture resistant labeled containers as sharp containers. This includes syringes, Pasteur pipettes, blades, etc.

d. Broken glass must be disposed in a specified container, not together

with regular paper or other discarded material.

e. Regular paper waste may be discarded by the regular maintenance personnel, this does not require specifications.

f. All contaminated waste as well as biological tissues must be incinerated. The institution keeps a contract with a qualified medical waste disposal firm, which takes care of thismaterial.

a. Prior to disposal all biohazardous waste should be maintained and stored separately from general waste.

b. The containers used to store biohazardous waste should be leak proof, clearly labeled with red or orange universal biohazard symbol, and sealed tightlywhen transported.

Appendix A
Chemical Hazards

Hazardous chemicals present physical and/or health threats to workers in clinical, industrial, and academic laboratories. Laboratory chemicals include cancer-causing agents (carcinogens), toxins (e.g., those affecting the liver, kidney, and nervous system), irritants, corrosives, sensitizers, as well as agents that act on the blood system or damage the lungs, skin, eyes, or mucous membranes. OSHA rules regulate exposures to approximately 400 substances.

Laboratory Standard (29 CFR 1910.1450)

In 1990, OSHA issued the Occupational Exposure to Hazardous Chemicals in Laboratories standard (29 CFR 1910.1450). Commonly known as the Laboratory standard, it was developed to address workplaces where relatively small quantities of hazardous chemicals are used on a non-production basis. However, not all laboratories are covered by the Laboratory standard. For example, most quality control laboratories are not covered under the standard. These laboratories are usually adjuncts of production operations which typically perform repetitive procedures for the purpose of assuring reliability of a product or a process. On the other hand, laboratories that conduct research and development and related analytical work are subject to the requirements of the Laboratory standard, regardless of whether or not they are used only to support manufacturing.

The purpose of the Laboratory standard is to ensure that workers in non-production laboratories are informed about the hazards of chemicals in their workplace and are protected from chemical exposures exceeding allowable levels [i.e., OSHA permissible exposure limits (PELs)] as specified in Table Z of the Air Contaminants standard (29 CFR 1910.1000) and as specified in other substance-specific health standards. The Laboratory standard achieves this protection by establishing safe work practices in laboratories to implement a Chemical Hygiene Plan (CHP).

Scope and Application

The Laboratory standard applies to all individuals engaged in laboratory use of hazardous chemicals. Work with hazardous chemicals outside of laboratories is covered by the Hazard Communication standard (29 CFR 1910.1200). Laboratory uses of chemicals which provide

no potential for exposure (e.g., chemically impregnated test media or prepared kits for pregnancy testing) are not covered by the Laboratory standard.

Formaldehyde is one of the most commonly used hazardous chemicals in laboratories. The OSHA Formaldehyde standard (29 CFR 1910.1048) specifically deals with protecting workers from the hazards associated with exposure to this chemical. It should be noted that the scope of the Formaldehyde standard is not affected in most cases by the Laboratory standard. The Laboratory standard specifically does not apply to formaldehyde use in histology, pathology and human or animal anatomy laboratories; however, if formaldehyde is used in other types of laboratories which are covered by the Laboratory standard, the employer must comply with 29 CFR 1910.1450.

Hazard Identification

Each laboratory must identify which hazardous chemicals will be encountered by its workers. All containers for chemicals must be clearly labeled. An employer must ensure that workers do not use, store, or allow any other person to use or store, any hazardous substance in his or her laboratory if the container does not meet the labeling requirements outlined in the Hazard Communication standard, 29 CFR 1910.1200(f)(4). Labels on chemical containers must not be removed or defaced. Material Safety Data Sheets (MSDSs) for chemicals received by the laboratory must be supplied by the manufacturer, distributor, or importer and must be maintained and readily accessible to laboratory workers. MSDSs are written or printed materials concerning a hazardous chemical. Employers must have an MSDS in the workplace for each hazardous chemical in use.

MSDS sheets must contain:

1. Name of the chemical;
2. Manufacturer’s information;
3. Hazardous ingredients/identity information;
4. Physical/chemical characteristics;
5. Fire and explosion hazard data;
6. Reactivity data;
7. Health hazard data;
8. Precautions for safe handling and use; and
9. Control measures.

Exposure Determination

OSHA has established permissible exposure limits (PELs), as specified in 29 CFR 1910, subpart Z, for hundreds of chemical substances. A PEL is the chemical-specific concentration in inhaled air that is intended to represent what the average, healthy worker may be exposed to daily for a lifetime of work without significant adverse health effects. The employer must ensure that workers' exposures to OSHA-regulated substances do not exceed the PEL. However, most of the OSHA PELs were adopted soon after the Agency was first created in 1970 and were based upon scientific studies available at that time. Since science has continued to move forward, in some cases, there may be health data that suggests a hazard to workers below the levels permitted by the OSHA PELs. Other agencies and organizations have developed and updated recommended occupational exposure limits (OELs) for chemicals regulated by OSHA, as well as other chemicals not currently regulated by OSHA. Employers should consult other OELs, in addition to the OSHA PEL, to make a fully informed decision about the potential health risks to workers associated with chemical exposures. The American Conference of Governmental Industrial Hygienists (ACGIH), the American Industrial Hygiene Association (AIHA), the National Institute for Occupational Safety and Health (NIOSH), as well as some chemical manufacturers have established OELs to assess safe exposure limits for various chemicals.

Employers must conduct exposure monitoring, through air sampling, if there is reason to believe that workers may be exposed to chemicals above the action level or, in the absence of an action level, the PEL. Periodic exposure monitoring should be conducted in accord with the provisions of the relevant standard. The employer should notify workers of the results of any monitoring within 15 working days of receiving the results. Some OSHA chemical standards have specific provisions regarding exposure monitoring and worker notification. Employers should consult relevant standards to see if these provisions apply to their workplace.

