جامعة الإمام عبدالرحمن بن فيصل
IMAM ABDULRAHMAN BIN FAISAL UNIVERSITY
مركز البحوث العلمية الأساسية والتطبيقية
Basic and Applied Scientific Research Center

IMAM Abdulrahman bin Faisal University

Basic and Applied Scientific Research Center

Laboratory Safety Guide

2021

Vision

A leading basic and applied scientific research center achieving excellence in national and international level.

Mission

Providing significant contributions through innovative basic and applied scientific research to serve the community aligned with world economic development strategies.

Value

(BASRC)

B: Belief in Teamwork

A: Accountability

S: Social Responsibility

R: Respect

C: Creativity

Table of Contents

Abbreviation

PPE	Personal Protective Equipment
CHP	Chemical Hygiene Plan
SOPs	Standard Operating Procedures
PELs	Permissible exposure Limits
MSDSs	Material safety data sheets
TWA	Time weighted average
HPAI	Highly Pathogenic Avian Influenza

Introduction

The administration of Imam Abdulrahman bin Faisal University Center for basic and Applied Scientific Researches (BASRC) committed to protecting its employees, resources and assets from harm or physical injury or damage. This manual contains recommendations as well as descriptions of mandatory safety and health standards. The recommendations are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace.

The laboratory environment can be a hazardous place to work. Laboratory workers are exposed to numerous potential hazards including chemical, biological, physical and radioactive hazards, as well as musculoskeletal stresses. Laboratory safety is governed by numerous local, state and federal regulations. This document is intended for supervisors, principal investigators and employees who have the primary responsibility for maintaining laboratories under their supervision as safe, healthy places to work and for ensuring that applicable health, safety and environmental regulations are followed. Worker guidance in the form of Fact Sheets and is also provided for certain hazards that may be encountered in laboratories. This document is designed to make employees aware of the standards to be followed to protect themselves from the diverse hazards encountered in laboratories. The extent of detail on specific hazards provided in this document is dependent on the nature of each hazard and its importance in a laboratory setting.

Hierarchy of Controls

Occupational safety and health professionals use a framework called the "hierarchy of controls" to select ways of dealing with workplace hazards. The hierarchy of controls prioritizes intervention strategies based on the premise that the best way to control a hazard is to systematically remove it from the workplace, rather than relying on workers to reduce their exposure. The types of measures that may be used to protect laboratory workers, prioritized from the most effective to least effective, are:

- Engineering Controls
- Administrative Controls
- Work Practices
- Personal Protective Equipment (PPE)

BASRC uses a combination of control methods to protect its employees that combine both immediate actions as well as longer term solutions. A description of each type of control for non-production laboratories follows.

Engineering Controls involve making changes to the work environment to reduce work-related hazards. These types of controls are preferred over all others because they make permanent changes that reduce exposure to hazards and do not rely on worker behavior. By reducing a hazard in the workplace, engineering controls can be the most cost-effective solutions for employers to implement. Examples include chemical fume hoods and biological safety cabinets

Administrative Controls are those that modify workers' work schedules and tasks in ways that minimize their exposure to workplace hazards. Examples include a chemical hygiene plan and the standard operating procedures for chemical handling.

Work Practices are procedures for safe and proper work that are used to reduce the duration, frequency or intensity of exposure to a hazard. Examples include no mouth pipetting and chemical substitution where feasible (e.g., selecting a less hazardous chemical for a specific procedure).

Personal Protective Equipment (PPE) is protective clothing and accessories needed to keep workers safe while performing their jobs. Examples of PPE include respirators, face shields, goggles and disposable gloves.

While engineering and administrative controls and proper work practices are considered to be more effective in minimizing exposure to many workplace hazards, the use of PPE is also very important in laboratory settings. PPE should be:

- Selected based upon the hazard to the worker
- Properly fitted and in some cases periodically refitted (e.g., respirators)
- Conscientiously and properly worn
- Regularly maintained and replaced in accordance with the manufacturer's specifications;
- Properly removed and disposed of to avoid contamination of self, others or the environment;
- If reusable, properly removed, cleaned, disinfected and stored.

The following sections of this document are organized based upon classes of hazards, i.e., chemical, biological, physical, safety and other hazards.

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.

