جامعة الإمام عبد الرحمن بن فيصل
IMAM ABDULRAHMAN BIN FAISAL UNIVERSITY

College of Engineering

Laboratory Safety Manual

Prepared by

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1.0 Introduction

All laboratory procedures cover some elements of danger. Safe working conducts are needed in experimental work. Good housekeeping, using the right tools for the right jobs, avoiding hazards, keeping the lab area clean - all contribute to safe operation. Accidents should be reported as soon as possible to a Faculty member. Emergency service is available twenty four hours a day at the department of Security and safety of Imam Abdulrahman Bin Faisal University.

2.0 Scope

The present Laboratory Safety Manual describes policies, procedures, equipment, personal protective equipment, and work practices that are capable of protecting students and all users (including visitors) of Dry laboratories (Concrete, Fluid Mechanics, Thermodynamics, Unit operations, Soil Mechanics, Physics Labs etc.) at College of Engineering. This manual is applicable to students, teaching assistants, visitors, and any individual entering spaces assigned to labs. This manual covers field work / in-room experiment, handling testing equipment/tools, taking readings during/after lab session, storing materials, tools and equipment, performing basic maintenance tasks, and housekeeping.

2.1 General Safety Guidelines & Rules

The following guidelines have been established to minimize or eliminate hazards in the laboratory to maintain a safe laboratory environment. It is the responsibility of each person that enters into the laboratory to understand the safety and health hazards associated with potential hazardous materials and equipment in the laboratory. It is also the individual's responsibility to practice the following general safety guidelines at all times:

1. Never perform any hazardous work when alone in the laboratory. At least two people should be present. Undergraduate students must be supervised by an instructor at all times.
2. Never remove chemicals, biological agents, or radioactive materials from the facility without proper authorization.
3. Chemical fume hood sashes should be kept closed whenever possible. Maintain the minimum possible opening when working. Do not store chemicals in fume hoods
4. Eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are prohibited in areas where specimens are handled.
5. Food and drink should not be brought into, stored in or consumed in a laboratory.
6. Any Consumable/Eatables are not to be stored in refrigerators, freezers, cabinets, or on shelves, countertops, or bench tops where blood or other potentially infectious materials are stored or in other areas of possible contamination.

7. Confine long hair and loose clothing. Do not wear high-heeled shoes, open-toed shoes, sandals or shoes made of woven material.
8. Always wash hands and arms with soap and water before leaving the work area. This applies even if you have been wearing gloves and:
    a. After completion of work and before leaving the laboratory.
    b. After removing gloves.
    c. Before eating, drinking, applying cosmetics, changing contact lenses or using lavatory facilities.
    d. Before all other activities which entail hand contact with mucous membranes or breaks in the skin.
    e. Immediately after accidental skin contact with blood or other potentially infectious materials.
    f. Between patient contact and before invasive procedures.
9. Visitors to the laboratory must observe all safety regulations, including, but not limited, to the wearing of eye protection.
10. Smoking is prohibited in the College, and Labs.
11. Shoes that provide full coverage of the feet, and appropriate personal clothing should be worn in laboratories.
12. Appropriate eye protection should be worn, when using toxic chemicals or operating mechanical equipment.
13. Lab users should know the locations and operation of safety and emergency equipment such as fire.
14. Extinguishers, first aid kits, emergency eyewash stations and emergency showers, emergency power off, emergency telephones, and emergency exits.
15. Unauthorized person(s) will not be allowed in a laboratory. 'Authorized' students or any other individuals have to be under immediate and direct supervision of a qualified authorized person at all times.
16. Never open or remove the cover of any equipment in the laboratories. Furthermore, Laboratory should remain locked after regular office hours.
17. Report all problems to the lab supervisor and avoid misuse of equipment for purposes other than that for which they are intended.
18. Maintain dry conditions on the equipment and avoid spillage of water.
19. Do not handle the water without wearing gloves as there may be contamination.
20. Do not use wet hand when using electrical items like switches or plugs.
21. Do not physically contact any of the rotating components of the equipment.
22. Remove the unwanted items immediately. Loose clothes, books and note books should be kept outside.
23. All spilled liquids should be cleaned immediately.

24. Students should make themselves familiar with the experimental control system before you start using it.

It is the responsibility of everyone working in the laboratory to make certain that the laboratory is left clean after work is performed.

3.0 Responsibility

It is the responsibility of the faculty teaching the course to ensure that the procedures described in this document are implemented by the lab instructors.

3.1 Lab Instructor Responsibility

3.1.1 Duty of Instruction

This task involves providing adequate written instruction before the commencement of any laboratory activity that is accurate, appropriate to the situation, setting, and maturity of the audience. The instructor should address reasonably foreseeable dangers, identify and clarify any specific risk involved, explain proper procedures to be used, and present comments concerning appropriate/inappropriate conduct in the lab.

3.1.2 Duty of Supervision

This includes adequate supervision as defined by professional and regulatory guidelines to ensure students behave properly in light of any foreseeable dangers. It should be noted that misbehavior of any type will not be tolerated and failure to act properly will make the instructor liable. It is equally important to note that the greater the degree of danger, the higher the level of supervision that will be required and the younger the age of students or the greater the degree of inclusion of special population students, the greater the level of supervision required. Students should not be left unattended, except in an emergency where the potential harm is greater than the perceived risk to students. Even then, the risk should be minimized or responsibility transferred to another authorized person if the situation permits.

3.1.3 Duty of Maintenance

This duty includes ensuring a safe environment for students and teaching/research staff. The lab instructor should ensure that defective equipment are used for any reason and written reports for maintenance/correction of hazardous conditions or defective equipment with responsible administrators are properly filed. The lab instructor should as well establish regular inspection schedules and procedures for checking safety and first-aid equipment, and follow all safety guidelines concerning proper labeling, storage, and disposal of chemicals. By properly keeping records of all hazard notifications and maintenance inspections, the instructor's liability in the event

of an accident is tremendously minimized in cases where no corrective actions were subsequently made.

3.2 Students' Responsibility

The students are required to duly observe the '**SAFELAB**' etiquette.

- Supervision - never work in the lab without the supervision of a competent person.
- Attention - always pay attention to the work and do not fool around in the lab.
- Follow instructions - always perform experiments precisely as directed by the supervisor
- Emergency readiness - know what to do in the event of an emergency.
- Labeling – always check labels to verify substances before using them, and properly ensure that substance are labeled in containers before usage.
- Apparel - always wear appropriate protective equipment and apparel
- Brains - use your brain wisely - safety begins with you
- Responsible to read and understand the experiments before conducting them and to be aware of any activity is going to do in the laboratory (e.g. design etc.)
- Responsible use of equipment following the user manuals and instructor advice
- Responsible to follow the instructor instructions
- Responsible to leave the class only after warning the instructor
- Responsible to report any safety concern to the instructor
- Responsible to take care of the colleagues safety
- Responsible for cleaning the workplace after the experiment and switch off the equipment
- Responsible not to introduce any dangerous object, substance, and not to use food and drinks in the lab
- Responsible for storing in a safe place bags and other material in order to avoid dangers or difficulties during the Lab time or after
- Responsible to follow the safety procedures, manuals, related to the Laboratory and its devices
- Responsible for safe behavior (e.g. sitting only on chairs, maintain discipline and order etc.)

3.3 Safety Obligations

Prior to the students performing any activities in the laboratory, it is the responsibility of the lab instructor(s) to provide a copy of the lab manual to the students and concise safety guidance at the beginning of the semester. The lab instructor(s) should ensure that each student signs and dates this statement, after which he then collects the signed papers (document below) and keep them for the duration of the semester.

Students must read the below 'safety declaration' carefully before attempting any laboratory activities. The lab instructor(s) will describe each procedure and address any questions that students may have. The students should print their names, sign and date at the end of this document to prove that they have received the safety orientation and that they understood the procedures outlined in the safety orientation given by the instructor, as well the procedures in this document. The following statement should be signed.

I hereby declare that I have carefully read and understood the content of this **Lab Safety Procedure Statement** and that the lab instructor(s) has (have) clarified all the outlined procedures. By this, I agree to comply with the procedures listed in this statement.