Specific Chemical Hazards

Air Contaminants standard (29 CFR 1910.1000)

The Air Contaminants standard provides rules for protecting workers from airborne exposure to over 400 chemicals. Several of these chemicals are commonly used in laboratories and include: toluene, xylene, and acrylamide. Toluene and xylene are solvents used to fix tissue

specimens and rinse stains. They are primarily found in histology, hematology, microbiology and cytology laboratories.

Employers must do the following to prevent worker exposure:
Implement a written program for chemicals that workers are exposed to and that meet the requirements of the Hazard Communication standard. This program must contain provisions for worker training, warning labels and access to Material Safety Data Sheets (MSDSs).

Formaldehyde standard (29 CFR 1910.1048)
Formaldehyde is used as a fixative and is commonly found in most laboratories. The employer must ensure that no worker is exposed to an airborne concentration of formaldehyde which exceeds 0.75 parts formaldehyde per million parts of air (0.75 ppm) as an 8-hour time weighted average (TWA), 29 CFR 1910.1048(c)(1).The Hazard Communication standard requires employers to maintain an MSDS, which manufacturers or distributors of formaldehyde are required to provide. The MSDS must be kept in an area that is accessible to workers that may be exposed to formaldehyde.

Formaldehyde		
Exposure routes	**Symptoms**	**Target Organs**
Inhalation; Ingestion; Skin and/or eye contact.	Irritation of eyes, skin, nose, throat, respiratory system; Tearing; Coughing; Wheezing; Dermatitis; Potential occupational nasal carcin-ogen.	Eyes; Skin; Respiratory system.

Employers must provide the following to workers to prevent exposure:

- Appropriate PPE, 29 CFR 1910.132, 29 CFR1910.133, and 29 CFR 1910.1048(h).
- Acceptable eyewash facilities within the immediate work area for emergency use, if there is any possibility that a worker's eyes may be splashed with solutions containing 0.1 percent or greater formaldehyde, 29 CFR 1910.1048(i)(3).

Latex

One of the most common chemicals that laboratory workers are exposed to is latex, a plant protein. The most common cause of latex allergy is direct contact with latex, a natural plant derivative used in making certain disposable gloves and other products. Some healthcare workers have been determined to be latex sensitive, with reactions ranging from localized dermatitis (skin irritation) to immediate, possibly life-threatening reactions. Under OSHA's Personal Protective Equipment standard, 29 CFR 1910.132, the employer must ensure that appropriate personal protective equipment (PPE) is accessible at the worksite or issued to workers. Latex-free gloves, glove liners, powder-free gloves, or other similar alternatives are obtainable and must be readily accessible to those workers who are allergic to latex gloves or other latex-containing PPE, 29 CFR 1910.1030(c)(3)(iii).

Latex allergy should be suspected in workers who develop certain symptoms after latex exposure, including:

- nasal, eye, or sinus irritation
- hives or rash
- difficulty breathing
- coughing
- wheezing
- nausea
- vomiting
- diarrhea

An exposed worker who exhibits these symptoms should be evaluated by a physician or other licensed healthcare professional because further exposure could cause a serious allergic reaction.

Once a worker becomes allergic to latex, special precautions are needed to prevent exposures. Certain medications may reduce the allergic symptoms, but complete latex avoidance is the most effective approach.

Appropriate work practices should be used to reduce the chance of reactions to latex. If a worker must wear latex gloves, oil-based hand creams or lotions (which can cause glove

deterioration) should not be used unless they have been shown to reduce latex-related problems and maintain glove barrier protection. After removing latex gloves, workers should wash their hands with a mild soap and dry them thoroughly.

Appendix B
Biological Hazards

Biological Agents (other than Bloodborne Pathogens) and Biological Toxins

Many laboratory workers encounter daily exposure to biological hazards. These hazards are present in various sources throughout the laboratory such as blood and body fluids, culture specimens, body tissue and cadavers, and laboratory animals, as well as other workers.

A number of OSHA's Safety and Health Topics Pages mentioned below have information on select agents and toxins. These are federally regulated biological agents (e.g., viruses, bacteria, fungi, and prions) and toxins that have the potential to pose a severe threat to public health and safety, to animal or plant health, or to animal or plant products. The agents and toxins that affect animal and plant health are also referred to as high-consequence livestock pathogens and toxins, non-overlap agents and toxins, and listed plant pathogens. Select agents and toxins are defined by lists that appear in sections 73.3 of Title 42 of the Code of Federal Regulations (HHS/CDC Select Agent Regulations), sections 121.3 and 121.4 of Title 9 of the Code of Federal Regulations (USDA/APHIS/VS Select Agent Regulations), and section 331.3 of Title 7 of the Code of Federal Regulations (plants - USDA/APHIS/PPQ Select Agent Regulations) and Part 121, Title 9, Code of Federal Regulations (animals – USDA/APHIS). Select agents and toxins that are regulated by both HHS/CDC and USDA/APHIS are referred to as "overlap" select agents and toxins (see 42 CFR section 73.4 and 9 CFR 121.4). Employers may use the list below as a starting point for technical and regulatory information about some of the most virulent and prevalent biological agents and toxins. The OSHA Safety and Health Topics Page entitled Biological Agents can be accessed at: www.osha.gov/SLTC/biologicalagents/index.html.

Anthrax. Anthrax is an acute infectious disease caused by a spore-forming bacterium called Bacillus anthracis. It is generally acquired following contact with anthrax-infected animals or anthrax-contaminated animal products. Bacillus anthracis is an HHS and USDA select agent.