Laboratory Standard

The Laboratory standard was developed to address workplaces where relatively small quantities of hazardous chemicals are used on a non-production basis. Laboratories that conduct research and development and related analytical work are subject to the requirements of the Laboratory standard. 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. The Laboratory standard achieves this protection by establishing safe work practices in laboratories to implement a Chemical Hygiene Plan (CHP).

Program Description

This Laboratory Standard consists of five major elements:

- Hazard Identification
- Chemical Hygiene Plan
- Information and Training
- Exposure Monitoring
- Medical Consultation and Examinations

Hazard Identification: All containers for chemicals must be clearly labeled. BASRC will ensure that workers do not use, store, or allow any other person to use or store, any hazardous substance in the laboratory if the container does not meet the labeling requirements. Labels on chemical containers must not be removed or defaced.

Material Safety Data Sheets (MSDSs) for chemicals received by the laboratory are available and will be maintained and readily accessible to laboratory workers. MSDSs are written or printed materials concerning a hazardous chemical. BASRC has an MSDS in the workplace for each hazardous chemical in use. MSDS sheets contain:

- Name of the chemical
- Manufacturer's information
- Hazardous ingredients/identity information
- Physical/chemical characteristics
- Fire and explosion hazard data
- Reactivity data
- Health hazard data
- Precautions for safe handling and use
- Control measures

Chemical Hygiene Plan: The Chemical Hygiene Plan (CHP) provides guidelines for prudent practices and procedures for the use of chemicals in the laboratory. A CHP has been formulated for BASRC and is strictly adhered to. The CHP has the following:

- Standard Operating Procedures (SOPs)
- Criteria for Exposure Control Measures
- Adequacy and Proper Functioning of Fume Hoods and other Protective Equipment
- Information and Training
- Requirement of Prior Approval of Laboratory Procedures
- Medical Consultations and Examinations
- Chemical Hygiene Officer Designation
- Particularly Hazardous Substances

Information and Training:
Laboratory workers at BASRC are provided with information and training relevant to the hazards of the chemicals present in the laboratory. The training is provided at the time of initial assignment to a laboratory and prior to assignments involving new exposure situations.
Employees are informed of the following:

- Location and availability of the Chemical Hygiene Plan
- Permissible exposure limits or recommended exposure levels for other hazardous chemicals
- Signs and symptoms associated with exposure to hazardous chemicals in the laboratory
- Location and availability of reference materials

Training includes the following:

- Methods and observations used to detect the presence or release of a hazardous chemical. These may include employer monitoring, continuous monitoring devices, and familiarity with the appearance and odor of the chemicals.
- The physical and health hazards of chemicals in the laboratory work area.
- The measures that workers can take to protect themselves from these hazards, including PPE, appropriate work practices, and emergency procedures
- Access to the Chemical Hygiene Plan.

Exposure Determination
OSHA has established permissible exposure limits (PELs) 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. BASRC will ensure that workers' exposures to OSHA-regulated substances do not exceed the PEL.

Medical Consultations and Examinations: Provisions for medical consultation and examination when exposure to a hazardous chemical has or may have taken place. BASRC will provide the following:

- Provide all exposed workers with an opportunity to receive medical attention by a licensed physician, including any follow-up examinations which the examining physician determines to be necessary.
- Provide an opportunity for a medical consultation by a licensed physician whenever a spill, leak, explosion or other occurrence results in the likelihood that a laboratory worker experienced a hazardous exposure in order to determine whether a medical examination is needed.
- Provide an opportunity for a medical examination by a licensed physician whenever a worker develops signs or symptoms associated with a hazardous chemical to which he or she may have been exposed in the laboratory.
- Establish medical surveillance for a worker as required by the particular standard when exposure monitoring reveals exposure levels have been exceeded
- Provide the examining physician with the identity of the hazardous chemical(s) to which the individual may have been exposed, and the conditions under which the exposure may have occurred, including quantitative data, where available, and a description of the signs and symptoms of exposure the worker may be experiencing.

- Provide all medical examinations and consultations without cost to the worker, without loss of pay, and at a reasonable time and place.
- The examining physician must complete a written opinion that includes the following information:

    - Recommendations for further medical follow-up.
    - The results of the medical examination and any associated tests.
    - Any medical condition revealed in the course of the examination that may place the individual at increased risk as a result of exposure to a hazardous chemical in the workplace.
    - A statement that the worker has been informed of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
    - The written opinion must not reveal specific findings of diagnoses unrelated to occupational exposure. A copy of the examining physician's written opinion must be provided to the exposed worker.

