Second Version 1437 AH/2016

Rector's Message

Praise is to Allah who made this country the home of revelation, the source of the message, and that it was blessed with a leadership that provided all the potentials to serve this religion, community building and providing all people needs. Furthermore, one of the most fascinating things provided by our civilization is the cognitive values that helped establishing the perfection in settling the ground for the foundations of education, and encouraging the spreading of education where the observer of the university finds it under constant developing in all aspects. One of the most prominent aspects of development that the university is going through is the establishment of the Vice-Rector Office, in which great importance it represents in shaping, following up and controlling the developing system of university environment, in order to achieve the goals that the university seeks.

Watching this growing Vice-Rector Office achieving a number of accomplishments and successes in what developmental projects it carried out in the area of the university environment, gives us a great pleasure. The Vice-Rector Office has blessing efforts in order to promote the university and provide its different needs. This version has shown the bright aspects of developmental roles that Vice-Rector Office leads, which in spite of the short time since its establishment, but they are valuable efforts indicating great work.

In this occasion, praise is to Allah that guide us all to achieve these successes, which were not possible without the Almighty's precedence, and thanks go to the great support that university receives from the Custodian of the Two Holy Mosques King Salman bin Abdulaziz, - may Allah protect him - and under the guidance and follow-up of His Excellency the Minister of Education, and the cooperation of the citizens of the employees of the university to be in the right way and to achieve its achievements in all fields. Wish you the best of luck.

The Rector of Majmaah University

Dr. Khalid Sa'ad Al-Mugren

Vice-Rector's Message

All praise is to Allah who taught man what he never knew, and peace be upon the leader of teachers, our prophet Mohammad.

The unlimited support that the University receives from rulers- May Allah bless them - and from the Ministry of Education and from the Rector – May Allah protect him- that motivate us to achieve the highest international standards of quality for all the university components by providing outstanding university service leading to create a competitive outcomes that fit the desired overall development plans.

As the Vice Rector office holds the management of university environment development in all fields. Thus, its performance starts from scientific grounds and global experiments in practicing its developmental role for university environment, and on sustained basis.

Since the development of the university environment is the main concern of the Vice-Rector Office and all departments in all majors, so the Vice-Rector Office adopted the highest international standards relating to the development of university environments, where these criteria are directed to its developmental activities, which enabled it with collaboration with the various departments of the university to provide excellent academic service, to develop an educational environment that encourages creativity and stimulates excellence, based on processes that take advantage of the experiences of the most prestigious academic establishments at home and abroad in all the tasks and functions assigned to them.

One of the first areas handled by Vice-Rector Office in the process of developing the university environment field is safety and occupational health at the university, in which the human element occupies a large role in the future of universities and the impact on the quality and efficiency to achieve university facilities for its objectives assigned to them.

On the basis of this importance and in line with the direction of Vice-Rector Office in excellence, which stems from universities policies in this regard, Vice-Rector Office, represented by University Environment and Occupational Health Department, issued this handbook related to safety and occupational health in the university environment at Majmaa University. So the Vice-Rector Office hopes

All praise first is to Allah who facilated this task, then thanks go to the University rector for his constant support to Vice-Rector Office to promote the university environment In light of unlimited support that university receives from the Custodian of the Two Holy Mosques King Salman bin Abdulaziz, Crown Prince and Deputy Crown Prince.

Vice-Rector

Dr. Mosallam bin Mohammad Al-Dosari

Introduction

Majmaa University is characterized by being multispecies and forms of educational and research environment. As the university environment contains different sources of risk in degree and quality, may cause harmful traces on the environment and public health in the internal and external environment of the university, which requires action to reduce these risks and to achieve a safe and supportive campus environment for excellence and creativity. The need to develop safety and occupational health management system in the university environment handbook at Majmaa University has emerged. This handbook defines responsibilities and duties, and the mechanism to deal with what may be suffered by workers in the university environment.

Department of university occupational and environmental health in the Vice-Rector Office is pleased by esteemed University leadership confidence by taking the preparation of this handbook, which sets a key framework for the system of safety and occupational health management in in the work place, in order to achieve the responsibility of the regular university to protect its employees who they may be subjected to risk during the performance of the work assigned to them, as well as to attain a high level of safety and occupational health in the university environment.

This guide emphasizes the need to know in advance hazard sources and the necessary procedures taken to reduce them, and the necessary procedures to deal with incidents that may occur in laboratories environment.

Department of university occupational and environmental health in the Vice-Rector Office, provides the second version of this handbook to be pleased with the participation of all members of the university community through

sending their developmental notes and suggestions for this version to the Department's email: *enviro@mu.edu.sa* to be able to develop and improve the third edition of this handbook.

The Director of the Department

Mr. Abdelelah bin Abdullah Al-Mutairi

Handbook for Safety and Occupational Health in the Work Environment

Prepared by:

Occupational Health and Safety Expert

Abdul ilah bin Abdullah Al-Mutairi

(Second Edition (1438 AH

Important notice:

The materials -information- contained in this handbook have been compiled from sources believed to be reliable and to represent the best opinions on the subject. This handbook is intended to serve only as a starting point for good practices and does not purport to specify minimal legal standards, thus, this handbook is intended to provide basic guidelines for safe practices. Therefore, it cannot be assumed that all necessary warning and precautionary measures are contained in this handbook and that other or additional information or measures may not be required. Users of this handbook should consult additional sources of safety information prior to undertaking specific tasks.