Avian Flu. Avian influenza is caused by Influenza A viruses. These viruses normally reside in the intestinal tracts of water fowl and shore birds, where they cause little, if any, disease. However, when they are passed on to domestic birds, such as chickens,
they can cause deadly contagious disease, highly pathogenic avian influenza (HPAI). HPAI

viruses are considered USDA/APHIS select agents.

Botulism. Cases of botulism are usually associated with consumption of preserved foods. However, botulinum toxins are currently among the most common compounds explored by terrorists for use as biological weapons. Botulinum neurotoxins, the causative agents of botulism, are HHS/CDC select agents.

Foodborne Disease. Foodborne illnesses are caused by viruses, bacteria, parasites, toxins, metals, and prions (microscopic protein particles). Symptoms range from mild gastroenteritis to life-threatening neurologic, hepatic and renal syndromes.

Hantavirus. Hantaviruses are transmitted to humans from the dried droppings, urine, or saliva of mice and rats. Animal laboratory workers and persons working in infested buildings are at increased risk to this disease.

Legionnaires' Disease. Legionnaires' disease is a bacterial disease commonly associated with water-based aerosols. It is often the result of poorly maintained air conditioning cooling towers and potable water systems.

Molds and Fungi. Molds and fungi produce and release millions of spores small enough to be air-, water-, or insect-borne which may have negative effects on human health including, allergic reactions, asthma, and other respiratory problems.

Plague. The World Health Organization reports 1,000 to 3,000 cases of plague every year. A bioterrorist release of plague could result in a rapid spread of the pneumonic form of the disease, which could have devastating consequences. Yersinia pestis, the causative agent of plague, is an HHS/CDC select agent.

Ricin. Ricin is one of the most toxic and easily produced plant toxins. It has been used in the past as a bioterrorist weapon and remains a serious threat. Ricin is an HHS/CDC select toxin.

Severe Acute Respiratory Syndrome (SARS). SARS is an emerging, sometimes fatal, respiratory illness. According to the Centers for Disease Control and Prevention (CDC), the most recent human cases of SARS were reported in China in April 2004 and there is currently

no known transmission anywhere in the world.

Smallpox. Smallpox is a highly contagious disease unique to humans. It is estimated that no more than 20 percent of the population has any immunity from previous vaccination. Variola major virus, the causative agent for smallpox, is an HHS/CDC select agent.

Tularemia. Tularemia is also known as “rabbit fever” or “deer fly fever” and is extremely infectious. Relatively few bacteria are required to cause the disease, which is why it is an attractive weapon for use in bioterrorism. Francisella tularensis, the causative agent for tularemia, is an HHS/CDC select agent.

Viral Hemorrhagic Fevers (VHFs). Hemorrhagic fever viruses are among the agents identified by the Centers for Disease Control and Prevention (CDC) as the most likely to be used as biological weapons. Many VHFs can cause severe, life-threatening disease with high fatality rates. Many VHFs are HHS/CDC select agents; for example, Marburg virus, Ebola viruses, and the Crimean-Congo hemorrhagic fever virus.

An additional OSHA Safety and Health Topics page on Pandemic Influenza has been added in response to the 2009 H1N1 influenza pandemic. It can be accessed at: www.osha.gov/dsg/topics/pandemicflu/index.html.

Pandemic Influenza. A pandemic is a global disease outbreak. An influenza pandemic occurs when a new influenza virus emerges for which there is little or no immunity in the human population; begins to cause serious illness; and then spreads easily person-to-person worldwide.

Material Safety Data Sheets (MSDSs) on Infectious Agents

Although MSDSs for chemical products have been available to workers for many years in the U.S. and other countries, Canada is the only country that has developed MSDSs for infectious agents. These MSDSs were produced by the Canadian Public Health Agency for personnel working in the life sciences as quick safety reference material relating to infectious microorganisms.

These MSDSs on Infectious Agents are organized to contain health hazard information such

as infectious dose, viability (including decontamination), medical information, laboratory hazard, recommended precautions, handling information and spill procedures. These MSDSs are available at: www.phac-aspc.gc.ca/msds-ftss

Bloodborne Pathogens

The OSHA Bloodborne Pathogens (BBP) standard (29 CFR 1910.1030) is designed to protect workers from the health hazards of exposure to bloodborne pathogens. Employers are subject to the BBP standard if they have workers whose jobs put them at reasonable risk of coming into contact with blood or other potentially infectious materials (OPIM). Employers subject to this standard must develop a written Exposure Control Plan, provide training to exposed workers, and comply with other requirements of the standard, including use of Standard Precautions when dealing with blood and OPIM. In 2001, in response to the Needlestick Safety and Prevention Act, OSHA revised the Bloodborne Pathogens standard. The revised standard clarifies the need for employers to select safer needle devices and to involve workers in identifying and choosing these devices. The updated standard also requires employers to maintain a log of injuries from contaminated sharps.

OSHA estimates that 5.6 million workers in the healthcare industry and related occupations are at risk of occupational exposure to bloodborne pathogens, including HIV, HBV, HCV, and others. All occupational exposure to blood or OPIM places workers at risk for infection with bloodborne pathogens. OSHA defines blood to mean human blood, human blood components, and products made from human blood. OPIM means: (1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; (2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and (3) HIV- or HBV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

The Centers for Disease Control and Prevention (CDC) notes that although more than 200 different diseases can be transmitted from exposure to blood, the most serious infections are hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). Fortunately, the risk of acquiring any of these infections is low. HBV is the most infectious

virus of the three viruses listed above. For an unvaccinated healthcare worker, the risk of developing an infection from a single needlestick or a cut exposed to HBV-infected blood ranges from 6-30%. The risk for infection from HCV- and HIV-infected blood under the same circumstances is 1.8 and 0.3 percent, respectively. This means that after a needlestick/cut exposure to HCV-contaminated blood, 98.2% of individuals do not become infected, while after a similar exposure to HIV-contaminated blood, 99.7% of individuals do not become infected. (http://www.cdc.gov/OralHealth/infectioncontrol/faq/bloodborne_exposures.htm).