Department:
Course Number:
Lab Instructor Name:
Date:
Student Name:
Signature:

3.4 Standard operating procedures (SOPs)

Standard operating procedures (SOPs) provide a detailed work practices in the lab. They are developed to provide guidance for the safe handling of hazardous materials. SOPs include but are not limited to procurement, distribution, storage, labelling, equipment usage, general lab practices, and disposal and emergency procedure practices for the particular chemical, work or hazard group. Information about each chemical can be obtained using the material safety data sheets (MSDS), hazard labelling uniform adopted by laboratory such as National Fire Protection (NFPA) labelling, Hazardous Martial Identification System (HMIS) or Right to Know (RTK) labelling uniform that provide the chemical name and probable hazards.

3.5 Eye Safety

1. Lab personnel should know where the nearest eye wash station is located and how to operate it.
2. Eyewashes should be flushed weekly and documented on eyewash tags.

3. Do not use contact lenses in the laboratory unless absolutely necessary. Vapours and chemicals can get trapped under the lens and make it impossible to remove the lens to rinse the eye. Severe eye damage can occur. If they are worn, the supervisor must be informed so that special precautions can be taken.
4. In the event of a chemical splash into an eye, it is often nearly impossible to remove the contact lens to irrigate the eye because of involuntary spasm of the eyelid
5. Eye goggles should be worn:
    a. When working with certain caustic reagents and/or solvents, or concentrated acids and bases.
    b. When performing procedures that are likely to generate droplets/aerosols of blood or other body fluid.
    c. When working with reagents under pressure.
    d. When working in close proximity to ultra-violet radiation (light).

3.6 Personal Protection

Personnel (faculty, students and technicians) must be aware of the types of protective equipment available and use the proper type for each job. Everyone, including visitors, must wear the appropriate eye protection where chemicals are stored or handled. Appropriate Personal Protective Equipment (PPE) should be used where indicated:

a. **Lab coats** or disposable aprons should be worn in the lab to protect from contamination.
b. **Lab footwear** should consist of normal closed shoes to protect all areas of the foot from possible puncture from sharp objects and/or broken glass and from contamination from corrosive reagents and/or infectious materials.
c. **Gloves** should be worn for handling chemicals, blood or other biohazards.
d. **Protective eyewear** and/or masks may need to be worn when contact with hazardous aerosols; caustic chemicals and/or reagents are anticipated.

3.7 Laboratory Housekeeping for Dry Labs

Good housekeeping practices can significantly reduce the risk of accidents and exposure to hazardous materials. Spills and accidents are more likely to occur in cluttered work spaces. Follow the good laboratory housekeeping guideline:

1. Lab areas (bench tops, hoods, etc.) are to be kept clean and uncluttered. This will help prevent spillage, breakage, personal injuries and unnecessary contact with chemicals.
2. Put away any clean glassware that is not being used. Avoid accumulating large amounts of dirty dishes on lab benches and by sinks. Clean them when your

experiment is done. Never leave glassware in the sink because it can easily break.

3. Regularly check glassware for star cracks, chips, or cracks, and promptly discard or repair any unsafe glassware.
4. Properly label chemical waste with specific contents. Keep label attached to the container at all times. Always replace old and deteriorated labels.
5. Keep chemical waste containers closed.
6. Any spills or accumulations of chemicals on work surfaces shall be removed as soon as possible with techniques that minimize residual surface contamination.
7. Floors and walkways should be maintained dry at all times.
8. Doorways and walkways shall not be blocked or used for storage.
9. Access to exits, emergency equipment, and utility controls shall never be blocked.

Remove any equipment or clutter that interferes with access to emergency equipment such as eyewash stations, safety showers, and fire extinguishers.

4.0 Laboratory Hazard Assessment

For Construction Engineering and other related labs, a three-step activity-based hazard assessment is followed.

4.1 Hazard Identification

This is to understand the nature of the potential hazard to meet in lab activities. For this purpose, an inventory of the lab work activities form is established. Hazard identification should begin with a walkthrough survey of the laboratory to develop a list of potential hazards. Things to look for during the walkthrough survey include:

- Sources of electricity.
- Sources of motion such as machines or processes where movement may exist that could result in an impact between personnel and equipment.
- Sources of high temperatures that could result in burns, eye injuries or fire.
- Types of chemicals used in the workplace.
- Sources of harmful dusts.
- Sources of light radiation, such as welding, brazing, cutting, furnaces, heat treating, high intensity lights, etc.
- The potential for falling or dropping objects.
- Sharp objects that could poke, cut, stab or puncture.
- Biologic hazards such as blood or other potentially infected material.

In future, inspection checklists, archived accident report forms, and past records may give a relevant feedback for the process of hazard identification.

Inventory of Lab Work Activities			
Workplace:		Date:	
Form No:	Process / Location	Work Activities	

Risk assessment - risk assessment involves examining and evaluating the likelihood and severity (or consequence) of the potential risks associated with each of the hazards identified during previous step in order to rank risks for control step. The scale for risk assessment and control is provided below:

- **Likelihood:** 5 – frequent, 4 – moderate, 3 – occasional, 2 – remote, 1 – unlikely.
- **Severity:** 1 – negligible, 2 – marginal, 3 – serious, 4 – very serious, 5 – critical
- **Risk Level:** 1 to 6 - Low, 7 to 10 - medium, 11 to 15 - warning, 16 and above is considered high.

Laboratory Activity Based Risk Assessment Form					
Workplace :		**Conducted by (name):**	**Sign:**		
Process / Location:			**Date:**		
Approved by Project Supervisor	..... Name, sign & Date	**Last review date:**		**Next review date:**	

Hazard Identification			Risk Evaluation				Risk Control					
Activity	Hazard	Risk involved	Existing Risk Control	Severity (S)	Likelihood (L)	Risk Level (L*S)	Additional Risk Control	Severity (S)	Likelihood (L)	Risk Level (L*S)	Follow-up by (name & date)	Remarks

4.2 Risk Control

This step provides a means by which risks can be systematically evaluated against a set of control options (the hierarchy of controls). The risk control considers ranked risks from the highest to the least weighty. The hierarchy of controls is as follows:

- Eliminate the hazard.

- Substitute with a lesser hazard.
- Use engineering controls to reduce hazard.
- Administrative controls such as workplace procedures.
- Personal Protective Equipment.

4.3 Review of Risk Management

Through review step, risk management is kept current and effective, as new hazards and those overlooked in the original process are identified and controlled. Monitoring and review involves the systematic re-implementation of the original safety program steps of hazard identification, risk assessment and risk control.

5. Safety Rules for Dry Laboratory

5.1 Dress Guidelines

Apparel in the laboratory should conform to the following guidelines:

- Always wear appropriate eye protection (i.e., chemical splash goggles) in the laboratory.
- Wear disposable gloves, as provided in the laboratory, when handling hazardous materials. Remove the gloves before exiting the laboratory.
- Wear a full-length, long-sleeved laboratory coat or chemical-resistant apron.
- Wear shoes that adequately cover the whole foot; low-heeled shoes with non-slip soles are preferable. Do not wear sandals, open-toed shoes, open-backed shoes, or high-heeled shoes in the laboratory.
- Avoid wearing shirts exposing the torso, shorts, or short skirts; long pants that completely cover the legs are preferable.
- Secure long hair and loose clothing (especially loose long sleeves, neckties, or scarves) to avoid contact with flames or chemicals.
- Remove jewelry (especially dangling jewelry).
- Synthetic fingernails are not recommended in the laboratory; they are made of extremely flammable polymers that can burn to completion and are not easily extinguished.

5.2 Electrical safety in the Laboratory

5.2.1 Preventing Electrical Hazards

It is a good practice to ensure that all personal equipment (e.g. laptops) are tested and tagged as well

- Switch off all electrical equipment when not in use.
- Do not attempt to do any electrical repairs or investigations - refer your problem to the appropriate qualified staff.

- If equipment is to be left on for a specific reason, then a '**leave on**' sign should be displayed, with name and date.
- All equipment should undergo regular electrical testing.
- Report to the lab instructor any items dysfunction for appropriate action to be undertaken.
- Since the MRI Lab uses high voltage magnets it is recommended that expecting mothers as well as people with cardiac peacemakers must keep a distance of at least 1 m from the magnet.