Chapter One
The Culture of Safety and Occupational Health in the Work Environment

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1-1 Introduction

Majmaah University, by the year 2020, which is consistent with the transformation plan of our dear country, puts a top priority to maintain the safety and health of the human element with different categories (faculty members, staff, students and visitors), and to achieve a safe and supportive for excellence work environment. So the university adopted a management system that includes instructions that comply with the regulations approved by the relevant authorities and benefit from international experiences in this field. So, the university has adopted a practical plan that achieves the parallel development of the application of the highest safety and occupational health standards within the university facilities. University employees or visitors have an overall responsibility for safety and occupational health to achieve the desired goals.

The university's keenness to disseminate the culture of safety and occupational health in the society is by promoting behaviors and precautionary basic habits, thus, safety is an integral part of all the activities and processes that occur within its facilities, as ethical, occupational and practical considerations regardless of being primarily legal and regulatory requirements. Thus, most accidents can be avoided by taking the proper precautionary measures and the use of appropriate personal protective means backed by adequate inspection and reporting practices, and guided by occupational health and safety policy of the university and procedures of occupational health and safety management system. As a part of this culture, all members of the university, faculty, staff and students should understand the importance of reducing the dangers of exposure to hazardous

substances in laboratories as well as the danger of the wrong deal with accidents and injuries that occur in the laboratories.

1-2: The Culture of Safety and Occupational Health in the Work Environment

The definition of safety culture shows that Occupational health and safety culture is the collective commitment of the organization members in various categories and levels because Occupational health and safety is a top priority to achieve the objectives and to ensure the protection of people and the environment. Since the culture of the university is the result of achieving a number of elements that can be customized in attitudes, behaviors, values, beliefs and ways of doing business and a number of properties that are shared by individuals.

Since the safety and occupational health is a positive value in case of being achieved in any organization, it prevents injuries, saves lives and improves productivity and outputs. When practicing safety effectively and regarding it as an important fundamental value by officials of different levels, it gives a sense of confidence and concern for all staff of the organization.

The safety and occupational health culture is well-established among the members of the working environment community as a result of proliferation of the concept of participation, cooperation and clarity of values and effectiveness leading to effective occupational health and safety management system in the work environment which achieves the aspirations of the employees of the university, and an evidence for success of the adopted plans and policies. To

achieve the proliferation of occupational health and safety culture in the work environment the following must be achieved:

1. Top management commitment. 2. Comprehensiveness of risk management plans. 3. Clarity of tasks and responsibilities. 4. Self and institutional censorship. 5. Continuous development. 6. Keeping away from punishment and ensuring motivation and positivity 7.Communication easiness.

In other words, a well- established occupational health and safety culture in the work environment is a result of:

1. Positive attitudes in the work environment by all university employees, visitors and customers. 2. Cooperation of all university employees to address any shortcomings or reduce the sources of danger.

3. Adopting achievable and measurable goals for Occupational Health and Safety. 4. Clarity of policies and procedures, and providing advisory services. 5. Providing training programs for all employees of the university. 6. Clarity of responsibilities and tasks of all employees of the university.

The poor performance of the management of any university system in the occupational health and safety issues can be resulted from a number of structural and organizational factors at the university, such as the faculty members, managers, supervisors, employees or students who are not aware of their tasks and duties in the occupational health and safety management system. As well as it may also lie in the cultural aspects since working safely and preventing accidents may not be a fundamental value in the systems and operations of the university,

leading to an atmosphere of non-compliance with the practices of safe operation, the poor communication on topics of occupational health and safety, and the failure to take effective action to address occupational health and safety problems.

In addition to the pursuit of the university to carry out its responsibilities to adhere to rules and regulations issued by the competent authorities in the Kingdom of Saudi Arabia, which included many of the rules and regulations for safety in laboratories and other work environments, as well as controls of the proper disposal of hazardous waste, including medical waste generated from carried out operations and activities, Therefore, the university adopted an application of an international occupational health and safety management system (OHSAS 18001) to help it performing its obligations relating to safety and occupational health in an efficient and effective way, and to support the achievement of many goals: 1. To reduce or prevent risks for employees of the university and any other individuals may be exposed to risks of safety and occupational health related to work activities. 2. To apply, evaluate and improve safety and occupational health management system constantly. 3. To ensure Safety and Occupational Health Management System Compatibility with safety and occupational health policy of the university.

For example, one company which one of its employees subjected to a serious accident, the investigations carried out after the accident showed that some minor incidents leading up to the occurrence of this incident, however, the competent administration has not been informed, and no measures have been

taken to control the source of danger that can prevent or limit accidents. From a practical point of view, it can be said that there was a lack of communication about Occupational health and safety issues.

The university is aware that the most important success factors of Safety and Occupational Health Management system depends on clearly defined attitudes of teamwork and personal responsibility and occupational health and safety in the work environment is not simply a matter of materials and equipment but also of processes, behaviors and participatory learning in the culture of risk assessment, experiment planning, and consideration of worst-case possibilities—for oneself and one's fellow workers. Accordingly, a crucial component of Safety and Occupational Health Management system in the work environment is to nurture basic attitudes and habits of prudent behavior so that safety is a valued and inseparable part of all laboratory activities. In this way, a culture of the work environment safety becomes an internalized attitude, not just an external expectation driven by institutional rules.

1-3 Safety and Occupational Health Management in the Work Environment:

To implement a safety and occupational health management system in the work environment, it is required to provide rules and requirements for mandatory safety, ongoing training, awareness and assessment programs, the commitment of the university members therein and the university employees' adoption of a well-established culture of safety and occupational health is a crucial element to ensure a safe laboratory environment. Safety and occupational health management is a good system if it is not ignored by the senior management, so it will be dealt with intermittently by the university workers.

The top management at the university, which ensures an effective security system, which is complied with and adopted by all university members is the

key to building a highly efficient safety and occupational health management system, though leaders are role models for the rest of the employees of the university to comply with the requirements and rules of safety and occupational health.