Many factors influence the risk of becoming infected after a needlestick or cut exposure to HBV-, HCV- or HIV-contaminated blood. These factors include the health status of the individual, the volume of the blood exchanged, the concentration of the virus in the blood, the extent of the cut or the depth of penetration of the needlestick, etc.

Employers must ensure that workers are trained and prohibited from engaging in the following activities:

- Mouth pipetting/suctioning of blood or OPIM,29 CFR 1910.1030(d)(2)(xii);
- Eating, drinking, smoking, applying cosmetics or lip balm, or handling contact lenses in work areas where there is a reasonable likelihood of occupational exposure to blood or OPIM, 29 CFR 1910.1030(d)(2)(ix); and
- Storage of food or drink in refrigerators, freezers, shelves, cabinets or on countertops or benchtops where blood or OPIM are present, 29 CFR 1910.1030(d)(2)(x).

Employers must ensure that the following are provided:

- Appropriate PPE for workers if blood or OPIM exposure is anticipated, 29 CFR 1910.1030(d)(3);
    - The type and amount of PPE depends on the anticipated exposure.
        - Gloves must be worn when hand contact with blood, mucous membranes, OPIM, or non-intact skin is anticipated, or when handling contaminated items or surfaces, 29 CFR 1910.1030(d)(3)(ix).
        - Surgical caps or hoods and/or shoe covers or boots must be worn in instances when gross contamination can reasonably be anticipated such as during autopsies or orthopedic surgery, 29 CFR 1910.1030(d)(3)(xii).
- Effective engineering and work practice controls to help remove or isolate exposures

to blood and bloodborne pathogens, 29 CFR 1910.1030(d)(2)(i), CPL 02-02-069 (CPL 2-2.69); and

- Hepatitis B vaccination (if not declined by a worker) under the supervision of a physician or other licensed healthcare professional to all workers who have occupational exposure to blood or OPIM, 29 CFR 1910.1030(f)(1)(ii)(A)-(C).

Labels

When any blood, OPIM or infected animals are present in the work area, a hazard warning sign (see graphic) incorporating the universal biohazard symbol, 29 CFR1910.1030(g)(1)(ii)(A), must be posted on all access doors, 29 CFR 1910.1030(e)(2)(ii)(D)

Specific Engineering Control – Biological Safety Cabinets (BSCs)

Properly maintained BSCs, when used in conjunction with good microbiological techniques, provide an effective containment system for safe manipulation of moderate and high-risk infectious agents [Biosafety Level 2 (BSL 2) and 3 (BSL 3) agents]. BSCs protect laboratory workers and the immediate environment from infectious aerosols generated within the cabinet.

Biosafety Cabinet Certifications

BSCs must be certified when installed, whenever they are moved and at least annually, 29 CFR1030(e)(2)(iii)(B).

Appendix C
Physical Hazards and Others

Besides exposure to chemicals and biological agents, laboratory workers can also be exposed to a number of physical hazards. Some of the common physical hazards that they may encounter include the following: ergonomic, ionizing radiation (non-applicable in SJBSM), non-ionizing radiation (non-applicable in SJBSM) and noise hazards. These hazards are described below in individual sections.

Ergonomic Hazards

Laboratory workers are at risk for repetitive motion injuries during routine laboratory procedures such as pipetting, working at microscopes, operating microtomes, using cell counters and keyboarding at computer workstations. Repetitive motion injuries develop over time and occur when muscles and joints are stressed, tendons are inflamed, nerves are pinched and the flow of blood is restricted. Standing and working in awkward positions in front of laboratory hoods/biological safety cabinets can also present ergonomic problems.

By becoming familiar with how to control laboratory ergonomics-related risk factors, employers can reduce chances for occupational injuries while improving worker comfort, productivity, and job satisfaction. In addition to the general ergonomic guidance, laboratory employers are reminded of some simple adjustments that can be made at the workplace. While there is currently no specific OSHA standard relating to ergonomics in the laboratory workplace, it is recommended that employers provide the information to laboratory workers contained in the new OSHA fact sheet.

Ionizing Radiation

OSHA's Ionizing Radiation standard, 29 CFR 1910. 1096, sets forth the limitations on exposure to radiation from atomic particles. Ionizing radiation sources are found in a wide range of occupational settings, including laboratories. These radiation sources can pose a considerable health risk to affected workers if not properly controlled.

Any laboratory possessing or using radioactive isotopes must be licensed by the Nuclear Regulatory Commission (NRC) and/or by a state agency that has been approved by the NRC, 10 CFR 31.11 and 10 CFR 35.12. The fundamental objectives of radiation protection

measures are: (1) to limit entry of radionuclides into the human body (via ingestion, inhalation, absorption, or through open wounds) to quantities as low as reasonably achievable (ALARA) and always within the established limits; and (2) to limit exposure to external radiation to levels that are within established dose limits and as far below these limits as is reasonably achievable.

All areas in which radioactive materials are used or stored must conspicuously display the symbol for radiation hazards and access should be restricted to authorized personnel.

The OSHA Ionizing Radiation standard requires precautionary measures and personnel monitoring for workers who are likely to be exposed to radiation hazards. Personnel monitoring devices (film badges, thermoluminescent dosimeters (TLD), pocket dosimeters, etc.) must be supplied and used if required to measure an individual's radiation exposure from gamma, neutron, energetic beta, and X-ray sources. The standard monitoring device is a clip-on badge or ring badge bearing the individual assignee's name, date of the monitoring period and a unique identification number. The badges are provided, processed and reported through a commercial service company that meets current requirements of the National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NIST NVLAP).