BASRC will maintain an accurate record of exposure monitoring activities and exposure measurements as well as medical consultations and examinations, including medical tests and written opinions. BASRC will maintain worker exposure records for 30 years and medical records for the duration of the worker's employment plus 30 years. Such records will be maintained, transferred, and made available to an individual's physician or made available to the worker or his/her designated representative upon request.

Roles and Responsibilities

The **Director of BASRC** bears ultimate responsibility for chemical hygiene within the facility and provides continuing support for chemical hygiene.

The **Chemical Hygiene Officer** will fulfill the following duties:

- Develops and implements appropriate chemical hygiene policies and practices
- Monitors procurement, use, and disposal of chemicals used in the lab
- Ensures that appropriate audits are maintained
- Knows the current legal requirements concerning regulated substances
- Seeks ways to improve the chemical hygiene program
- Development and maintenance of lists of hazardous chemicals present in each laboratory
- Ensures that containers of chemicals in the laboratories are properly labeled
- Develops and implements worker training programs regarding hazards of chemicals employees may be exposed to and the appropriate protective measures that must be used when handling these chemicals

Laboratory Supervisors will fulfill the following duties:

- Have overall responsibility for chemical hygiene in the laboratory

- Ensure that laboratory workers know and follow the chemical hygiene rules.
- Ensure that protective equipment is available and in working order.
- Ensure that appropriate training has been provided
- Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment.
- Know the current legal requirements concerning regulated substances.
- Determine the required levels of PPE and equipment.
- Ensure that facilities and training for use of any material being ordered are adequate.

Laboratory Workers have the following responsibilities:

- Plan and conduct each operation in accordance with BASRC chemical hygiene procedures, including use of PPE and engineering controls, as appropriate
- Develop good personal chemical hygiene habits
- Report all accidents and potential chemical exposures immediately.

Two OSHA Fact Sheets have been developed to supplement this section. One is entitled Laboratory Safety – OSHA Laboratory Standard, and the other is entitled Laboratory Safety – Chemical Hygiene Plan. Both are available at the end of this manual.

Chemical Hazards

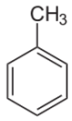
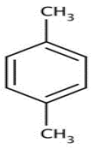
Hazard Communication Standard: This standard is designed to protect against chemical source illnesses and injuries by ensuring that employers and workers are provided with sufficient information to recognize, evaluate and control chemical hazards and take appropriate protective measures. The steps that BASRC will take to comply with the requirements of this standard include, but are not limited to:

- Development and maintenance of a written hazard communication program for the workplace, including lists of hazardous chemicals present
- Ensuring that containers of chemicals in the workplace, as well as containers of chemicals being shipped to other workplaces, are properly labeled
- Ensuring that material safety data sheets (MSDSs) for chemicals that workers may be exposed to are made available to workers
- Development and implementation of worker training programs regarding hazards of chemicals they may be exposed to and the appropriate protective measures that must be used when handling these chemicals.

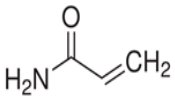
An OSHA Fact Sheet entitled Laboratory Safety – Labeling and Transfer of Chemicals has been developed to supplement this section. This is available at the end of this manual.

Specific Chemical Hazards

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.

Chemical	Exposure Routes	Symptoms	Target Organs
Toluene 	Inhalation; Ingestion; Skin and/or eye contact; Skin absorption	Irritation of eyes, nose; weakness, exhaustion, confusion, euphoria, headache; Dilated pupils & tearing; Anxiety; Muscle fatigue; Insomnia; Tingling, pricking, or numbness of skin; Dermatitis; Liver & kidney damage	Eyes; Skin; Respiratory system; Central nervous system; Liver; Kidneys
Xylene 	Inhalation; Ingestion; Skin and/or eye contact; Skin absorption.	Irritation of eyes, skin, nose, throat; Dizziness, excitement, drowsiness, incoherence, staggering gait; Corneal vacuolization (cell debris); Anorexia, nausea, vomiting, abdominal pain; Dermatitis.	Eyes; Skin; Respiratory system; Central nervous system; GI tract; Blood; Liver; Kidneys.