Whereas the safety and occupational health is an educational requirement at the first place, which makes it imperative to sequence responsibilities and duties clearly from the Rector to the deans, then the heads of departments and finally to all the members of the department.

All members of the General Department of University Safety and Security and the Department of occupational and environmental health have an overall and direct responsibility for the application of safety and occupational health management system in the work environment. However, the responsibility to work and comply with the requirements and rules of occupational health and safety rests with all university staff and visitors. The Vice-Rectors, deans, departments' heads and faculty members bear a responsibility to promote safety and occupational health among students as well as teaching them the necessary skills to deal with the work environment and its contents of the materials and equipment with high-risk nature.

The way of personal example (role model that is emulated) is the best way to promote safety and occupational health culture among members of the university community.

1-4 Tips for Encouraging Safety and Occupational Health Culture in the Work Environment

1- Make a topic of occupational health and safety an item on every group meeting agenda.

2- Periodically review the results of work environment inspections for occupational health and safety procedures with the entire group.

3- Encourage students and department employees to contact the Department of Occupational and Environmental Health office if they have a question about safe methods of handling hazardous chemicals.

4- Require that all accidents and incidents, even those that seem minor, are reported so that the cause can be identified.

5- Review new experimental procedures with students and department employees and discuss all safety concerns.

6- Make sure the safety rules within the work environment (e.g., putting on eye protection at the door).

7- **Recognize and reward students and staff for attention to occupational health and safety in the laboratory**.

Table (1): Clarification of Safety and Occupational Health Culture Process with Examples and Behaviors

System	Example	Behavior
Initializing the application of safety an occupational health management system.	**Rewards and motivation programs**	**Demonstrating safe working practices.**
Document of Occupational Health an Safety Policy and procedures.	**continuous improvement**	**Active participation in occupational health and safety issues.**
Commitment by using safe accomplish metho for work	**Reporting and monitoring specified requirements**	**Leading the bottom- top.**
Determining the responsibilities and duties of each function of the Occupational Health and Safety.	**Accountability and integrating it into the Performance Evaluation**	**Commitment and continuity.**
Performance Measurement.	**Effective Leadership**	**Preparing reports on the potential sources of danger.**
Internal reporting processes.	**Awareness and education programs**	**Taking responsibility for personal safety.**
Data collection and analysis of trends.	**Risk Management Approach**	**Review and improvement processes.**

Occupational Health and Safety in the Work Environment

Adopting an effective occupational health and safety culture in the work environment and through leadership, communication and training by using systems, examples and behaviors

Commitment to work through:

Consultation, partnership and benefiting from feedback; It is the way to accomplish work.

Top

- Assessing appropriateness of facilities and Occupational health and safety as much as productivity and financial results.
- Ensuring clarity of responsibilities and tasks in Occupational health and safety management system.
- Effective and continuous communication to the concerns of workers for Occupational health and safety.

Deans and Heads

- Occupational health and safety guarantee is one of the pillars of business planning.
- Demonstrating commitment to occupational health and safety through adherence to procedures and guidelines.
- Managing risks through adherence to occupational health and safety management system effectively.
- Identifying sources of risk and taking proactive precautionary measures

Students, Administrators,

- **Ensuring compliance with the requirements of Occupational health and safety in the work environment.**
- **commitment to report any observations affect Occupational health and safety.**
- **Working with the management in determining the Occupational health and safety problems at work environme and proposing solutions.**

They need to:

- Understand the tasks and responsibilities in Occupational health and safety management system.
- Improve Occupational health and safety level in the work environment by all levels of employees of the organization.
- Adhere to the deployment of Occupational health and safety culture in the work environment, and to be part of the performance of our daily lives.

This is our approach in performing our business constantly

Chapter Two

Occupational Health and Safety Management System in the Work Environment

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2-1 Introduction

Majmaa University takes over extreme importance for the implementation of high standards for occupational health and safety management system in the work environment, as it deals with key aspects of its other activities. High standards, that ensure a safe work environment, require a systematic approach to identify hazards, to assess and control risks associated with the work and to take proactive and preventive highly efficient procedures. So in this chapter aims at improving occupational health and safety management system performance at work environment and strengthening the concept of integration between the different parties inside or outside the university.

Many of the features of the safety and occupational health management system matching the administrative practices advocated quality assurance and excellence in work, so the health and safety risks are controlled effectively in a systematic way.

The university work environment is featured by multiplicity of the contents of the educational and physical environment and the diversity of its materials and equipment which vary in the degree of gravity resulting from their use in different processes or risk resulting from the nature of the materials and equipment. Thus the need to establish the safety and occupational health management system shows reduces or prevents the risks to staff or any other individuals who may be exposed to the risk of safety and occupational health related to work activities. Implementing maintenance and improving safety and occupational health management system consistently make sure that it is compatible with safety and occupational health management system policy adopted by the competent authorities. To ensure the quality of this system the university was keen to show the safety and health management professional safety and occupational health management system consistency with the approved international standards in this area. So the university has made a point to disclose the extent of the application of standards within their facilities, and to seek assurance conformity with the aspirations of the other parties interested in the university, such as students and parents, so the university is seeking assurance on the accuracy of previously admitted through an external party, as well as affirmation or registering of safety and occupational health management system by an external organization.

To achieve this, the university turned to the application of an international occupational health and safety management system (OHSAS 18001), is a practical system to evaluate safety and occupational health management systems and it helps organizations to meet their obligations related to safety and occupational health in an efficient and effective way. This system can be divided into four major phases: planning phase which includes risk assessment and legislations identification that can be applied. Implementation phase is the delineation of responsibilities and powers, training, communication, control and emergency preparedness. Examination and observation and recording observations and a review of the system phase. The final phase is the development phase for improvement.