5.2.2 Safety Precautions and Procedures Related to Electrical & Laser Equipment

- Never short the terminal on a power supply, battery, or other voltage source unless instructed to do so.
- Be sure to use wire leads and patch cords that have sufficient insulation when creating electrical circuits.
- Avoid using high current (greater than 75mA) in any application for which high current is not prescribed.
- Never test battery voltage and capacity using anything other than a voltage sensor or voltmeter.
- The experiments on the Medical Laser can be conducted only under the supervision of a qualified person.
- Before any operation, the student must have read and understood the user Manual of the Laser KIT and Laser Diode and have read the instructions for the experiments.
- For all the duration of the experiment, everybody inside the Lab must wear the safety glasses, compliant to the wavelength and power of the laser, and the access to the lab is forbidden. The students must stay distant from the experiment KIT when the laser diode is switched ON.
- The dresses and all the objects used must be not reflecting.
- Always work with the supervision of a qualified person.
- For low power lasers used in the Optic Labs, don't look into the laser or stare at bright mirror-like reflections of the beam (for the laser used in the Medical Laser Lab is instead mandatory to use the safety glasses compliant to the wavelength and power of the laser.
- Wear not reflecting dresses and remove all bright mirror-like objects from the work area, including rings, watches, metal bands and tools. Beam reflections can be nearly as intense as the original beam.
- Block off the beam at a point beyond the farthest point of interest. Use a dull, non-reflective object, such as a piece of wood.
- If the beam must travel a long distance, keep it directed close to the ground or overhead so it does not cross walkways at eye level.
- Never use magnifiers such as binoculars or telescopes to look at the beam as it travels or when it strikes a surface.
- Never allow unauthorized people to handle lasers; store them in a safe place away from unauthorized users.

- Never point a laser at anyone, no matter how far away.
- Make sure the laser is always secured on a solid foundation. Keep power cords and adapters away from areas where they can be accidentally disturbed.
- Helium-neon lasers employ high voltages. The power supply retains potentially harmful voltage for periods after the input power has ceased. Never open the housing and expose anyone to these voltages.
- Always read and understand the user manual and the lab sheets, especially the safety aspects, before starting the experiments.
- Since optics and laser kits contain glass pieces, it is important to remember that they can present a cutting hazard. Please handle them carefully and make sure that you don't contact any edges that might cut you.

5.2.3 Water-Related Safety Precautions and Procedures

- Keep water away from electrical outlets.
- Keep water away from all electronic equipment.
- If water is boiled for an experiment involving heat, make sure it is never left unattended. Remember, too, that the hot plate will stay hot well after it is unplugged or turned off.

5.3 Security and Safety of Computing Resources

5.3.1 Security

Computers in the lab are secured using a combination of physical and software-based method to ensure the safety and security of our students, faculty, staff, and equipment and computer network.

- Restriction of computer access: To prevent unauthorized use of computing resources.
- Physical security: Equipment is placed in a manner to limit access to physical ports on the CPU.
- Prevention of installation of malicious software: In addition to the standard anti-virus and anti-spyware clients installed on each computer, all lab computers are further protected either through group policy, security software, or a combination of the two to prevent malicious software from being installed and executed. As a further security measure, all campus computers require a unique, authorized login for authentication before granting network access.

The following conducts regarding copyright laws must be obeyed:

- Copying Software – Unauthorized copying of licensed software from the lab hard disks is a violation of copyright laws.
- Saving Files – Anything saved on the computer hard drive will be deleted. Data files created in the lab should be saved directly on a storage media.

- Unauthorized modification for data and information - Changing data and information related to software or hardware configurations in the computers is prohibited.
- Any misinformation, accuracy of data and their reintegration and compatibility in the computers is prohibited.
- The unauthorized access to systems, programs or database through the illegal use of the username or the password is prohibited.
- Changing Hardware and Software Configurations – Changing hardware and software configurations in the computers is prohibited. This includes modifications of the settings, configurations of printers and modification of system software.
- Periodic maintenance should be ensured by the college/university IT department to minimize the risk of outage of the main computers or the outage of programs, systems that serve the most important processes or services offered by the college. Also the outage of the service and loosing data information due to floods, fires, earthquakes, or destruction of the information center should be part of action plan of the college/university.
- Theft of servers and storage devices should be avoided at all cost through ensuring proper entry/exit mechanism and following strictly the guideline provided by the university security agency.
- The risk of power outage, water leakage and outage of air-conditioning should be avoided at all cost through proper and regular maintenance by the university assigned authority.

The college must develop procedures and policies for information security in accordance with international standards and the best practices such as (ISO27000) which develop procedures and policies of access.

5.3.2 Safe Use & Ergonomics

To escape aching muscles and tired eyes while working at a desk or a computer, try the following:

- Lab users should check their postures
- Taking short breaks regularly – try the exercises on the next page.
- Adjusting the chair height so that the arms are approximately parallel with the floor.
- If the front of the chair is causing pressure on the back of your thighs or behind your knees, readjust the chair.
- Adjust the chair backrest to support the lower back while you sit in the typing posture
- Locate the computer screen approximately one full arm's length away and position it so that your line of sight to the screen is slightly below horizontal.

- As muscles get tired from holding the keying posture, they need to relax regularly during the day. Two to three minute breaks are recommended every 15-20 minutes.
- A total of 4 hours (not including breaks) of intensive keyboard work is the maximum time recommended each day.

5.4 Compressors and Compressed Air Safety Procedures

- The compressors should be equipped with pressure-relief valves and pressure gauges.
- Only clean air should be allowed to enter the compressor by installing air filters on the compressor intake.
- The safety devices on compressed air system should be checked regularly.
- Proper lubrication should be provided as per manufacturer recommendations.
- The compressor pressure system should be locked out before any repair work is done.
- Signs to be posted on compressor's automatic starting feature.
- Belt drive system should be enclosed from all sides.
- The direction of the compressed air system should be towards the intended used.
- The compressed air over 29 Psi usage for cleaning purposes is not recommended unless appropriate arrangement is being made i.e. approved nozzle with pressure relief and clip guard & Personal protective equipment.
- High pressure hoses and connections need to be checked regularly and repaired if needed.
- The pressure limits of empty liquid container should be checked before use of compressed air.
- The movement of combustible dust which may cause fire or explosion is prohibited by compressed air.
- Approved plastic pipe should be used for compressed airline services as some of the PVC pipes are not recommended. ABS pipes are more appropriate.

5.5 Hand Tools and Equipment

- All the tools and equipment should be maintained in proper working conditions
- Broken hand tools must be replaced promptly.
- While the hand tools are used safety glasses, face shields should be used because it might produce flying material.

5.6 Personal Protective Equipment (PPE)

- The workplace hazards must be assessed that requires PPE.
- The assessment should be documented. The documentation must identify the evaluated workplace.

- Training is required for all employees who are required to wear PPE and the record for the training must be documented.
- Safety glasses should be worn at all times in areas where there is a risk of eye injury.

5.7 Flammable and combustible materials safety measures

- The combustible and flammable material like petrol, diesel should be properly stored.
- Combustible scrap, waste and debris need to be removed immediately.
- Proper ventilation arrangement is necessary for the place storage place of combustible materials.
- Vacuuming should be used instead of weeping combustible dust.
- Fuel gas cylinders and oxygen cylinders should be at proper distance and fire-resistant barriers.
- Proper fire extinguishers for different class of combustible materials need to be provided and placed in areas where they are required.
- Proper signs and poster needs to be displaced near flammable and combustible materials.

5.8 Floor and wall openings safety measures

- All floor holes or openings should be guarded by a cover.
- Glass windows, doors and glass walls should be appropriate for the intended load impact.
- Grates over floor openings such as floor drains designed so that the grate spacing will not catch foot or other rolling equipment.

5.9 Hearing conservation safety measures

- Areas where sounds level exceeds 85 dBA must be identified.
- It is recommended to isolate the noisy machinery from the rest of the operations.
- Engineering controls over excessive noise should be the first priority, otherwise administrative controls must be used to reduce employee and student exposures to noise.
- Hearing protective equipment must be used in place where noise level goes beyond 90 dB.
- All the concerned persons exposed to continuous noise must be trained properly to avoid the negative consequences.

5.10 Piping systems safety measures

- The piping system should be tagged properly when non portable water is piped through it to alert the students that the water is not safe for personal use.
- Proper piping system must be used where the purpose is to supply the steam in the laboratory like in humidifier.

- Inlet and outlet valves should be closed for the water supply pipes after usage.

5.11 Welding, cutting and brazing safety procedures and guidelines

- Trained persons should be allowed only to use welding, cutting, milling and brazing equipment in the workshop.
- Cylinders should be placed away from the heat source.
- Proper sign should be placed on the empty and filled cylinders used for welding purposes.
- The electrodes should be removed from holder when not in use and similarly the electricity supply should be switched off.
- Proper ventilation is necessary where welding or cutting is performed.
- Eye protection helmets, hand shields and goggles is important while working welding.