It is important for employers to understand and follow all applicable regulations for the use of isotopes. In institutional settings, it is the responsibility of each institution to ensure compliance with local, state, and federal laws and regulations; to obtain licenses for official use of radioactive substances; and to designate a radiation safety officer (RSO) to oversee and ensure compliance with state and/or NRC requirements. Information on radioactive materials licenses may be obtained from the Department of Public Health from individual states or from the NRC.

The following OSHA Safety and Health Topics Page provides links to technical and regulatory information on the control of occupational hazards from ionizing radiation: www.osha.gov/SLTC/radiationionizing/index.html.

Non-ionizing Radiation

Non-ionizing radiation is described as a series of energy waves composed of oscillating electric and magnetic fields traveling at the speed of light. Nonionizing radiation includes the spectrum of ultraviolet (UV), visible light, infrared (IR), microwave (MW), radio frequency (RF), and extremely low frequency (ELF). Lasers commonly operate in the UV, visible, and IR frequencies. Non-ionizing radiation is found in a wide range of occupational settings and can pose a considerable health risk to potentially exposed workers if not properly controlled.

The following OSHA Safety and Health Topics Pages provide links to technical and regulatory information on the control of occupational hazards from non-ionizing radiation and are available at: www.osha.gov/SLTC/radiation_nonionizing/index.html.

Extremely Low Frequency Radiation (ELF)

Extremely Low Frequency (ELF) radiation at 60 HZ is produced by power lines, electrical wiring, and electrical equipment. Common sources of intense exposure include ELF induction furnaces and high-voltage power lines.

Radiofrequency and Microwave Radiation

Microwave radiation (MW) is absorbed near the skin, while radiofrequency (RF) radiation may be absorbed throughout the body. At high enough intensities both will damage tissue through heating. Sources of RF and MW radiation include radio emitters and cell phones.

Infrared Radiation (IR)

The skin and eyes absorb infrared radiation (IR) as heat. Workers normally notice excessive exposure through heat sensation and pain. Sources of IR radiation include heat lamps and IR lasers.

Visible Light Radiation

The different visible frequencies of the electromagnetic (EM) spectrum are "seen" by our eyes as different colors. Good lighting is conducive to increased production, and may help prevent incidents related to poor lighting conditions. Excessive visible radiation can damage the eyes and skin.

Ultraviolet Radiation (UV)

Ultraviolet radiation (UV) has a high photon energy range and is particularly hazardous

because there are usually no immediate symptoms of excessive exposure. Sources of UV radiation in the laboratory include black lights and UV lasers.

Laser Hazards

Lasers typically emit optical (UV, visible light, IR) radiations and are primarily an eye and skin hazard. Common lasers include CO2 IR laser; helium - neon, neodymium YAG, and ruby visible lasers, and the Nitrogen UV laser.

LASER is an acronym which stands for Light Amplification by Stimulated Emission of Radiation The laser produces an intense, highly directional beam of light. The most common cause of laser-induced tissue damage is thermal in nature, where the tissue proteins are denatured due to the temperature rise following absorption of laser energy.

The human body is vulnerable to the output of certain lasers, and under certain circumstances, exposure can result in damage to the eye and skin. Research relating to injury thresholds of the eye and skin has been carried out in order to understand the biological hazards of laser radiation. It is now widely accepted that the human eye is almost always more vulnerable to injury than human skin.

Noise

OSHA's Occupational Noise Exposure standard, 29 CFR 1910.95, requires employers to develop and implement a hearing conservation program that includes the use of PPE (e.g., hearing protectors), if workers are exposed to a time-weighted average (TWA) of ≥ 85 dBA over an 8-hour work shift. In addition, when workers are exposed to noise levels ≥ 85 dBA, the employer must develop a monitoring program to assess noise levels. The monitoring program must include the following components:

- All continuous, intermittent, and impulsive sound levels from 80-130 dBA must be included
- in noise measurements, 29 CFR 1910.95(d)(2)(i);
- Instruments used to measure worker noise exposure must be calibrated to ensure measurement accuracy, 29 CFR 1910.95(d)(2)(ii); and
- Monitoring must be repeated whenever a change in production, process, equipment, or controls increases noise exposures, 29 CFR 1910.95(d)(3).

Laboratory workers are exposed to noise from a variety of sources. Operation of large analyzers (e.g., chemistry analyzer), fume hoods, biological safety cabinets, incubators, centrifuges (especially ultracentrifuges), cell washers, sonicators, and stirrer motors, all contribute to the noise level in laboratories. Further sources of noise in laboratories include fans and compressors for cryostats, refrigerators, refrigerated centrifuges, and freezers. As an example, a high-speed refrigerated centrifuge alone can generate noise levels as high as 65 dBA. To provide some further context, a whisper registers approximately 30 dBA; normal conversation about 50 to 60 dBA; a ringing phone 80 dBA and a power mower 90 dBA. If noise levels exceed 80 dBA, people must speak very loudly to be heard, while at noise levels of 85 to 90 dBA, people have to shout.

In order to determine if the noise levels in the laboratory are above the threshold level that damages hearing, the employer must conduct a noise exposure assessment using an approved sound level monitoring device, such as a dosimeter, and measuring an 8-hour TWA exposure. If the noise levels are found to exceed the threshold level, the employer must provide hearing protection at no cost to the workers and train them in the proper use of the protectors. The potential dangers of miscommunicating instructions or laboratory results are obvious, and efforts should be made to improve the design of clinical laboratories and to evaluate new instrumentation with regard to the impact of these factors on worker noise exposure.