Figure (2)

The Quality Cycle of Occupational Health and Safety Management System

2.2 Safety and Occupational Health Management System

The system consists of seven guiding principles and five central functions for Safety and Occupational Health Management System

2.2.1 Principles

The university is seeking to achieve the availability of the highest occupational health and safety standards in the work environment demonstrating its commitment to carry out its regulatory and ethical duties and responsibilities, and it considers adherence to Occupational Health and Safety Management system is effective and sound approach to fulfill their duties and responsibilities towards the achievement of a safe working environment. Thus, it adopted seven guidelines as a practical tool to achieve continuous improvement for the performance of this system in the work environment, and the guidelines are:

1- Line management responsibility for occupational health and safety:

Line management is directly responsible for the protection of the public, the workers, and the environment, and it provides safety policy, enforcement, and independent oversight functions.

2-Clear roles and responsibilities:

Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the Department and its contractors.

3-Competence commensurate with responsibilities:

Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.

4-Balanced priorities:

Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.

5-Identification of occupati0onal health safety standards and requirements:

Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences.

6-Hazard controls tailored to work being performed:

Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.

7-Operations authorization:

The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.

2.2.10 Functions

1-Define the scope of work: Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

2-Analyze the hazards: Hazards associated with the work are identified, analyzed, and categorized.

3-Develop and implement hazard controls: Applicable standards and requirements are identified and agreed upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.

4-Perform work within controls: Readiness is confirmed and work is performed safely.

5-Provide feedback and continuous improvement: Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

2.2.3 Safety and Occupational Health Policy:

Occupational health and safety rules and regulations are created to protect work environment from unsafe work practices and exposure to hazardous materials. Consistently following and enforcing occupational health and safety rules in order to create a safe and healthful work environment. So the university is keen that occupational health and safety management system is integrated with the other management systems.

Communication and debate on occupational safety and health risks among all employees of the university in different levels is a main part of the occupational health and safety by the management system. The university is committed that Occupational Safety and Health Policy is documented and available to stakeholders, as well as appropriate to the nature and scope of the dangers of working

out environment, ensuring the commitment to continuous improvement to it, committing to abide with international and local legislative requirements in this area, and keening to review it periodically to ensure that it is still connected and suitable for the work environment.

2.2.4 Objectives:

University seeks to maintain the goals documented for Occupational Safety and Health in relation to each function and level within (targets of measurable whenever possible), and when reviewing the goals, the university is keen to be mindful of the legislative requirements, sources of risk in the work environment, technology, engineering and alternatives used and requirements financial, operational and views of stakeholders. And shall be consistent with university policy, including the commitment to continuous improvement goals.

Occupational Safety and Health main goals of the University in the work environment are to:

1. reduce or prevent exposure university employees to hazards that are components of a work environment, or any other individuals may be exposed to the risk of occupational safety and health-related work activities.
2. Apply, evaluate and constantly improve occupational health and safety management system (OHSAS 18001).

3. Ensure occupational safety and health with the occupational safety and health policy, the university management system compatibility, and integration with other systems by management.

2.2.5 Practices

Prudent execution of work requires not only sound judgment and an accurate assessment of the risks involved in the work environment, but also the selection of appropriate work practices to reduce risk and protect the health and safety of university personnel as well as the work environment. And the work environment at the university has many risk sources such as chemicals used in laboratories, microbes and radioactive materials. However, there is a fact unknown to many employees that most of the risks associated with those materials are unknown to employees of the university, as well as laboratory processes lead to the formation of many unknown chemical compounds and materials properties with unknown risk.

Therefore, the university seeks to give employees the skills and knowledge of how to accomplish the tasks assigned to them under conditions leading to reducing the risk expected to occur due to the size of unknown materials or known characteristics and qualities. Four fundamental principles underlie all the work practices discussed in this chapter. Consideration of each should be encouraged before beginning work as part of the culture of safety within the laboratory:

- **Plan ahead. Determine the potential hazards associated with an experiment before beginning.**

- **Minimize exposure to chemicals. Do not allow laboratory chemicals to come in contact with skin. Use laboratory chemical hoods and other ventilation devices to prevent exposure to airborne substances whenever possible.**

- **Do not underestimate hazards or risks. Assume that any mixture of chemicals will be more toxic than its most toxic component. Treat all new compounds and substances of unknown toxicity as toxic substances. Consider how the chemicals will be processed and whether changing states or forms (e.g., fine particles vs. bulk material) will change the nature of the hazard.**

- **Be prepared for accidents. Before beginning an experiment, know what specific action to take in the event of accidental release of any hazardous substance. Post telephone numbers to call in an emergency or accident in a prominent location. Know the location of all safety equipment and the nearest fire alarm and telephone, and know who to notify in the event of an**

emergency. Be prepared to provide basic emergency treatment. Keep your co-workers informed of your activities so they can respond appropriately.

2.2.6 Responsibility and Accountability:

Ensuring a safe work environment is the combined responsibility of university personnel, department of occupational health and safety personnel, and the management, though the primary responsibility lies with the individual performing the work. Of course, state, and local laws and regulations make occupational health and safety in the work environment a legal requirement and an economic necessity. Occupational health and safety, although altruistic, is not a purely voluntary function; it requires mandatory safety rules and programs and an ongoing commitment to them.

A sound occupational health and safety organization that is respected by all requires the participation and support of university administrators, employees, and students. The ultimate responsibility for creating a safe environment and for encouraging a culture of safety rests with the head of the department and its operating units. Leadership by those in charge ensures that an effective safety program is embraced by all. Even a well-conceived safety program will be treated casually by workers if it is neglected by top management.

Therefore, the university strives to determine the responsibilities and powers in occupational health and safety management system to achieve its objectives in the work environment, and by establishing structures and audits to ensure the following:

1. Comply with the requirements and standards of occupational health and safety and should be of direct management responsibility.