6.0 Safety Policy Communication

Safety instructions, guidelines should be communicated through different media e.g. posters, signs, flyers, and manuals. Lab safety signs and posters should be displayed in the main entrances and inside of all labs in strategic locations.

6.1 Signboards

The following safety information should be provided in a posted signage:

- Exits
- Fire Extinguishers
- Eye Washes
- Chemical and supply storage areas (including the NFPA diamond)
- Gas Lines
- Specific depositories (e.g. bio-hazardous waste, glass, chemical, garbage)
- Distinguish between potable, non-potable, and deionized water sources
- Diagram of the classroom that includes the location of items listed above
- Emergency plan and phone numbers

Safety signs and signals to be used should include
Prohibiting signs in round shape complying to ISO 7010 standards

- **MANDATORY SIGNS**

- **WARNING SIGNS IN TRIANGULAR SHAPES INCLUDING**

- **EMERGENCY ESCAPE OR FIRST-AID SIGNS (RECTANGULAR OR SQUARE SHAPE)**

- **FIRE-FIGHTING SIGNS**

6.2 Safety Posters

It is the means by which safety standards are kept currently remembered in adequate locations and workplaces. They are posted permanently in the lobbies of labs and during awareness campaign and similar events (safety training).

6.3 Labeling – Tagging

Lab instructor should ensure labels are clearly provided for all chemicals (including soap), first aid/biohazard/chemical spill kits and lab supplies. Tag out should be provided for all ongoing testing operations and all locked energized machines and tools.

7.0 Emergency Prevention - Preparedness - Response

7.1 Approaches for Emergency Management

This section describes how institution will meet its responsibilities to prepare for laboratory-related emergencies. The closed-loop process of emergency management consists of:

- Events driven phases
    - Prepare
    - Respond
    - Recover
- Event independent phase : mitigation/prevention

7.2 Emergency Equipment and Facilities

Emergency equipment and facilities includes:

- Emergency Telephones and Posted Telephone Numbers
- Showers and Eyewash Stations
- Chemical Spill Control Equipment
- Fire Alarm System
- Fire Extinguishers
- Fire Blankets
- First Aid Kit

7.2.1 Emergency Telephones and Posted Telephone Numbers

Every lab should have a clearly marked phone with emergency telephone numbers listed next to it. If there is no phone in the lab, there must be an alternative written plan for contacting emergency or other personnel. This alternative plan must be clearly posted in the laboratory. Specific telephone numbers to be posted are indicated above.

7.2.2 Using the Fire Extinguisher

Portable extinguishers must be present in all laboratories, chemical storage and preparation areas.

In the event that a fire extinguisher is used, the following four steps should be duly taken '**PASS**':

- **Pull** the pin out on the extinguisher.
- **Aim** the extinguisher at the base of the fire.
- **Squeeze** the nozzle to release extinguishing material.

Type	Effective Against	Do Not Use On
Water	**Class A fires**: burning paper, wood, coal, rubber, textiles	Electrical, liquid or metal fires
Carbon Dioxide	**Class B fires**: petroleum hydrocarbons (flammable solvents, motor oil, grease)	Metal fires (including lithium aluminum hydride)
Dry Powder or Dry Chemical	**Class C fires**: burning liquids, large quantities of flammable solvents, electrical fires	Metal fires, fires involving delicate instruments
Met-L-X and other **Class D** extinguishers with special granular formations	**Class D fires**: burning metal (e.g. lithium, magnesium, potassium, sodium, alloys of reactive metals, metal hydrides, metal alkyls, and other organometallics)	Paper, trash, liquid, electrical fires
Halon Substitute fire extinguishing	**Class A**, **B**, and **C** fires	**Class D** fires

In the event that a fire extinguisher is used, the following four steps should be duly taken '**PASS**':

- **Pull** the pin out on the extinguisher.
- **Aim** the extinguisher at the base of the fire.
- **Squeeze** the nozzle to release extinguishing material.
- **Sweep**: Use a back and forth sweeping motion.

SAFETY GUIDELINES RELATED TO WET LABORATORIES

8.0 Introduction

Imam Abdulrahman Bin Faisal University (IAU) is devoted to render a secure and wholesome work and study environment for all employees, students, contractors and visitors. IAU shall continuously venture to tackle realistic and acceptable initiative to curb and reduce the likelihood of bruises, health pitfall regarding any workforce and viable detrition to stuffs. IAU shall also endeavor proactive steps towards the restoration and safeguarding of the habitat. The main motto of this blueprint is to foster safety apprehension and embolden safe operational exercises in the workshop. Allocated constraints would succor as a cue of things you can do to work more securely and are related to all workforce of the workshop

In order to achieve this commitment, IAU shall:

- Fortify that all factors including health, well-being and habitat prescription are in accordance with the points mentioned in the guidelines.
- Allocate the pertinent structure and set up a federation accountable to supervise health, protection and environmental affairs and assess them for regular up gradation.
- Pioneer and systematize unbroken agenda to pinpoint and control all menace at the university premises.
- Assure that all amenity, gadgetry and instruments rendered are safeguarded at every moment.
- There should be a regular conversation with all the staffs, employees, students, contractors and visitors regarding Health, Safety and Environmental topics.
- Set up contingency blueprint to oversee any crisis that may evolve.
- IAU needs all its staffs, contractors and students to strictly abide to these regulations at all moments.

8.1 Safety Doctrine

Constraints on laboratory security and chemical use are articulated based on prior occurring in laboratories, elementary chemical understanding, the characteristics of discrete chemicals, and general knowledge. Safety blueprints were formulated in many affairs in response to definite commotion of laboratory and chemical misuse. In addition, Health & Safety Managerial has furnished blueprints under both "the Control of Substances Hazard to Health (COSHH)". Moreover the "Occupational safety and Hygiene Association (OSHA)" These blueprints includes all chemical managing and use in a workplace. They are imperative and they cover to all chemical regulation and users. Regardless of blueprints and staff regulation, the chief authority for well-being pertains with the single entity. An accountable, attentive operator with complete knowledge of the functioning of the laboratory, its apparatus, elementary

chemistry, basic understanding, and an insight for self-conservation will have trivial problems with laboratory and chemical blueprints or chemical security. The personnel cannot administer working all the time. Under these circumstances, any heedless operator can risk his or her own as well as other's security. Chunk of snag, event and neglect in the laboratory are the result of rapidity. Hurry, however, leads to splurge, as the old quotation quotes. Performing under such shape, you can dissipate your samples, waste time and money, get dirty results, crack things, and risk yourself and others by being negligent. If there is lack of time to do things precisely and securely, with ample time for idea, it is advised to remain apart from the laboratory.

All research staffs are presumed to obey to safety guidelines and perpetuate safety quality demanded in a university facility where direct staff monitoring is not feasible.

8.2 Safety Guidelines for Wet Laboratories

Acquaint yourself with the suitable precautionary steps when exposed to the mentioned sections of hazardous entities. i.e. Combustible, Caustic, Noxious, Carcinogen, Compressed Gases Poisons Separate solvents or chemicals by affinity cluster for storage. Spill additional intensive solutions into little intensive solutions to keep away from vicious response (i.e. mix acid to water, not water to acid). Keep away from disturbing other worker. Use device just for its assigned sense. Deploy & affix devices used for chemical reactions in order to authorize its formatting or customization instead of its relocation during the reaction process. Immunity of health and safety of staffs during working hours is a legitimate necessity for all pertaining to Health and Safety Executive Ordinance. Acquaint yourself with the safety rules and strictly abide to these laws. Spilling out of chemicals or any sort of flying species is probable at any time in a workspace. Eye protection should be worn in the laboratory all every time. Safety glasses, Goggles, and Safety Visors are readily present in the labs. It is advised to choose the one most suitable for your requirement or need. Following are the few General Guidelines for the Safety While working in Wet labs.

8.2.1 Personal Safety & Hygiene

- Regularly use extricated aqueous stalls for chemical process.
- Always wear secure specs at regular times in the laboratory.
- Always wear laboratory apron in the laboratory.
- Suitable gloves or mitten should be worn as required.
- Suitable shoes should be worn in the laboratory.
- Try to wear breathing mask as and when required.
- Only trained staffs may use breathing devices.
- Washing of hands prior to the leaving of laboratory is a mandatory task.
- Never mouth swallows anything in a pipette in the laboratory.
- No food or drink is permitted in laboratories or sections where chemicals are kept

- No food should be eaten or kept in a laboratory refrigerator.
- Avoid eating or drinking from the laboratory glassware.
- Keep exposed skin shielded in the laboratory.