The employer should evaluate the possibility of relocating equipment to another area or using engineering controls to reduce the noise level below an 8-hour TWA of 85 dBA in order to comply with OSHA’s Occupational Noise Exposure standard. While most laboratories’ noise levels do not equal or exceed the 8-hour TWA of 85 dBA, certain accrediting agencies are implementing special emphasis programs on noise reduction in the laboratory. Because noise is becoming more of a concern in the clinical setting, the College of American Pathologists has added evaluation of noise in the laboratory under their general checklist for accreditation (GEN.70824).

Appendix D
Safety Hazards

Employers must assess tasks to identify potential worksite hazards and provide and ensure that workers use appropriate personal protective equipment (PPE) as stated in the PPE standard, 29 CFR 1910.132.

Employers must require workers to use appropriate hand protection when hands are exposed to hazards such as sharp instruments and potential thermal burns. Examples of PPE which may be selected include using oven mitts when handling hot items, and steel mesh or cut-resistant gloves when handling or sorting sharp instruments as stated in the Hand Protection standard, 29 CFR 1910.138.

Autoclaves and Sterilizers

Workers should be trained to recognize the potential for exposure to burns or cuts that can occur from handling or sorting hot sterilized items or sharp instruments when removing them from autoclaves/ sterilizers or from steam lines that service the autoclaves.

In order to prevent injuries from occurring, employers must train workers to follow good work practices such as those outlined in the QuickCard™ at https://www.osha.gov/.

Centrifuges

Centrifuges, due to the high speed at which they operate, have great potential for injuring users if not operated properly. Unbalanced centrifuge rotors can result in injury, even death. Sample container breakage can generate aerosols that may be harmful if inhaled.

The majority of all centrifuge accidents are the result of user error. In order to prevent injuries or exposure to dangerous substances, employers should train workers to follow good work practices such as those outlined in the QuickCard™ at https://www.osha.gov/.

Employers should instruct workers when centrifuging infectious materials that they should wait 10 minutes after the centrifuge rotor has stopped before opening the lid. Workers should also be trained to use appropriate decontamination and cleanup procedures for the materials being centrifuged if a spill occurs and to report all accidents to their supervisor immediately.

Compressed Gases

According to OSHA's Laboratory standard, a "compressed gas" (1) is a gas or mixture of gases in a container having an absolute pressure exceeding 40 pounds per square inch (psi) at 70°F (21.1°C); or (2) is a gas or mixture of gases having an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or (3) is a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM (American Society for Testing and Materials) D-323-72, [29 CFR 1910. 1450(c)(1)-(3)].

Within laboratories, compressed gases are usually supplied either through fixed piped gas systems or individual cylinders of gases. Compressed gases can be toxic, flammable, oxidizing, corrosive, or inert. Leakage of any of these gases can be hazardous. Leaking inert gases (e.g., nitrogen) can quickly displace air in a large area creating an oxygen-deficient atmosphere; toxic gases (e.g., can create poison atmospheres; and flammable (oxygen) or reactive gases can result in fire and exploding cylinders. In addition, there are hazards from the pressure of the gas and the physical weight of the cylinder. A gas cylinder falling over can break containers and crush feet. The gas cylinder can itself become a missile if the cylinder valve is broken off.

Compressed gases contained in cylinders vary in chemical properties, ranging from inert and harmless to toxic and explosive. The high pressure of the gases constitutes a serious hazard in the event that gas cylinders sustain physical damage and/or are exposed to high temperatures.

Store, handle, and use compressed gases in accord with OSHA's Compressed Gases standard (29 CFR 1910.101) and Pamphlet P-1-1965 from the Compressed Gas Association.

- All cylinders whether empty or full must be stored upright.
- Secure cylinders of compressed gases. Cylinders should never be dropped or allowed to strike each other with force.
- Transport compressed gas cylinders with protective caps in place and do not roll or drag the cylinders.

Cryogens and Dry Ice

Cryogens, substances used to produce very low temperatures [below -153°C (-243°F)], such

as liquid nitrogen (LN2) which has a boiling point of -196°C (-321°F), are commonly used in laboratories. Although not a cryogen, solid carbon dioxide or dry ice which converts directly to carbon dioxide gas at -78°C (-109°F) is also often used in laboratories. Shipments packed with dry ice, samples preserved with liquid nitrogen, and in some cases, techniques that use cryogenic liquids, such as cryogenic grinding of samples, present potential hazards in the laboratory.

Overview of Cryogenic Safety Hazards

The safety hazards associated with the use of cryogenic liquids are categorized as follows:

(1) **Cold contact burns** - Liquid or low-temperature gas from any cryogenic substance will produce effects on the skin similar to a burn.

(2) **Asphyxiation** - Degrees of asphyxia will occur when the oxygen content of the working environment is less than 20.9% by volume. This decrease in oxygen content can be caused by a failure/leak of a cryogenic vessel or transfer line and subsequent vaporization of the cryogen. Effects from oxygen deficiency become noticeable at levels below approximately 18% and sudden death may occur at approximately 6% oxygen content by volume.

(3) **Explosion – Pressure** - Heat flux into the cryogen from the environment will vaporize the liquid and potentially cause pressure buildup in cryogenic containment vessels and transfer lines. Adequate pressure relief should be provided to all parts of a system to permit this routine outgassing and prevent explosion.

(4) **Explosion – Chemical** - Cryogenic fluids with a boiling point below that of liquid oxygen are able to condense oxygen from the atmosphere. Repeated replenishment of the system can thereby cause oxygen to accumulate as an unwanted contaminant. Similar oxygen enrichment may occur where condensed air accumulates on the exterior of cryogenic piping. Violent reactions, e.g., rapid combustion or explosion, may occur if the materials which make contact with the oxygen are combustible.