2. Identify and clarify the responsibilities of persons engaged in the identification, assessment and control of hazards in the work environment, and should be clear to all employees of the university.

3. Provide effective oversight when necessary to ensure the protection of the safety and health of workers.

4. Encourage cooperation and communication among university members of all categories.

5. Achieve the guidelines for Occupational Health and Safety Management System.

6. Support complying with occupational health and safety policy.

7. support the achievement of occupational health and safety goals.

8. Provide appropriate resources to ensure that those responsible for the occupational health and safety to their functions and duties.

9. Participation of workers or their representatives in the committees of occupational health and safety.

2.2.7 Performance Measurement and Change Management

The primary purpose of measuring occupational health and safety system performance is to judge the implementation and effectiveness of the processes established for controlling risk. Performance measurement provides information on the progress and current status of the arrangements (strategies, processes, and activities) used by an organization to control risks to occupational health and safety system. Measurement information includes data to judge the management system by

- **gathering information on how the system operates in practice,**
- **identifying areas where corrective action is necessary, and**
- **providing a basis for continual improvement.**

All of the components of the occupational health and safety management system should be adequately inspected, evaluated, maintained, and monitored to ensure continued effective operation. Risk assessment and risk control should be reviewed in the light of modifications or technological developments. Results of evaluation activities are used as part of the planning process and management review, to improve performance and correct deficiencies over time.

Periodic audits that enable a deeper and more critical appraisal of all of the elements of the occupational health and safety management system should be scheduled and should reflect the nature of the organization's hazards and risks. To maximize benefits, competent persons independent of the area or activity should conduct the audits. The use of external, impartial auditors should be considered to assist in evaluation of occupational health and safety management system. When performing these

reviews, it is important that the organization have a plan for following up on the results of the audit to ensure that problems are addressed and that recognition is given where it is deserved.

2.2.8 Top Management Actions to Support the Continuous Improvement:

1. Defining the responsibilities and tasks of the university employees of all categories and levels in occupational health and safety management system, and senior management will be responsible for check compliance.
2. Developing and providing means of controlling the sources of risk, and encourage participation by all employees of the university.
3. Supporting and encouraging managers and supervisors to determine the objectives of the occupational health and safety for their departments balanced with productivity goals.
4. Leading positive change to raise the occupational health and safety level in the work environment.
5. Ensuring encouragement and motivation and away as possible from accountability and punishment.
6. Providing multiple means of contact for employees for reporting accidents and health concerns in the work environment.
7. Ensuring that the members and staff of occupational health and safety department have efficiency and competence.

8. Activating an effective system to identify, assess and manage risk sources.

9. Adopting a system to investigate the incidents and identify their causes, and to ensure progress continuously.

10. Adopting an easy and clear mechanism for reporting accidents and injuries, and emphasizing the need to report them, and the need to inform the workers on the reports issued by the reporting processes and their positive impact to the achievement of a safe and healthy work environment.

2.2.9 Procurement:

Procedures must be developed and implemented to ensure:

A. Comply with the requirements of the occupational health and safety of the University assessed, identified and integrated into the purchase and lease specifications.

B. Laws, regulations and requirements occupational health and safety in the university must be adopted prior to the purchase of goods and provision of services.

C. Arrangements must be taken to achieve compliance with requirements by the use of goods and supplied materials must be clear and specific.

2.2.10 Contracting:

Requirements of occupational health and safety must be identified clearly to stakeholders, or at least equivalent, and they are applied to contractors and their workers; these requirements must:

1. Include occupational health and safety standards for assessing procedures and selecting of contractors.

2. Include effective communication and continuous coordination among appropriate levels at the university and contractors before starting work, and identify legislative requirements, risk reporting mechanism and measures to prevent and control them.

3. Include reporting procedures about occupational injuries and diseases, and accidents in the workplace.

4. Provide education and training about the risks to the safety and health of employees to contractors or their workers before starting work and while doing it, if necessary.

5. Regularly assesses the performance of occupational health and safety services in the activities of the contractors in the workplace.

6. Ensure that contractors follow the procedures and precautions of occupational health and safety in the work environment.

2.2.11 Health Surveillance:

The university is keen to provide outstanding medical care services for its employees, including conducting occupational health monitoring by medical specialist staff, and assessing the need to make the necessary medical tests for workers in hazardous work environments or employees who exhibit symptoms of occupational health abnormalities.

In cases of controlling sources of risk by using the means of personal, administrative or engineering protection, tests are conducted for employees by qualified medical staff to determine the following:

1. The efficiency of these methods to the conditions of the work environment.
2. Any restrictions should be applied to their work.
3. The required awareness and training programs for employees.
4. Needed procedures to reduce risk among vulnerable groups (such as the elderly or pregnant women).

2.2.12 Accessibility for Disabled:

The university is committed that universal culture of accessibility for disabled in the workplace is a logical extension of the culture of occupational health and safety. Therefore, the university adopts universal access disabled guide issued by King Salman Center for Disability Research as an engineering reference in the engineering design of facilities and initialization of study and work environment for its employees.

2.2.13Safety and Occupational Health Rules in Laboratories

Below are some basic guidelines for maintaining a safe laboratory environment.