8.2.2 Fire Prevention

- Acquaint yourself of burning spots or points in the laboratory and service areas (open flames, heat, and electrical equipment).
- Purchase chemicals in exact amount that won't be exhausted or misused.
- Always keep combustible solutions in suitable pockets or cabinets.
- Do not keep incompatible solutions or chemicals at one place (for e.g., any kind of acids with organic solvents).
- Avoid placing of ethers or alike solvents or chemicals for larger span of time as it may lead to formation of explosive peroxides.
- Always put a proper Date on chemicals or solvents bottles when received and opened for use.
- Make certain that all electrical cords are in nice status and all electrical exits are earthed.
- Keep a distance from the spot of a fire or casualties if you are not in position to help or support.
- Try to acquaint yourself with placing and conditioning of fire extinguishers. Ruptured seals imply that fire extinguisher has been used and needs to be refilled.
- Avoid the use of fire extinguishers until & unless you are well-trained and feel sure to use them well.

8.2.3 Laboratory Housekeeping for Wet Labs

Remove safety risks by supervising the laboratory work areas in a good condition and keep neat steps to the laboratory outlet.

- A regular basis try to keep bench tops, extracted wet benches, floors and passages clear of unwanted material.
- Mop down bench tops and other laboratory surfaces after regular usage.
- The entire device should be inspected or scrutinized prior to its use.
- If experiments are left incomplete or unattended, put a note or a proper symbol beside its experimental device showing the chemicals used and potential hazards and operator name and a number where it can be pointed in case of any casualties or emergency.
- Keep the laboratory passages or aisles dehumidified at all times. Pin point to slippery spots or spills at once and make other ware of such pitfalls so as to avoid potential slipping risks.
- Only trained & designated staffs should do maintenance work on laboratory devices.

- The points or sink traps should be flushed or cleaned with water on priority basis to intercept the evolving of indecent smells of chemicals or solvents in the laboratory.
- All compressed gas cylinders should be safely fastened or secured with a chain to a rack or a suitable spot.
- Take empty cylinders to the empty cylinder point for collection.

8.2.4 Emergency Processes

It is advised to acquaint ourselves with the location, use & restrictions of the summed down safety equipment's or gadgets. e.g Eye Wash Station, Breathing Apparatus, Spill Cleanup Materials, First Aid Kit, Fire Alarm, Fire Extinguisher. Furthermore the following point should be kept in mind.

- Cleanse up every small spills instantaneously. If the observed spill is humongous and is presumed to lead to a major risk to others in the laboratory, immediately finish the process or device if practicable, and summon some expert for support.
- If in any case evaporative, combustible, or noxious solvent spills off, close down flames and spark-emanating devices immediately and leave the workspace and summon one of the expert staff for support who can deal with such situation.
- In the matter of fire or flares, summon some expert for help & support.
- Keep a clear track to all safety devices at every times.

8.2.5 Personal Protective Items

a) The laboratory Coat is fabricated to save the clothing and skin from chemicals that might be spilled or splashed. It is advised to wear laboratory coat in the chemistry laboratory every time.

b) An apron renders a substitute to the lab coat. It is generally made of plastic or rubber to save the worker or operator from abrasive or etching solvents. An apron should be worn over the clothes which envelope the arms and body, just similar to a laboratory coat mentioned above. It is mandatory you preserve & store the protective clothing in nice status. Untidy and disfigured clothing should be cleaned and rectified. Untidy protective clothing is a risk in itself.

c) Try to wear protective gloves all the times in the laboratory especially when chemicals are being used. As specific glove types are not water-repellant in contact with chemicals, so it is advised to choose the gloves on the basis of the material being used & the related hazard which may be involved. Prior to the use of chemicals, be very sure about the gloves that they are in suitable position and exempted from perforation, ruptures, and cuts. Glove manufacturer/supplier and the Material Safety Data Sheets (MSDS) acknowledging product in use are good origins of specific glove selecting

data. A little tips for the choosing of right kind of gloves, Like for example PVC saves us from mild corrosives and etchants, Latex gives light safety from irritants and narrow safety from Contagious sources. Natural Rubber saves us from tender abrasive material and electric shock. Neoprene rubber is suitable for working with solvents, oils, or tender abrasive material. Cotton soaks moisture, keeps objects tidy and lead to a narrow flare. Retardant properties. Thermal gloves should only be preferred when handling small hot materials.

d) Certain laboratory operations can lead to poisonous odor and hazards. It generally occurs when engineering mastery cannot successfully reduce or eradicate the dominant unfavorable fumes. Various people have unalike responsiveness when exposed to some specific chemicals, in this condition one might attain a breathing problem. The two variety of protection present, a Respiratory mask or Breathing apparatus. Respiratory masks are elementary in use and are present with filters for distinct hazards. In workshop work these are majority believable to be a custom option. Companies like VWR International, Aldrich and RS catalogues give specific details for the choosing of acceptable respiratory mask and filters suitable for certain hazardous filth. Respiratory device is moderately more complex kits and not trouble free to use in a laboratory atmosphere. These are usually used in tough conditions. Only trained professionals are permitted to use them.

8.2.6 Foot Protection

Foot protection is fabricated to avert tear from abrasive chemicals, bulk things, electrical shock, as well as giving friction on aqueous passages. It is advised to wear strong shoes that will cover the foot in a broader way. It will provide the best safety. Avoid shoes that soak feet in any of the condition.

9.0 General Laboratory Equipment Safety

Casualties encompassing glassware are a major sign of laboratory bruises. These can be stopped or prevented by adopting basic elementary steps. Generally, assure that you have attained suitable directive prior to the use of glass devices meant for specific procedures that includes rare hazards or major risks. Here is some of the safety regulation listed below:

- Manage and keep glassware in a careful manner to avoid its breakage.
- Save your hands using a heavy glove or towel.
- Oil tubing or stopper with water or soap solution and make sure that the outside ends of the glass tubing are fire-polished.
- Bear hands near jointly to restrict motion of glass to avoid rupture.
- Replace plastic fixtures for glass wherever required to descend the harm of tear.

- Use glassware for void work that is fabricated for that requirement. When dealing with ruptured glass wear hand safety when selecting up the pieces. Utilize a broom to mop undersized slices into a dustpan and keep glass slices in a fabricated bin for rupture glass.
- Heating Equipment's: Electrical devices which bestow heat in laboratories incorporate: Hotplates, Tube & Box Furnaces Heating Mantles, Hot-Air Guns, Oil Baths. Inappropriate use of any one of these could lead in flare or blaze to the operator. Prior using any heating equipment we should do these steps.
- Inspect to identify if the unit has an automatic safety shutdown in case of overheating.
- Jot down the status of electrical cords and have them substituted as needed.
- Be sure the equipment has been preserved as needed by the manufacturer.
- Scan to note that every warming section in use depriving automatic shut-off have been closed prior evacuating a fixed location for any larger duration of time.
- Flare catching solvents or chemicals should be avoided in a heated bath or should be kept adjacent to the bath. Oil baths should inevitably be placed in a safe chemical fume hood or section.
- Apprise yourself with the processes of the vacuum system which is in use. (Note if operator is not aware with the operations & working of Rotary, Diaphragm, Diffusion or Turbo Pumps, it is advised to learn about these in advance). Inappropriate use may give rise to risks or casualties, lethal deterioration of pump, chunk of the amount would be spent in restoration or mending of the pump in addition it may lead to the hindrance or obstruction in the project activity.
- Be assured about the service cord and switch are independent of noticeable flaws and attainable in situation of crisis.
- Consistently use a trap on the suction line to stop liquids from being drawn into the pump.
- Suppose gases or vapors are being drawn through the pump, in this particular case a cold trap must be used in the suction line to avoid contamination of the pump oil.
- Keep a tray under the pump to seize any oil drips.
- A lot of devices are available for operations and analytical work. Majority of these are hard to handle and even fragile in nature. Every piece of device is under the charge of a staff member and or an authorized member mainly lab technicians. That authorized member will educate users on that specific device. After the rigorous training if he/she is contempt, the user will be entitled to run the specific device with no further assistance. These kinds of approach to a specific device or its thorough training are believed as a crucial part of the learning system. Every device certainly possesses sets of rules and operational techniques that are pre-decided by the staff to make sure about the working and safe operation of the device. Any kind of neglect of these rules or

careless in the operation may lead to damage of that specific device, & down-time and even substantial expenditure.