Employer Responsibility

It is the responsibility of the employer, specifically the supervisor in charge of an apparatus, to ensure that the cryogenic safety hazards are minimized. This will entail (1) a safety analysis and review for all cryogenic facilities, (2) cryogenic safety and operational training for relevant workers, (3) appropriate maintenance of cryogenic systems in their original working order, i.e., the condition in which the system was approved for use, and (4) upkeep of inspection

schedules and records.

Employers must train workers to use the appropriate personal protective equipment (PPE) Whenever handling or transfer of cryogenic fluids might result in exposure to the cold liquid, boil-off gas, or surface, protective clothing must be worn.

This includes:
• face shield or safety goggles;
• safety gloves; and
• long-sleeved shirts, lab coats, aprons.

Eye protection is required at all times when working with cryogenic fluids. When pouring a cryogen, working with a wide-mouth Dewar flask or around the exhaust of cold boil-off gas, use of a full face shield is recommended.

Hand protection is required to guard against the hazard of touching cold surfaces. It is recommended that Cryogen Safety Gloves be used by the worker.

Electrical

In the laboratory, there is the potential for workers to be exposed to electrical hazards including electric shock, electrocutions, fires and explosions. Damaged electrical cords can lead to possible shocks or electrocutions. A flexible electrical cord
may be damaged by door or window edges, by staples and fastenings, by equipment rolling over it, or simply by aging.

The potential for possible electrocution or electric shock or contact with electrical hazards can result from a number of factors, including the following:

- Faulty electrical equipment/instrumentation or wiring;
- Damaged receptacles and connectors; and
- Unsafe work practices.

Employers are responsible for complying with OSHA's standard 1910 Subpart S-Electrical
Subpart S is comprehensive and addresses electrical safety requirements for the practical safeguarding of workers in their workplaces. This Subpart includes, but is not limited to, these

requirements:

- Electrical equipment must be free from recognized hazards, 29 CFR 1910.303(b)(1);
- Listed or labeled equipment must be used or installed in accord with any instructions included in the listing or labeling, 29 CFR 1910.303(b)(2);
- Sufficient access and working space must be provided and maintained around all electrical equipment operating at ≤ 600 volts to permit ready and safe operation and maintenance of such equipment, 29 CFR 1910.303(g)(1);
- Ensure that all electrical service near sources of water is properly grounded.
- Tag out and remove from service all damaged receptacles and portable electrical equipment, 29 CFR 1910.334(a)(2)(ii);
- Repair all damaged receptacles and portable electrical equipment before placing them back into service, 29 CFR 1910.334(a)(2)(ii);
- Ensure that workers are trained not to plug or unplug energized equipment when their hands are wet, 29 CFR 1910.334(a)(5)(i);
- Select and use appropriate work practices, 29 CFR 1910.333; and
- Follow requirements for Hazardous Classified Locations, 29 CFR 1910.307. This section covers the requirements for electric equipment and wiring in locations that are classified based on the properties of the flammable vapors, liquids or gases, or combustible dusts or fibers that may be present therein and the likelihood that a flammable or combustible concentration or quantity is present.

Fire

Fire is the most common serious hazard that one faces in a typical laboratory. While proper procedures and training can minimize the chances of an accidental fire, laboratory workers should still be prepared to deal with a fire emergency should it occur. In dealing with a laboratory fire, all containers of infectious materials should be placed into autoclaves, incubators, refrigerators, or freezers for containment.

Small bench-top fires in laboratory spaces are not uncommon. Large laboratory fires are rare. However, the risk of severe injury or death is significant because fuel load and hazard levels

in labs are typically very high. Laboratories, especially those using solvents in any quantity, have the potential for flash fires, explosion, rapid spread of fire, and high toxicity of products of combustion (heat, smoke, and flame).

Employers should ensure that workers are trained to do the following in order to prevent fires

- Plan work. Have a written emergency plan for your space and/or operation.
- Minimize materials. Have present in the immediate work area and use only the minimum quantities necessary for work in progress. Not only does this minimize fire risk, it reduces costs and waste.
- Observe proper housekeeping. Keep work areas uncluttered, and clean frequently. Put unneeded materials back in storage promptly. Keep aisles, doors, and access to emergency equipment unobstructed at all times.
- Observe restrictions on equipment (i.e., keeping solvents only in an explosion-proof refrigerator).
- Keep barriers in place (shields, hood doors, lab doors).
- Wear proper clothing and personal protective equipment.
- Avoid working alone.
- Store solvents properly in approved flammable liquid storage cabinets.
- Shut door behind you when evacuating.
- Limit open flames use to under fume hoods and only when constantly attended.
- Keep combustibles away from open flames.
- Do not heat solvents using hot plates.
- Remember the “RACE” rule in case of a fire.
    - R= Rescue/remove all occupants
    - A= Activate the alarm system
    - C= Confine the fire by closing doors
    - E= Evacuate/Extinguish

Employers should ensure that workers are trained in the following emergency procedures

- Know what to do. You tend to do under stress what you have practiced or pre-planned. Therefore, planning, practice and drills are essential.
- Know where things are: The nearest fire extinguisher, fire alarm box, exit(s), telephone, emergency shower/eyewash, and first-aid kit, etc.

- Be aware that emergencies are rarely “clean” and will often involve more than one type of problem. For example, an explosion may generate medical, fire, and contamination emergencies simultaneously.
- Train workers and exercise the emergency plan.
- Learn to use the emergency equipment provided.

Employers must be knowledgeable about OSHA’s Portable Fire Extinguishers standard, 29 CFR 1910.157, and train workers to be aware of the different fire extinguisher types and how to use them. OSHA’s Portable Fire Extinguishers standard, 29 CFR 1910.157, applies to the placement, use, maintenance, and testing of portable fire extinguishers provided for the use of workers. This standard requires that a fire extinguisher be placed within 75 feet for Class A fire risk (ordinary combustibles; usually fuels that burn and leave “ash”) and within 50 feet for high-risk Class B fire risk (flammable liquids and gases; in the laboratory many organic solvents and compressed gases are fire hazards).