1. **To ensure that help is available if needed, do not work alone if using hazardous materials or performing hazardous procedures.**

2. **To ensure that help is available in case of emergencies, laboratory personnel should not deviate from the assigned work schedule without prior authorization from the laboratory supervisor.**

3. **Do not perform unauthorized experiments.**

4. **Plan appropriate protective procedures and the positioning of all equipment before beginning any operation. Follow the appropriate standard operating procedures at all times in the laboratory.**

5. **Always read the MSDS and the label before using a chemical in the laboratory.**

6. **Wear appropriate PPE, including a laboratory apron or coat, at all times in the laboratory.**

7. **Everyone, including visitors, must wear appropriate eye protection in areas where laboratory chemicals are used or stored.**

8. **Wear appropriate gloves when handling hazardous materials. Inspect all gloves for holes and defects before using.**

9. **Use appropriate ventilation such as laboratory chemical hoods when working with hazardous chemicals.**

10. **Contact the CHO or the EHS office if you have questions about the adequacy of the safety equipment available or chemical handling procedures.**

11. **Know the location and proper use of the safety equipment (i.e., eyewash unit, safety shower, fire extinguisher, first-aid kit, fire blanket, emergency telephone, and fire alarm pulls).**

12. **Maintain situational awareness. Be aware of the hazards posed by the work of others in the laboratory and any additional hazards that may result from contact between materials and chemicals from different work areas.**

13. **Make others in the laboratory aware of any special hazards associated with your work.**

14. **Notify supervisors of any chemical sensitivities or allergies.**

15. **Report all injuries, accidents, incidents, and near misses as directed by the organization's policy.**

16. **For liability, safety, and security reasons, do not allow unauthorized persons in the laboratory.**

17. **Report any unsafe conditions to the laboratory supervisor or CHO.**

18. **Properly dispose of all chemical wastes. Follow organizational policies for drain and trash disposal of chemicals.**

2.3.14 General Procedures for Working with Hazardous Chemicals

Personal Behavior

Demonstrating prudent behavior within the laboratory is a critical part of a culture of safety. This includes following basic safety rules and policies being cognizant of the hazards within the laboratory and exhibiting professionalism with co-workers. Maintaining an awareness of the work being performed in nearby hoods and on neighboring benches and any risks posed by that work is also important.

Minimizing Exposure to Hazardous Chemicals

Take precautions to avoid exposure by the principal routes, that is, contact with skin and eyes, inhalation, and ingestion. The preferred methods for reducing chemical exposure are, in order of preference,

1. **substitution of less hazardous materials or processes**
2. **engineering controls**
3. **administrative controls**
4. **personal protective equipment (PPE)**

See also the Occupational Safety and Health Administration's (OSHA) Safety and Health Management eTool, Hazard Prevention and Control module available before beginning work, review all proposed laboratory procedures thoroughly to determine potential health and safety hazards

Engineering Controls

Engineering controls are measures that eliminate, isolate, or reduce exposure to chemical or physical hazards through the use of various devices. Examples include laboratory chemical hoods and other ventilation systems, shields, barricades, and interlocks. Engineering controls must always be considered as the first and primary line of defense to protect personnel and property. When possible, PPE is not to be used as a first line of protection. For instance, a personal respirator should not be used to prevent inhalation of vapors when a laboratory chemical hood (formerly called fume hoods) is available.

Avoiding Eye Injury

Eye protection is required for all personnel and visitors in all locations where laboratory chemicals are stored or used, whether or not one is actually performing a chemical operation. Visitor eye protection should be made available at the entrances to all laboratories.

Researchers should assess the risks associated with an experiment and use the appropriate level of eye protection:

- **Safety glasses with side shields provide the minimum protection acceptable for regular use. They must meet the American National Standards Institute (ANSI) Z87.1-2003 Standard for Occupational and Educational Eye and Face Protection, which specifies minimum lens thickness and impact resistance requirements.**

- **Because chemical splash goggles offer little protection to the face and neck, full-face shields should be worn in addition to safety glasses or goggles when conducting particularly hazardous laboratory operations (e.g., working with glassware under vacuum or handling potentially explosive compounds). In addition, glassblowing and the use of laser or ultraviolet light sources require special glasses or goggles.**

- **Operations at risk of explosion or that present the possibility of projectiles must have engineering controls as a first line of protection. For instance, in addition to chemical splash goggles or full-face shields, these operations must be conducted behind blast shields, in rubber-coated or taped glassware.**

To prevent some common laboratory accidents:

1. **Always protect hands with appropriate gloves when cutting glass tubing. To avoid breakage, do not attempt to dry glassware by inserting a glass rod wrapped with paper towels. Always lubricate glassware with soap or glycerin before inserting rods, tubing, or thermometers into stoppers.**

2. **To reduce the chances of injuries from projectiles, when heating a test tube or other apparatus, never point the apparatus toward yourself or others.**

3. **Be sure that glassware has cooled before touching it. Hot glass looks just like cold glass.**

4. **Dilute concentrated acids and bases by slowly pouring the acid or base into the water while stirring.**

2.2.15 How to Avoid Routine Exposure to Hazardous Chemicals

Many chemicals and solutions routinely used in laboratories present a significant health risk when handled improperly. Today, in that same spirit, trained laboratory personnel are encouraged to reduce personal risk by minimizing exposure to hazardous chemicals and by eliminating unsafe work practices in the laboratory.

The OSHA Laboratory Standard defines a hazardous chemical as one “for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed persons.” Note that this definition is not limited to toxic chemicals and includes corrosives, explosives, and other hazard classes. Routes of exposure to hazardous materials include contact with skin and eyes, inhalation, ingestion, and injection.

Acute exposure is defined as short durations of exposure to high concentrations of hazardous materials in the workplace. Chronic exposure is defined as continual exposure over a long period of time to low concentrations of hazardous materials in the workplace. Overexposure to chemicals whether a result of a single episode or long-term exposure can result in adverse health effects. These effects are categorized as acute or chronic. Acute health effects appear rapidly after only one exposure and symptoms include rashes, dizziness, coughing, and burns. Chronic health effects may take months or years before they are diagnosed. Symptoms of chronic health effects include joint paint, neurological disorders, and tumors.