- It is advised to make yourself acquainted with the first aid and emergency steps to prevent any adversity that can be abruptly contained. It is the task of the injured person to report immediately about the injury or property harm to the concerned authority or personnel (names and phone numbers to be filled) Departmental Safety Officer. Required forms and instructions are present with the authorized safety officer's office. It is mandatory to call the College Health Centre (South Side) and make them aware about your injury prior visiting the concerned center for any kind of material help.
- Clean area with the help of appropriate water as required. For Tiny slit and abrade keep sterile pad on the wound and spread mild pressure uniformly with the reverse hand. Suppose direct mild pressure is not able to control bleeding, increase the area above the level of the heart. Smear dressing plaster required. If in any case, there is a lot of noticeable bleeding which cannot be controlled keep sterile pad on the wound spot and apply mild pressure and immediately call the Health Centre (South Side) for support and further assistance.
- First or primary level burns are basically indicated by redness or patching of the exposed skin section, gentle bulge and slight soreness in that area or spot. The problems can be served by flushing or submerging in water for a minimum of 10 minutes and coding an antiseptic cream as required, and taking appropriate medical treatment as required. In the second case, namely Second and third degree burns are signified by red or petrified skin with high bulge white (second degree) or intense blacken skin (third degree). The Prompt first aid should be to cleanse the exposed spot if feasible or applicable and place it dry and call Health Centre (South Side) for medical support & assistance on priority basis.
- Chemical Burns: If harmful chemicals come into contact with skin or eyes, follow the instruction mentioned below.
- Skin: Remove garments as needed and flush the exposed spot with major quantities of water for a minimum of 15 minutes (sink, shower, or hose).
- Do not apply burn ointments/spray directly to affected spots. Call the Health Centre (names and phone numbers to be filled) for medical support & assistance without hold-up.
- Eyes: Flush section of eyes, eyelids, and face rigorously with tepid water for a minimum of 15 minutes at the eye wash station and call the Health Centre (South Side) for support & assistance without hold-up.

10.0 Laboratory Endangerment

Risks or **Endangerment** in the working place drop into three specific sections:

10.0.1 Device or Equipment

A broad array of device is used for various actions. Variety of the device is subtle, fragile and priceless. Prior to the starting of any device all its operational technicalities & safety suggestion should be thoroughly studied. Ill-use of device can lead to bruise obstruction in project work and notable price in maintenance invoice. Acquaint yourself with all spheres of safety & security prior to the start of any device. We should be attentive to all kinds of unsecure conditions of the devices, procedures & movements, and pay heed to them so that rectification may be applied before the start of any casualties. Jot down the storage conditions of all the chemicals used in the lab and abide to them.

10.0.2 Gases

A lot of compressed gases are pre-owned, quiet of which may be noxious, mordant, combustible, or eruptive. These risks have been reduced by the use of genuine device, appropriate durance, ventilation, secure valves, etc., and too by the proper measurable steering of devices. A proper understanding of secure managing of the compressed gases should be learnt prior to start of any devices which are operated by the help of these gases otherwise a slight mistake may lead to big casualties or even disasters.

10.0.3 Chemicals

Solvents or solutions in the form **of** Acids, bases, are generally used in analytical chemistry and equipment modelling or manufacturing. A chunk of these are "hands on" risk that is cumbersome to monitor by engineering monitors only. Solvents which are used may lead to excessive burns or flares, rupture cells or tissues, organ cleavage, unconsciousness & genetic destruction if used in an unprofessional way. All the safety points should be read before the use of these solvents or acids. Any kind of corrupt practices may lead to paramount accidents or fires. The solvents or acids which look simple by their appearance are not so easy to handle if used in an unprofessional way. The following points must be considered while handling chemicals.

- Mark all the storage pockets, place & keep all the solvents or acids in an appropriate marked pots or containers.
- Explicitly put an exact date on all the chemical containers mentioning the in & out starting from the purchased date & also the unlocking date.
- Please mention the expiry dates on all chemical containers.

11.0 Laboratory Safety Devices

11.0.1 Fume hoods

Fume hoods seizes, hold, and exude discharge triggered by harmful chemicals or chemical processes. All laboratory processes with chemicals must be performed in

extracted wet bench. As it is feasible to foresee the ejaculation of unwanted or harmful waste in most laboratory processes, rare things can occur most of the times. Hence, the extracted wet bench provides an additional computation of safety. Fume hood should not be used for long-lived chemical storage.

11.0.2 Chemical Storage Cabinets

Storage of flammable and corrosive chemicals in the lab should be restricted to small dosage as for as feasible. Flammable materials should be kept in combustible material storage cabinets. Storage outside of the cabinet should be restricted to materials used in the prevalent operation and should be removed following use to the suitable storage shelf. Abandoning chemicals on benches or working spot is riskier and is not feasible. Plastic shelf are fabricated for abrasion resilience and used for keeping solution and other abrasive materials. Acids and other abrasive chemicals or solutions are kept under fume hoods in the chemistry laboratory.

11.0.3 Refrigerators

To obstruct major safety risks, the amount or volume of storage of chemicals or solutions should be stored to a low level and refrigerators should be scrutinized on a regular basis.

11.0.4 Eyewash Stations

A bowl-mounted eyewash junction, that gives regular water flow along a plumbed part, is present in the chemistry laboratory and is approachable to every laboratory staffs. Always flush the eyewash line before use. Eye wash solutions are readily present in every laboratory. Specifically Water or eyewash solutions should not be straight focused on the eyelids, should be focused at the downward portion of the nose section. It will elevate the probability of capable flushing the eyes section without the involvement of chemicals (erratic streams of water might further escalate particles into the eyes section). In any case we are wearing contact lenses we need to take them out sooner, to flush eyes without the aid of any unsafe chemicals.

11.0.5 Biological Safety Cabinets (BSCs)

Properly maintained BSCs, when used in addition with the use of suitable microbiological processes, give a nice & suitable storage system for secure interpretation of impartial and high-risk infectious agents [Biosafety Level 2 (BSL 2) and 3 (BSL 3) agents]. BSCs protect laboratory workers and the immediate environment from virulent small particulate matter like aerosols or PM evolved inside the cabinet.

11.0.6 Chemical Hazards

All chemicals have some high or low level of hazard coupled to their use and it is significant prior any work is initiated that a careful scrutinee is made into the nature and the reaction of the chemicals in use to decide whether an unsafe situation could evolve. The aim is to safeguard people against the hazards to their health whether promptly or in delay mode. If the evaluation designates a hazard, then the stipulated hazard must be removed or monitored and the essential supervision must be exactly used and efficiently monitored.

12.0 COSHH Requirement

Control of Substances Hazardous to Health (COSHH), applies to a wide range of substances and preparations (mixtures of two or more substances) which have the potential to cause harm to health if they are ingested, inhaled, or are absorbed by, or come into contact with, the skin, or other body membranes. Hazardous substances can occur in many forms, including solids, liquids, vapors, gases and fumes. They can also be simple asphyxiants or biological agents. No operation or activity should be performed out that exposes a concerned person to any substance hazardous to health until & unless a proper and sufficient scrutinee of the hazards created by that work and of the steps needed to conform or match the COSHH requirements. To match with the COSHH requisite all work must be safeguarded by hazard evaluation. Hazard evaluation should be completed by the operator performing the work and approved by the mentor who will decide the course of activity suitable to the analysis prior to the work extension. People carrying out evaluation should jot down the risks linked with chemicals which can be grouped under the general listings:

1. Toxicity
2. Flammability
3. Explosibility
4. Biological effect, Dust & Generally offensive

The basic step to initiate is when endorsing chemicals is to chalk out as much as its feasibility regarding the associated or linked chemicals and the possible wastes from renowned links. The entire legal obligation regarding chemicals risk can be obtained from the suppliers who are selling these chemicals or they are liable to inform the purchasers regarding all the risks linked with the chemicals. When a new product is brought if its information is not present the decision must be implemented in foreseeing if a product will be risk free or risky. The risk associated with the chemicals is always not inevitable. Furthermore, dust also is a substance hazardous to health under COSHH when it is present at concentrations in the air equal to or greater than 10 mg/m^3 (as a time-weighted average over an eight-hour period) of inhalable dust or 4 mg/m^3 (as a time-weighted average over an eight-hour period) of respirable dust. All personal provisions regarding safety & risk like the wearing of gloves, eye protection, and other antidote needs must be readily present for use.