Acrylamide is usually found in research laboratories and is used to make polyacrylamide gels for separations of macromolecules (e.g., DNA, proteins). The exposure routes, symptoms and target organs are shown in the table below:

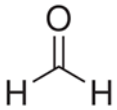
Chemical	Exposure Routes	Symptoms	Target Organs
Acrylamide 	Inhalation; Ingestion; Skin and/or eye contact; Skin absorption.	Irritation of eyes, skin; Ataxia (staggering gait), numb limbs, tingling, pricking, or numbness of skin; Muscle weakness; Absence of deep tendon reflex; Hand sweating; Tearing, Drowsiness; Reproductive effects; Potential Occupational carcinogen.	Eyes; Skin; Central nervous system; Peripheral nervous system; Reproductive system (in animals: tumors of the lungs, testes, thyroid and adrenal glands).

BASRC has implemented a written program for chemicals that workers are exposed to and that meet the requirements of the Hazard Communication standard. This program contains

provisions for worker training, warning labels and access to Material Safety Data Sheets (MSDSs).

Formaldehyde Standard

Formaldehyde is used as a fixative and is commonly found in most laboratories. Employees should not be 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 exposure routes, symptoms and target organs are shown in the table below:

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

BASRC provides the appropriate PPE and acceptable eyewash facilities within the immediate work area for emergency use, if there is any possibility that an employee's eyes may be splashed with solutions containing 0.1 percent or greater formaldehyde.

Latex

Latex is one of the most common chemicals that laboratory workers are exposed to. 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. BASRC will provide appropriate PPE and make it accessible, including latex-free gloves, glove liners, powder-free gloves, or other similar alternatives for those workers who are allergic to latex. Latex allergy should be suspected in employees, 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.

An OSHA Fact Sheet entitled Laboratory Safety – Latex Allergy has been developed to supplement this section. This is available at the end of this manual.

Specific Engineering Control

Chemical Fume Hoods

The fume hood is often the primary control device for protecting laboratory workers when working with flammable and/or toxic chemicals. BASRC requires that fume hoods be maintained and function properly when used.

Before using a fume hood:

- Make sure that you understand how the hood works
- You should be trained to use it properly
- Know the hazards of the chemical you are working with
- Ensure that the hood is on.
- Make sure that the sash is open to the proper operating level, which is usually indicated by arrows on the frame.
- Make sure that the air gauge indicates that the air flow is within the required range.

When using a fume hood:

- Never allow your head to enter the plane of the hood opening. For example, for vertical rising sashes, keep the sash below your face; for horizontal sliding sashes, keep the sash positioned in front of you and work around the side of the sash.
- Use appropriate eye protection
- Be sure that nothing blocks the airflow through the baffles or through the baffle exhaust slots.
- Elevate large equipment (e.g., a centrifuge) at least two inches off the base of the hood interior.
- Keep all materials inside the hood at least six inches from the sash opening

- When not working in the hood, close the sash.
- Do not permanently store any chemicals inside the hood.
- Promptly report any hood that is not functioning properly to the laboratory supervisor. The sash should be closed and the hood "tagged" and taken out of service until repairs can be completed.
- When using extremely hazardous chemicals, understand your laboratory's action plan in case an emergency, such as a power failure, occurs.

An OSHA Fact Sheet entitled Laboratory Safety – Chemical Fume Hoods has been developed to supplement this section. This is available at the end of this manual.

Biological Hazards

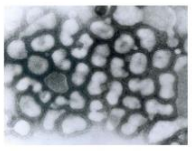
Biological Agents (other than Bloodborne Pathogens) and Biological Toxins

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. Biological agents (e.g. viruses, bacteria, prions and fungi) and toxins have the potential to pose a severe threat to public health and safety, to animal or plant health, or to animal or plant products. BASRC will 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.

Anthrax

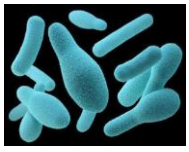
Anthrax is an acute infectious disease caused by a spore-forming bacterium called *Bacillus anthracis*. It is generally acquired following contact with anthrax-infected animals or anthrax-contaminated animal products.

Avian Flu



Avian influenza is caused by Influenza A viruses. These viruses normally reside in the intestinal tracts of waterfowl 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).

Botulism

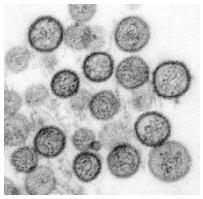


Cases of botulism are usually associated with consumption of preserved foods. However, botulinum toxins are currently among the most common compounds explored by terrorists for use as biological weapons.