An array of controls exists to protect laboratory personnel from the hazards listed above. Engineering controls (e.g., laboratory chemical hoods and gloveboxes), administrative controls (e.g., safety rules, CHPs, and standard operating procedures), and PPE (e.g., gloves, laboratory coats, and chemical splash goggles) are all designed to minimize the risks posed by these hazards.

2.2.16 Devices and Equipment Distribution within the Laboratory

- There is a positive relationship between the organization within the laboratory and the level of safety achieved in the laboratory, where the unorganized laboratory impedes workers in case of an emergency, so it is necessary to apply the following organizing rules**:**
- The need to remove all the things that may impede access to the exit points as well as emergency equipment such as fire extinguishers and sprinklers safety, and the laws of the local fire related to emergency exits electrical panels must be followed.
- The need to store personal belongings in the appropriate places.
- It is prohibited to use of floors, elevators and hallways as areas for storage because of the seriousness in emergency.
- The need to keep cabinets closed when they are not in use so as to avoid accidents.

- Labels must be put on all hazardous used materials correctly.
- the need to put labels on items that contain mobile hazardous materials to explain full name of the substance and the name of the factory and the degree of risk and any other warnings.
- The need to store hazardous materials properly in an organized way, labels must be put in the interface in order to be visible to all users, containers must be clean and free from dust, and it is prohibited to store any hazardous materials on the floor of the lab.
- The need to preserve the containers closed when they are not in use.
- The need for storing compressed gas outside the laboratory, and an appropriate place must be allocated according to the special requirements for such a purpose.
- The need to secure all water, air and electrical connections outlets.
- The need for returning all chemical and medical materials and equipment to their storage places after use by the end of the work.

- The need to reduce the chances of a collision of containers with floor, and bottles and containers must be put within 2 inches at least from the edge of the tables.
- The need to maintain a clean work environment, including the flooring, all fluids on the floor must be got rid quickly, as well as the remnants of dust accumulated and other chemicals must be got rid due to what could cause a risk to the respiratory tract. It is also prohibited the use of cleaning by drying in order to avoid the formation of aerosols. We must get rid of the broken glass and spilled chemicals and the remains of the leaves on the floor of the lab.
- The need not to close the drainage holes in order to avoid the buoyancy of water on the surface of the laboratory, a piece of rubber must be put on the bottom of the glass instruments to avoid breaking to avoid wounds.
- It is prohibited to leave glass instruments dirty in the laboratory so they should be washed carefully, they must be stored very carefully, and glass instruments that contain fractures or cracks should be disposed quickly.
- The need to get rid of all chemical, medical and radioactive waste properly and in accordance with the rules and regulations.
- The need to get rid of the fragments of broken glass and must be placed inside special containers for that purpose, and the broken glass that contained hazardous materials must be dealt with as a hazardous substance.

- The need for disposal of sharps, such as needles and razors blades in the special containers for such purpose**.**

2.2.17 Transport of Hazardous Materials

While transferring hazardous materials outside laboratory or among storage rooms, use secondary containers resistant to breakage. Secondary container resistant to breakage is made of rubber, metal or plastic and contains sufficient carrier handles to carry the container in the event of breakage. Plastics bags can also be used in case of transferring small amounts. Moreover, when transferring cylinders containing compressed gases, they must be well carried by vehicles of cylinder transfer and gas valve must be covered tightly.

2.2.18 Chemical Storage

There is a need to avoid the accumulation of chemicals in one place, where a minimum of chemicals must be stored, which are barely enough for research project or educational experiences. Labels of chemicals data should be put on all containers

properly and clearly, and labels must contain any special dangers, as well as the history of opening the containers should be written on private labels related to containers that contain hazardous materials.

You should limit the quantity of flammable and combustible liquids in laboratories. Flammable liquids that are not stored in safety cans should be placed in storage cabinets rated for flammable storage. When space allows, store combustible liquids in flammable-storage cabinets. Otherwise, store combustible liquids in their original containers. Fire codes and institutional policies regulate quantities of certain chemicals, most notably flammables and combustibles. For these materials, a maximum allowable quantity for laboratory storage has been established

Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed not to spark inside the refrigerator. If refrigerated storage is needed inside a flammable-storage room, it is advisable to choose an explosion-proof refrigerator.

Secondary containment, such as plastic trays, is highly recommended for all containers. Secondary containment captures spills and leaks. Extra care is required because laboratory refrigerators should have cautious labels against storing food and beverages.

It is prudent to store containers of incompatible chemicals separately. Separation of incompatibles will reduce the risk of mixing in case of accidental breakage, fire, earthquake, or response to a laboratory emergency.

2.2.19 Use and Maintenance of Equipment and Glassware

Good equipment maintenance is essential for safe and efficient operations. Laboratory equipment should be regularly inspected, maintained, and serviced on schedules that are based on the manufacturer's recommendations, as well as the likelihood and hazards of equipment failure. Maintenance plans should ensure that any lockout procedures cannot be violated.

Carefully handle and store glassware to avoid damage. Discard or repair chipped or cracked items. Handle vacuum-jacketed glassware with extreme care to prevent implosions. Evacuated equipment such as Dewar flasks or vacuum desiccators should be taped, shielded, or coated. Only glassware designed for vacuum work should be used for that purpose.

Use tongs, a tweezer, or puncture-proof hand protection when picking up broken glass. Small pieces should be swept up with a brush into a dustpan. Glassblowing operations should not be attempted unless an area has been made safe for both fabrication and annealing

2.2.20 Responding to Accidents and Emergencies

The university is working to adopt measures and plans to determine the likelihood of accidents and response mechanism. To prevent and reduce occupational diseases and damage associated with them. The University is committed to review these plans and procedures. It is important that the university conduct periodic tests of the plans and procedures, evaluation and continuous improvement.