13.0 Precautions

Almost all hazardous properties of chemicals are largely affected by the size and the and dose and therefore it is necessary, to be aware of the exposure limits commonly called Threshold Limit Value (TLV). It is a guide considered as being without hazard in a person's normal working. For a number of chemicals another exposure limit is introduced which is called Short Term Exposure Limit (STEL) and is defined as the maximal concentration to which a worker can be exposed for a period up to 15 minutes continuously without suffering from Irritation, Chronic or irreversible tissue change or Narcosis of sufficient degree to increase accident proneness, impair self-rescue or materially reduce work efficiency. No more than four periods of this concentration in a day are permitted. Occupational exposure limits (TLV*)* for chemicals are recorded in safety data sheets. Consult the relevant safety data sheet for guidance. If there is a potential risk then consideration should be given to how the risk can be eliminated or reduced to meet approved standards.

13.1 Safe Working Precautions

- Wear Protective Clothing apron/coat, Safety Goggles, Chemical Resistant Gloves, breathing mask.
- Use only extracted wet bench for chemical work
- Avoid contact of chemicals with Skin, Eyes or Clothing.
- Do not breath vapor.
- Keep containers tightly closed.
- Wash thoroughly after handling chemicals and before leaving laboratory
- In case of any mishap seek medical advice as appropriate.

13.2 First Aid Measures

- In an instance of contact rinse pretentious area proximately with enough water while eliminating dirty clothing etc.
- If inhaled move to fresh air, if there is trouble in breathing give non-natural inhalation or oxygen.
- If swallowed rinse out mouth with more amount of water provided the person is sensible.
- Pull out and rinse polluted clothe with water. Pursue medical assistance as apposite.

13.3 Handling of Compressed Air and Gases

- Flattened air and gases must be treated with importance. These simple principles will help to curtail any hazard of any occurrence.
- Cylinders are usually of solid drawn steel and must be treated with attention. They should not be exposed to shocks, falls, or unnecessary heating.

- Cylinders must permanently be stored vertical. Grease and oil should not be permitted to come in contact with the cylinders. All cylinders must be treated as if full.
- Cylinder valves should be opened slowly.
- Improvised tools must not be used for this purpose.
- Gas cylinders should be use with two stage regulator i.e. with two gauges on the regulator, one displaying cylinder pressure and the other outlet regulated pressure. Regulators should be used for gases for which they are proposed and marked. Keep regulators in good shape and maintained order.
- When connecting a regulator to a cylinder it is important that regulator connecting threads are bring into line accurately. If threads are uneven and forced to thread in it is possible to damage the regulator or cylinder head or both seriously.
- Sometimes leaks may happen between the regulator and cylinder. If a valve seat is leaking which is rare, a temporary measure is to attach a regulator to it and seek help from the concerned safety people. If a gas is flammable the cylinder should be immediately relocated to a safe place (open area), taking care to avoid possible sources of explosion.
- Leaking cylinder must not be left on its own. If the leak is between cylinder valve and the regulator, which is most common, close the cylinder valve and attend to the connection between regulator and the cylinder valve. Ask for assistance as proper.
- Connecting hoses must be of sound creation and of accepted standard for the working pressure.

13.4 Handling & Precautions Related to Liquefied Gases

- Usage of liquefied gases must be considered more risky than handling of liquid and solid materials. It is essential to know the hazardous properties of liquefied gases such as flammability, toxicity chemical activity and corrosive effects. All efforts should be put to learn various properties before the gas is fixed to use.
- Liquefied gases has exceptional properties like pressure, high diffusion, low flash points (for flammable gases), low boiling points and in certain cases no visual and/or odor detection.
- Leakage from the systems and inappropriate use of pressure controls may lead to hazard
- Diffusion of leaky gases may affect rapid contamination of atmosphere, giving rise to toxicity, anesthetic effects, suffocation and quick formation of explosive concentrations of flammable gases.
- Flammable gas under pressure has flash point always lower than the ambient therefore leaking gas can rapidly form an explosive mixture with air.

- Materials with low boiling point can cause frostbite on interaction with living tissue. This is common among the cryogenic liquids, such as liquid nitrogen, liquid oxygen and liquid air etc.
- Some other effects of liquefied gases are like to hazards found with other chemicals e.g. corrosion, irritancy, and high reactivity.
- The measures implemented for the safe handling of liquefied gases are mainly focused on control of material to prevent its escape to the atmosphere and appropriate control of pressure and flow.
- For the controlled removal of the liquefied gas a manual valve is used. Always remember that the withdrawal of liquid must certainly be done at the vapour pressure of the material. Slightly decline of pressure will result in flashing of all or part of the liquid to gas phase, hence leaking gas can quickly form an explosive mixture with the air.
- Rapid exclusion of a gas from liquefied gas cylinder may make the liquid to cool to rapidly causing the pressure and flow to drop the necessary level. In such cases cylinders (lecture bottles) may be kept in water bath to avoid drop in temperature of the cylinder
- By working in well ventilated areas hazards of toxic, flammable and corrosive gases can be minimized
- Leaks should not be allowed to go unchecked.

Leaks develop in cylinders should be treated as follows:

- Cylinder valve packing leaks can usually be adjusted by tightening the valve packing nut. Clockwise for acidic gases and anti-clockwise for basic gases observed from the above. If leak continue inform the supplier instantly. Take out the cylinder to a hood or place where the leakage cannot cause damage until the contents can be safely dealt with.
- On unusual circumstances emergency action may be compulsory in order to move a leaking cylinder to a location where it can vent safely.
- Cylinder are occasionally not equipped with hand wheel In the case of specialty gases, in order to open and close valves it require special cylinder key or wrenches to effect operation.
- A valve packnut comprises packing gland, packing around stem and it should not be altered. It may be tighten up if a leak is observed.
- A valve outlet is for connection to pressure or flow regulating apparatus. Use only supplier or manufacturer's suggested gas regulating equipment.
- Water hose connections to the taps and the equipment and the condensers in reflux or distillation set up must be safeguarded with hose clips which can resist variation of water pressure.

14.0 Safety Data Sheets

- All laboratories should maintain MSDS for chemicals supplied by the manufacturer, distributor, or importer and it must be readily accessible to laboratory workers
- MSDSs are written or printed materials regarding a hazardous chemical. Employers must have an MSDS in the place of work for each hazardous chemical in use.
- MSDS sheets must comprise: 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.

15.0 Physical Hazards

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. It is recommended that university provide the information to laboratory workers contained in the new OSHA fact sheet highlighted below.

15.0.1 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.

Radiation Hazard Symbol

15.0.2 Non-ionizing Radiation

Non-ionizing radiation is defined as a series of energy waves composed of oscillating electric and magnetic fields traveling at the speed of light. Nonionizing radiation comprises 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 significant 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.

15.0.3 Extremely Low Frequency Radiation (ELF)

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

15.0.4 Radiofrequency and Microwave Radiation

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

15.0.5 Infrared Radiation (IR)

The skin and eyes absorb infrared radiation (IR) as heat. Employees generally notice excessive exposure through heat sensation and pain. Sources of IR radiation are heat lamps and IR lasers.

15.0.6 Visible Light Radiation

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

15.0.7 Ultraviolet Radiation (UV)

Ultraviolet radiation (UV) has a high photon energy range and is mostly dangerous because there are usually no instant symptoms of excessive exposure. Sources of UV radiation in the laboratory include black lights and UV lasers.

15.1 Laser Hazards

LASER is an abbreviation which stands for Light Amplification by Stimulated Emission of Radiation. Lasers characteristically release optical (UV, visible light, IR) radiations and are mainly an eye and skin hazard. Common lasers include CO2 IR laser; helium - neon, neodymium YAG, and ruby visible lasers, and the Nitrogen UV laser. The laser produces an strong, 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 increase following absorption of laser energy. The human body is susceptible to the output of certain lasers, and in certain conditions, 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. Now it is widely accepted that the human eye is almost always more susceptible to injury than human skin.

15.2 Noise Hazards

Employers require 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 as per OSHA's Occupational Noise Exposure standard, 29 CFR 1910.95 In addition, when workers are exposed to noise levels ≥ 85 dBA, the employer must develop a monitoring program to evaluate noise levels. The monitoring program must contain the following components:

a) All continuous, intermittent, and impulsive sound levels from 80-130 dBA must be included in noise measurements.
b) Instruments used to measure employee noise exposure must be calibrated to ensure measurement accuracy.
c) Monitoring should be repeated whenever there is a change in production, process, equipment, or controls increases noise exposures.