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

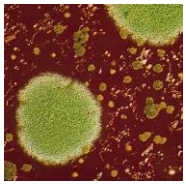


Hantaviruses are transmitted to humans from the dried droppings, urine, or saliva of mice and rats. Animal laboratory workers and persons working in infested buildings are at increased risk to this disease

Legionnaires' Disease

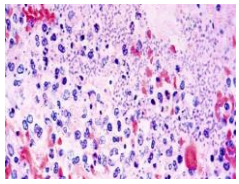
Legionnaires' disease is a bacterial disease commonly associated with water-based aerosols. It is often the result of poorly maintained air conditioning cooling towers and potable water systems.

Molds and Fungi



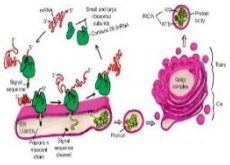
Molds and fungi produce and release millions of spores small enough to be air-, water-, or insect-borne which may have negative effects on human health including, allergic reactions, asthma, and other respiratory problems.

Plague



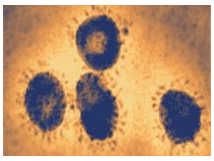
The World Health Organization reports 1,000 to 3,000 cases of plague every year. A bioterrorist release of plague could result in a rapid spread of the pneumonic form of the disease, which could have devastating consequences.

Ricin



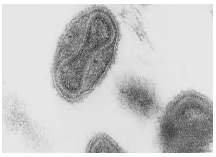
Ricin is one of the most toxic and easily produced plant toxins. It has been used in the past as a bioterrorist weapon and remains a serious threat.

SARS



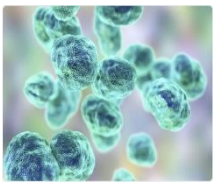
Severe Acute Respiratory Syndrome: SARS is an emerging, sometimes fatal, respiratory illness.

Smallpox



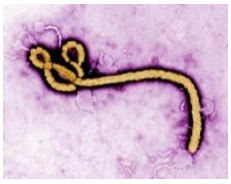
Smallpox is a highly contagious disease unique to humans. It is estimated that no more than 20 percent of the population has any immunity from previous vaccination.

Tularemia



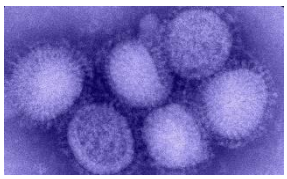
Tularemia is also known as “rabbit fever” or “deer fly fever” and is extremely infectious.
Relatively few bacteria are required to cause the disease, which is why it is an attractive weapon for use in bioterrorism.

VHFs



Viral Hemorrhagic Fevers: 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. VHFs include the Marburg virus, Ebola viruses, and the Crimean-Congo hemorrhagic fever virus.

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.

The list above does not include all the biological agents and toxins that may be hazardous to laboratory workers.

Bloodborne Pathogens

Employees are subject to the bloodborne pathogens if they have a reasonable risk of coming into contact with blood or other potentially infectious materials. BASRC will select safer needle devices and involve workers in identifying and choosing these devices. A log of injuries from contaminated sharps will also be maintained.

All occupational exposure to blood or Other Potentially Infectious Material (OPIM) places workers at risk for infection with bloodborne pathogens. Blood includes human blood, human blood components, and products made from human blood. OPIM includes 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
- Any unfixed tissue or organ (other than intact skin) from a human (living or dead)
- 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.

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. 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.

BASRC will ensure that workers are trained and prohibited from engaging in the following activities:

- Mouth pipetting/suctioning of blood or OPIM
- 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,
- Storage of food or drink in refrigerators, freezers, shelves, cabinets or on countertops or benchtops where blood or OPIM are present

BASRC will ensure that the following are provided:

- Appropriate PPE for workers if blood or OPIM exposure is anticipated. 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,
- Surgical caps or hoods and/or shoe covers or boots must be worn in instances when gross contamination can reasonably be anticipated
- Effective engineering and work practice controls to help remove or isolate exposures to blood and bloodborne pathogens,
- 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

HIV/HBV Laboratories

BASRC will ensure that:

- All activities involving OPIM are conducted in Biological Safety Cabinets (BSCs) or other physical-containment devices; work with OPIM must not be conducted on the open bench
- Certified BSCs or other appropriate combinations of personal protection or physical containment devices, such as special protective clothing, respirators, centrifuge safety cups, sealed centrifuge rotors, and containment caging for animals, be used for all activities with OPIM that pose a threat of exposure to droplets, splashes, spills, or aerosols
- Each laboratory contains a facility for hand washing and an eyewash facility which is readily available within the work area
- Each work area contains a sink for washing hands and a readily available eyewash facility. The sink must be foot, elbow, or automatically operated and must be located near the exit door of the work area.