The two most common types of extinguishers in the chemistry laboratory are pressurized dry chemical (Type BC or ABC) and carbon dioxide. In addition, you may also have a specialized Class D dry powder extinguisher for use on flammable metal fires. Water-filled extinguishers are not acceptable for laboratory use.

Employers should train workers to remember the “PASS” rule for fire extinguishers
PASS summarizes the operation of a fire extinguisher.

P – Pull the pin
A – Aim extinguisher nozzle at the base of the fire
S – Squeeze the trigger while holding the extinguisher upright
S – Sweep the extinguisher from side to side; cover the fire with the spray

Employers should train workers on appropriate procedures in the event of a clothing fire

- If the floor is not on fire, STOP, DROP and ROLL to extinguish the flames or use a fire blanket or a safety shower if not contraindicated (i.e., there are no chemicals or electricity involved).
- If a coworker’s clothing catches fire and he/she runs down the hallway in panic, tackle him/her and smother the flames as quickly as possible, using appropriate means that

are available (e.g., fire blanket, fire extinguisher)

Lockout/Tagout

Workers performing service or maintenance on equipment may be exposed to injuries from the unexpected energization, startup of the equipment, or release or stored energy in the equipment. OSHA's Control of Hazardous Energy standard, 29 CFR 1910.147, commonly referred to as the "Lockout/Tagout" standard, requires the adoption and implementation of practices and procedures to shut down equipment, isolate it from its energy source(s), and prevent the release of potentially hazardous energy while maintenance and servicing activities are being performed. It contains minimum performance requirements, and definitive criteria for establishing an effective program for the control of hazardous energy. However, employers have the flexibility to develop Lockout/Tagout programs that are suitable for their respective facilities.

This standard establishes basic requirements involved in locking and/or tagging equipment while installation, maintenance, testing, repair or construction operations are in progress. The primary purpose is to prevent hazardous exposure to personnel and possible equipment damage. The procedures apply to the shutdown of all potential energy sources associated with the equipment. These could include pressures, flows of fluids and gases, electrical power, and radiation. This standard covers the servicing and maintenance of machines and equipment in which the "unexpected" energization or startup of the machines or equipment, or release of stored energy could cause injury to workers.

Under the standard, the term "unexpected" also covers situations in which the servicing and/or maintenance is performed during ongoing normal production operations if:

- A worker is required to remove or bypass machine guards or other safety devices, 29 CFR 1910.147(a)2)(ii)(A) or
- A worker is required to place any part of his or her body into a point of operation or into an area on a machine or piece of equipment where work is performed, or into the danger zone associated with the machine's operation, 29 CFR 1910.147(a) (2)(ii)(B).

The Lockout/Tagout standard establishes minimum performance requirements for the control of such hazardous energy.

Maintenance activities can be performed with or without energy present. A probable, underlying cause of many accidents resulting in injury during maintenance is that work is performed without the knowledge that the system, whether energized or not, can produce hazardous energy. Unexpected and unrestricted release of hazardous energy can occur if: (1) all energy sources are not identified; (2) provisions are not made for safe work practices with energy present; or (3) deactivated energy sources are reactivated, mistakenly, intentionally, or accidentally, without the maintenance worker's knowledge.

Problems involving control of hazardous energy require procedural solutions. Employers must adopt such procedural solutions for controlling hazards to ensure worker safety during maintenance. However, such procedures are effective only if strictly enforced. Employers must, therefore, be committed to strict implementation of such procedures.

Trips, Slips and Falls

Worker exposure to wet floors or spills and clutter can lead to slips/trips/falls and other possible injuries. In order to keep workers safe, employers are referred to OSHA standard 29 CFR 1910 Subpart D – Walking-Working Surfaces, Subpart E - Means of Egress, and Subpart J - General environmental controls which states the following:

- Keep floors clean and dry, 29 CFR 1910.22(a)(2). In addition to being a slip hazard, continually wet surfaces promote the growth of mold, fungi, and bacteria that can cause infections.
- Provide warning (caution) signs for wet floor areas, 29 CFR 1910.145(c)(2).
- Where wet processes are used, maintain drainage and provide false floors, platforms, mats, or other dry standing places where practicable, or provide appropriate waterproof footgear, 29 CFR 1910.141(a)(3)(ii).
- The Walking/Working Surfaces standard requires that all employers keep all places of employment clean and orderly and in a sanitary condition, 29 CFR 1910.22(a)(1).
- Keep aisles and passageways clear and in good repair, with no obstruction across or in aisles that could create a hazard, 29 CFR 1910.22(b)(1). Provide floor plugs for equipment, so that power cords need not run across pathways.
- Keep exits free from obstruction. Access to exits must remain clear of obstructions at

all times, 29 CFR 1910.37(a)(3).

- Ensure that spills are reported and cleaned up immediately.
- Eliminate cluttered or obstructed work areas.
- Use prudent housekeeping procedures such as using caution signs, cleaning only one side of a passageway at a time and provide good lighting for all halls and stairwells to help reduce accidents, especially during the night hours.
- Instruct workers to use the handrail on stairs, to avoid undue speed, and to maintain an unobstructed view of the stairs ahead of them even if that means requesting help to manage a bulky load.
- Eliminate uneven floor surfaces.
- Promote safe work practices, even in cramped working spaces.
- Avoid awkward positions and use equipment that makes lifting easier.

ESCUELA DE MEDICINA
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Laboratory Safety Manual
(Chemical Hygiene Plan)

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