The college must conduct a noise exposure assessment using an approved sound level monitoring device, such as a dosimeter, and measuring an 8-hour TWA exposure in order to determine if the noise levels in the laboratory are above the threshold level that damages hearing. If the noise levels are found to surpass the threshold level, the employer must provide hearing protection at no cost to the employees and train them in the proper use of the protectors. The potential risks of miscommunicating directions or laboratory results are obvious, and efforts must be made to improve the design of clinical laboratories and to evaluate new instrumentation with respect to the impact of these factors on employee noise exposure. The university should relocate the equipment to another area or using engineering controls to decrease the noise level below an 8-hour TWA of 85 dBA in order to fulfill with OSHA's Occupational Noise Exposure standard. Continuous Exposure to noise may lead to the following stress-related symptoms:

- Depression
- Irritability
- Decreased concentration in the workplace
- Reduced efficiency and decreased productivity
- Noise-induced hearing loss
- Tinnitus (i.e., ringing in the ears) and
- Increased errors in laboratory work.
- Hypertension

Noise can be minimized in the laboratory by following several steps such as

- Moving noise –producing equipment's
- Locating compressors for controlled-temperature rooms remotely; and
- Providing acoustical treatment on ceilings and walls.

16.0 Responsibility of Laboratory Supervisors

- Have complete accountability for chemical hygiene in the laboratory.
- Ensure that laboratory employees know and follow the chemical hygiene guidelines.
- Make sure that the protective equipment is available and in working condition
- Ensure that appropriate training has been provided.
- Provide regular, formal chemical hygiene and housekeeping inspections, with routine inspections of emergency equipment.
- Knowledge of the current legal requirements concerning regulated substances.
- Determine the required levels of personal protective equipment (PPE).
- Make sure that the facilities and training for use of any material being ordered is adequate.

17.0 Responsibility of Laboratory Staff

- Plan and conduct each process in accordance with the facility's chemical hygiene procedures, including use of PPE "i.e. gloves, goggles, etc." and engineering controls," i.e. Chemical Fume Hoods and Biological Safety Cabinets (BSCs)". as appropriate.
- Develop decent personal chemical hygiene habits.
- Report all accidents and potential chemical exposures instantly.

18.0 Chemical Hygiene Plan (CHP)

The aim of the CHP is to issue the guidelines for prudent practices and measures for the use of chemicals in the laboratory. Ensure that the CHP set forth procedures, equipment, PPE, provision for handling hazardous chemicals requires by the laboratory is protecting the workers from health hazards.

The following information must be included in each CHP:

18.0.1 Standard Operating Procedures (SOPs)

Laboratory safety practices must be followed when working with chemicals in a laboratory. These include general and laboratory-specific procedures for work with hazardous chemicals. SOPs are recommended for all procedures that pose a potential risk to the health and safety of personnel.

18.0.2 Criteria for Exposure Control Measures

Standards used by the employer to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of PPE and hygiene practices.

18.0.3 Adequacy and Proper Working of Fume Hoods and other Protective Equipment

Precise measures that must be taken to ensure proper and adequate performance of protective equipment, such as fume hoods.

18.0.4 Information and Training

Information and training must provide by the employer in order to ensure that workers are explained of the hazards of chemicals in their work zones and related information.

18.0.5 Requirement of Prior Approval of Laboratory Procedures

The conditions under which some of the laboratory procedures or experiments require approval from the employer or employer's designee before work is began.

18.0.6 Medical Consultations and Examinations

Provisions for medical consultation and checkup when contact to a hazardous chemical has or may have taken place.

18.0.7 Chemical Hygiene Officer Designation

Identification of the laboratory CHO and summary of his or her role and responsibilities; and, where suitable, formation of a Chemical Hygiene Committee.

18.0.8 Particularly Hazardous Substances

Outlines extra employee protections for work with mainly hazardous substances. These include select carcinogens, reproductive toxins, and materials which have a high degree of acute toxicity.

DECLARATION

Before you sign the declaration please make sure you have understood all aspects of laboratory and chemical safety and you are confident enough to use equipment and chemicals.

I have read the safety guide and familiarized myself with the laboratory, equipment and chemical safety issues and have acquired all the know-how and the necessary training for safe working in the laboratory. I shall adhere to all safety guideline and safe working practices during my laboratory work as explained to me during the orientation session and the COSHH assessment.

Name ---------- Signature ---------- Date ----------

THIS MANUAL IS EFFECTIVE FROM _____, 20___. PERIODIC INSPECTION SHOULD BE CONDUCTED AT THE BEGINNING OF EVERY SEMESTER WITH A MAJOR INSPECTION SCHEDULES FOR EVERY TWO YEARS.

Signed: …… Date: ……

College Safety Officer

Signed: …… Date: ……

Dr. Muhammad Saleem

Head Committee on Safety and Security

Signed: …… Date: ……

Prof. Omer Aga

Vice Dean for Quality & Strategic Planning

Signed: …… Date: ……

Dr. Othman Subhi D. Alshamrani

Dean, College of Engineering

Health Hazard	Flame	Exclamation Mark
		
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder	**Corrosion**	**Exploding Bomb**
		
• Gases Under Pressure	• Skin Corrosion/ Burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle	**Environment** (Non-Mandatory)	**Skull and Crossbones**
		
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

NFPA Labeling Guide

Health Hazard	
4	Very short exposure could cause death or serious residual injury even though prompt medical attention was given.
3	Short exposure could cause serious temporary or residual injury even though prompt medical attention was given.
2	Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical attention is given.
1	Exposure could cause irritation but only minor residual injury even if no treatment is given.
0	Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.

Flammability	
4	Will rapidly or completely vaporize at normal pressure and temperature, or is readily dispersed in air and will burn readily.
3	Liquids and solids that can be ignited under almost all ambient conditions.
2	Must be moderately heated or exposed to relatively high temperature before ignition can occur.
1	Must be preheated before ignition can occur.
0	Materials that will not burn.

Instability	
4	Readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3	Capable of detonation or explosive reaction, but requires a strong initiating source or must be heated under confinement before initiation, or reacts explosively with water.
2	Normally unstable and readily undergo violent decomposition but do not detonate. Also: may react violently with water or may form potentially explosive mixtures with water
1	Normally stable, but can become unstable at elevated temperatures and pressures or may react with water with some release of energy, but not violently.
0	Normally stable, even under fire exposure conditions, and are not reactive with water.

Special Hazards	
This section is used to denote special hazards. There are only two NFPA 704 **approved** symbols:	
OX	This denotes an oxidizer, a chemical which can greatly increase the rate of combustion/fire
W	Unusual reactivity with water. This indicates a potential hazard using water to fight a fire involving this material.

Figure (1)

Fig (2)

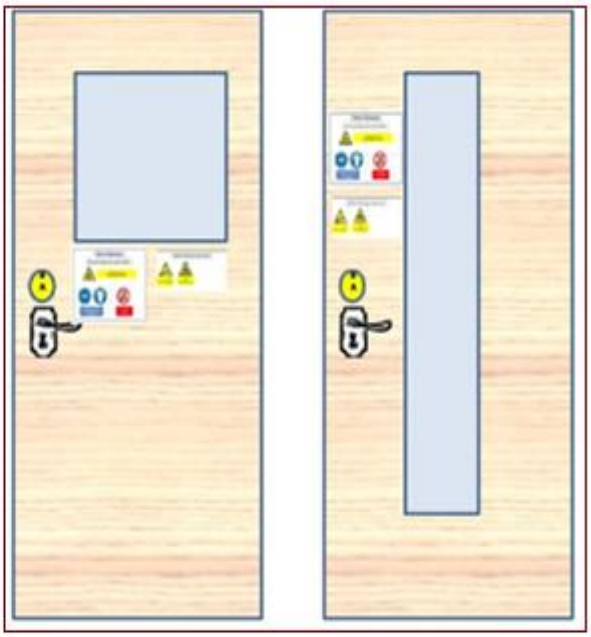

Fig (3)

Illustration Depicting Safety Gear for Students, Safety Signage on Chemicals and Lab Safety Labeling

REFERENCES:

- Laboratory Safety Guidance, Occupational Safety & Health Administration U.S. Department of Labor, Osha 3404-11r 2011.
- Laboratory & Chemical Safety Guide, Optical & Semiconductors Devices Group Department of Electrical & Electronics Engineering, Imperial College.