BASRC has also satisfied the additional requirements that apply to HIV and HBV research laboratories:

- Waste materials:

  - All regulated waste is either incinerated or decontaminated by a method such as autoclaving known to effectively destroy bloodborne pathogens
  - Contaminated materials that are to be decontaminated at a site away from the work area are placed in a durable, leak-proof, labeled or color-coded container that is closed before being removed from the work area.
- Access
  - Laboratory doors are kept closed when work involving HIV or HBV is in progress
  - Access to the production facilities' work area is limited to authorized persons. Written policies and procedures have been established whereby only persons who meet any specific entry requirements, and who comply with all entry and exit procedures will be allowed to enter the work areas and animal rooms,
  - Access doors to the production facilities' work area or containment module are self-closing.
  - Work areas are separated from areas that are open to unrestricted traffic flow within the building. Passage through two sets of doors is a basic requirement for entry into the work area from access corridors or other contiguous areas.
  - The surfaces of doors, walls, floors and ceilings in the work area are water-resistant so that they can be easily cleaned.

Research Animals

All procedures on animals are performed by properly trained personnel. By using safe work practices and appropriate PPE, workers can minimize the likelihood that they will be bitten, scratched, and/or exposed to animal body fluids and tissues. The most common work-related health complaints reported by individuals working with small animals include:

- Sprains
- Strains
- Bites
- Allergies

Of these injuries, allergies (i.e., exaggerated reactions by the body's immune system) to proteins in small animals' urine, saliva, and dander are the greatest potential health risk. An allergic response may evolve into life-long asthma. Because mice and rats are the animals most frequently used in research studies, there are more reports of allergies to rodents than other laboratory animals. Most workers who develop allergies to laboratory animals will do so within the first twelve months of working with them. Sometimes reactions only occur in workers after they have been handling animals for several years. Initially, the symptoms are present within minutes of the worker's exposure to the animals. Approximately half of allergic workers will have their initial symptoms subside and then recur three or four hours following the exposure. The adoption of the following best practices will reduce allergic responses of workers:

- Eliminate or minimize exposure to the proteins found in animal urine, saliva and dander.

- Limit the chances that workers will inhale or have skin contact with animal proteins by using well-designed air handling and waste management systems.
- Have workers use appropriate PPE (e.g., gloves, gowns, hair covers, respirators) to further minimize their risk of exposure.

Zoonotic Diseases

There are a host of possible infectious agents that can be transferred from animals to humans. These are referred to as zoonotic diseases. The common routes of exposure to infectious agents are inhalation, inoculation, ingestion and contamination of skin and mucous membranes. Inhalation hazards may arise during work practices that can generate aerosols. These include the following: centrifugation, mixing (e.g., blending, vortexing, and sonication), pouring/decanting and spilling/splashing of culture fluids. Inoculation hazards include needlesticks and lacerations from sharp objects. Ingestion hazards include the following: splashes to the mouth, placing contaminated articles/fingers in mouth, consumption of food in the laboratory, and mouth pipetting. Contamination of skin and mucous membranes can occur via splashes or contact with contaminated fomites (e.g., towels, bedclothes, cups, money). Some of the zoonotic diseases that can be acquired from animals are listed below.

Zoonotic Diseases – Wild and Domesticated Animals

Wild rodents and other wild animals may inflict an injury such as a bite or scratch. Workers are trained on the correct way to capture and handle any wild animals. While they may carry or shed organisms that may be potentially infectious to humans, the primary health risk to individuals working with captured animals is the development of an allergy. The development of disease in the human host often requires a preexisting state that compromises the immune system. Workers who have an immune compromising medical condition or who are taking medications that impair the immune system (steroids, immunosuppressive drugs, or chemotherapy) are at higher risk for contracting a rodent disease. Wild rodents may act as carriers for viruses such as Hantavirus and lymphocytic choriomeningitis virus (LCMV) depending on where they were captured. Additionally, each rodent species may harbor their own range of bacterial diseases, such as tularemia and plague. These animals may also have biting insect vectors which can act as a potential carrier of disease (mouse to human transmission). Examples of zoonotic diseases that can be transmitted from wild and domesticated animals to humans are shown below:

Disease	Disease agent	Animals				
		Cats	Dogs	Birds	Farm Animals	Wild Animals
Brucellosis	*Brucella canis*		X			
Campylobacteriosis	*Campylobacter jejuni*	X	X		X	
Cat Scratch Fever	*Bartonella henselae*	X				
Cryptococcosis	*Cryptococcus neoformans* and other species			X		
Hemorrhagic fever with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS)	Hantavirus					X
Lymphocytic choriomeningitis	Lymphocytic choriomeningitis virus (LCMV)			X		
Pasteurella pneumonia	*Pasteurella haemolytica*				X	
Histoplasmosis	*Histoplasma capsulatum*			X		
Orf	Poxvirus				X	
Plague	*Yersinia pestis*					X
Q-fever	*Coxiella burnetii*				X	
Rabies	Rabies virus	X	X			
Salmonellosis	*Salmonella enterica* serovar Typhi				X	
Toxoplasmosis	*Toxoplasma gondii*	X				
Tularemia	*Tularemia francisella*					X

Zoonotic Diseases – Non-human Primates (e.g., monkeys)

Humans and non-human primates are susceptible to similar infectious agents. Because of our differences, the consequences of infection with the same agent often vary considerably. Infection may cause few if any symptoms in one group and may be lethal to the other. Exposures to body fluids from non-human primates should be treated immediately. In 2003, a report entitled, Occupational Safety and Health in the Care and Use of Non-Human Primates was published. This report covers topics relevant to facilities in which non-human primates are housed or where non-human primate blood or tissues are handled. The report describes the hazards associated with work involving nonhuman primates and discusses the components of a successful occupational health and safety program, including hazard identification, risk assessment and management, institutional management of workers after a suspected occupational exposure, applicable safety regulations, and personnel training. BASRC will ensure that workers are trained to adhere to the following good practices to prevent exposure to zoonotic diseases when working with research animals. Employees should adhere to the following:

- Avoid use of sharps whenever possible. Take extreme care when using a needle and syringe to inject research animals or when using sharps during necropsy procedures. Never remove, recap, bend, break, or clip used needles from disposable syringes and use safety engineered needles when practical.
- Take extra precautions when handling hoofed animals. Due to the physical hazards of weight and strength of the animal, large hoofed mammals pose additional concerns for workers. Hoofed mammals may resist handling and may require multiple workers to administer medication or perform other functions.
- Keep hands away from mouth, nose and eyes.
- Wear appropriate PPE (i.e., gloves, gowns, face protection) in all areas within the animal facility. A safety specialist may recommend additional precautions, based upon a risk assessment of the work performed.
- Wear tear-resistant gloves to prevent exposure by animal bites. Micro-tears in the gloves may compromise the protection they offer.
- Remove gloves and wash hands after handling animals or tissues derived from them and before leaving areas where animals are kept.
- Use mechanical pipetting devices (no mouth pipetting).
- Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take or apply medicine in areas where research animals are kept.
- Perform procedures carefully to reduce the possibility of creating splashes or aerosols.
- Contain operations that generate hazardous aerosols in BSCs or other ventilated enclosures, such as animal bedding dump stations.
- Wear eye protection.
- Wear head/hair covering to protect against sprays or splashes of potentially infectious fluids.
- Keep doors closed to rooms where research animals are kept.
- Clean all spills immediately.
- Report all incidents and equipment malfunctions to the supervisor.
- Promptly decontaminate work surfaces when procedures are completed and after surfaces are soiled by spills of animal material or waste.
- Properly dispose of animal waste and bedding.
- Workers should report all work-related injuries and illnesses to their supervisor immediately.
- Following a bite by an animal or other injury in which the wound may be contaminated, first aid should be initiated at the work site. Contaminated skin and wounds should be washed thoroughly with soap and water for 15 minutes. Contaminated eyes and mucous membranes should be irrigated for 15 minutes using normal saline or water.
- Consult an occupational health physician concerning wound care standard operating procedures (SOPs) for particular animal bites/scratches.

An OSHA Fact Sheet entitled Laboratory Safety – Working with Small Animals has been developed to supplement this section. This is available at the end of this manual.

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. BSCs protect laboratory workers and the immediate environment from infectious aerosols generated within the cabinet. BSCs must be certified when installed, whenever they are moved and at least annually.

An OSHA Fact Sheet entitled Laboratory Safety – Biosafety Cabinets (BSCs) has been developed to supplement this section. This is available at the end of this manual.

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, nonionizing radiation 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.

An OSHA Fact Sheet entitled Laboratory Safety – Ergonomics for the Prevention of Musculoskeletal Disorders in Laboratories has been developed to supplement this section. This is available at the end of this manual.

Ionizing Radiation
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. 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. Personnel monitoring devices (film badges, thermoluminescent dosimeters (TLD), pocket dosimeters, etc.) are supplied to all those

who work in the radiation section. It is important for employers to understand and follow all applicable regulations for the use of isotopes.

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.

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.

Safety Hazards

BASRC will assess tasks to identify potential worksite hazards and provide and ensure that workers use appropriate personal protective equipment (PPE). BASRC 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.

Autoclaves and Sterilizers

Workers will 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, BASRC will train workers to follow good work practices such as those outlined in the Fact Sheet.

An OSHA Fact Sheet entitled Laboratory Safety – Autoclaves/Sterilizers has been developed to supplement this section. This is available at the end of this manual.

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, BASRC will train workers to follow good work practices such as those outlined in the Fact Sheet highlighted below. BASRC will instruct workers that when centrifuging infectious materials, they should wait 10 minutes after the centrifuge rotor has stopped before opening the lid. Workers will 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.

An OSHA Fact Sheet entitled Laboratory Safety – Centrifuges has been developed to supplement this section. This is available at the end of this manual.

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 BASRC, compressed gases are supplied through 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. BASRC includes compressed gases in their inventory of chemicals in their Chemical Hygiene Plan. 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. The storage, handling, and use of compressed gases are in accordance with international standards.

- All cylinders whether empty or full are 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 used in BASRC. Although not a cryogen, solid carbon dioxide or dry ice which converts directly to carbon dioxide gas at -78°C (-109°F) are also used. 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 a 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.

BASRC will ensure that cryogenic safety hazards are minimized. This will entail:

- A safety analysis and review for all cryogenic facilities,
- Cryogenic safety and operational training for relevant workers
- Appropriate maintenance of cryogenic systems in their original working order, i.e., the condition in which the system was approved for use
- 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
- 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.

An OSHA Fact Sheet entitled Laboratory Safety – Cryogens and Dry Ice has been developed to supplement this section. This is available at the end of this manual.

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

- Unsafe work practices

BASRC employees are responsible for notifying the Supervisor of any faulty instrumentation or wiring. The following should be adhered to:

- Electrical equipment must be free from recognized hazards
- Listed or labeled equipment must be used or installed in accordance with any instructions included in the listing or labeling
- 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
- All electrical service near sources of water must be properly grounded
- Tag out and remove from service all damaged receptacles and portable electrical equipment
- Repair all damaged receptacles and portable electrical equipment before placing them back into service
- Workers are trained not to plug or unplug energized equipment when their hands are wet

An OSHA Fact Sheet entitled Laboratory Safety – Electrical Hazards has been developed to supplement this section. This is available at the end of this manual.

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).

BASRC will 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 the 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

- BASRC will ensure that workers are trained in the following emergency procedures and exercise the emergency plan.
- 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.
- Training will be provided on the use and type of the emergency equipment (extinguishers etc.). The two most common types of extinguishers in the chemistry laboratory are pressurized dry chemical (Type BC or ABC) and carbon dioxide. In addition, specialized Class D dry powder extinguishers for use on flammable metal fires will be provided. Water-filled extinguishers are not acceptable for laboratory use.

BASRC will 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

BASRC will 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 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.

This process is commonly referred to as the "Lockout/Tagout" procedure and 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. BASRC has developed Lockout/Tagout programs that are suitable for the center. This procedure 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 procedure, 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
- 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

The Lockout/Tagout procedure 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
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. BASRC have adopted such procedural solutions for controlling hazards to ensure worker safety during maintenance. However, such procedures are effective only if strictly enforced. Staff at BASRC must strictly follow and implement these 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, the following must be strictly adhered to:

- Keep floors clean and dry. 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
- 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
- All places of employment must be kept clean and orderly and in a sanitary condition
- Keep aisles and passageways clear and in good repair, with no obstruction across or in aisles that could create a hazard.
- Keep exits free from obstruction. Access to exits must remain clear of obstructions at all times
- 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.
- Workers must 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.
- Promote safe work practices
- Avoid awkward positions and use equipment that makes lifting easier.