University confine the readiness and response plans are contingency consistent with the size and nature of the work by the environment, collaborating with competent third parties whenever possible, and that:
a. Ensure the provision of necessary information and reporting and internal and external coordination in order to protect all those who can be exposed to risks arising from emergencies.

B. Provide information and data necessary to the competent authorities, and those in the danger zone.

C. Ensure the provision of first aid services and medical assistance, firefighting and evacuation plans for all who are in the danger zone.

Dr. Provide relevant information and adequate training for all employees of the university on different levels.

A- General Preparation for Emergencies

Every laboratory should have a written emergency response plan that addresses injuries, spills, fires, accidents, and other possible emergencies and includes procedures for communication and response. All laboratory personnel should know what to do in an emergency. Laboratory work should not be undertaken without knowledge of the following points:

- **how to report a fire, injury, chemical spill, or other emergency and how to summon emergency response;**
- **the location of emergency equipment such as safety showers and eyewash units;**
- **the location of fire extinguishers and spill control equipment;**

- **the locations of all available exits for evacuation from the laboratory; and**
- **how police, fire, and other emergency personnel respond to laboratory emergencies, and the role of laboratory personnel in emergency response.**
- **Laboratory supervisors should ensure that all trained laboratory personnel are familiar with this information.**
- **Trained laboratory personnel should know their level of expertise with respect to using fire extinguishers and emergency equipment, dealing with chemical spills, and handling injuries.**
- **They should not take actions outside the limits of their expertise but instead should rely on trained emergency personnel.**
- **Names and contact information for individuals responsible for laboratory operations should be posted on the laboratory door.**

B- Notification of Personnel in the Area

Other nearby laboratory personnel should be alerted to the accident and the nature of the chemicals involved. If a highly toxic gas or volatile material is released, the laboratory should be evacuated and personnel posted at entrances to prevent others from inadvertently entering the contaminated area. In some cases (e.g., incidents involving the release of highly toxic substances and spills occurring in non-laboratory areas), it may be appropriate to activate a fire alarm to alert personnel to evacuate the entire building.

C- Handling the Accidental Release of Hazardous Substances

Experiments should always be designed to minimize the possibility of an accidental release of hazardous substances. Laboratory personnel should use the minimum amount of hazardous material possible and perform the experiment so that, as much as possible, any spill is contained.

In the event of an incidental, laboratory-scale spill, follow these general guidelines, in order:

1. **Tend to any injured or contaminated personnel and, if necessary, request help**
2. **If necessary, evacuate the area**

3. Notify other laboratory personnel of the accident.

4. Take steps to confine and limit the spill if this can be done without risk of injury or contamination

5. Clean up the spill using appropriate procedures, if this can be done without risk of injury and is allowed by institutional policy.

6. Dispose of contaminated materials properly, according to the procedures described in regulations.

D- Treatment of Injured and Contaminated Personnel

If an individual is injured or contaminated with a hazardous substance, tending to him or her generally takes priority over implementing the spill control measures. Obtain medical attention for the individual as soon as possible by calling emergency personnel. Provide a copy of the appropriate MSDS to the emergency responders or attending physician, as needed. If you cannot assess the conditions of the environment well enough to be sure of your own safety, do not enter the area. Call emergency personnel and describe the situation as best you can.

Every laboratory should develop specific procedures for the highest-risk materials used in their laboratory. To identify these materials, consider past accidents, chemicals used in large volumes, and particularly hazardous chemicals. For example, laboratories in which hydrofluoric acid (HF) is used should establish special procedures for accidental exposures, and laboratory personnel should be trained in these emergency procedures. When specific procedures have not been established, the following steps provide general guidance.

1- Spills Covering Small Areas of Skin:

1. **Immediately flush with flowing water for no less than 15 minutes; remove any jewelry or clothing as necessary to facilitate clearing of any residual materials.**
2. **If there is no visible burn, wash with warm water and soap.**
3. **Check the MSDS to determine if special procedures are needed or if any delayed effects should be expected.**
4. **Seek medical attention for even minor chemical burns.**

5. Do not use creams, lotions, or salves, unless specifically called for.

2- Spills on Clothes:

1. The emergency responder should wear appropriate PPE during emergency treatment to avoid exposure.

2. To avoid contamination of the victim's eyes, do not remove the victim's eye protection before emergency treatment.

3. Quickly remove all contaminated clothing, shoes, and jewelry while using the safety shower. Seconds count; do not waste time or limit the showered body areas because of modesty. Take care not to spread the chemical on the skin or, especially, in the eyes.

4. Cut off garments such as pullover shirts or sweaters to prevent spreading the contamination, especially to the eyes.

5. Immediately flood the affected body area with water for at least 15 minutes. Resume if pain returns.

6. Get medical attention as soon as possible. The affected person should be escorted and should not travel alone. Send a copy of the MSDS with the victim. If the institution's MSDS is digital, hardcopies of the relevant information should be

provided to responders. If the MSDS is not immediately available, it is vitally important that the person in charge convey the name of the chemical involved to the responders. The responders can then arrange for an MSDS to be available at the hospital, if necessary.

7. Discard contaminated clothes or have them laundered separately from other clothing.

3- Splashes into the Eye:

1. Immediately flush with tepid potable water from a gently flowing source for at least 15 minutes. Use an eyewash unit if one is available. If not, place the injured person on his or her back and pour water gently into the eyes for at least 15 minutes.

2. Hold the individual's eyelids away from the eyeball, and instruct him or her to move the eye up and down and sideways to wash thoroughly behind the eyelids.

3. Follow first aid by prompt treatment by medical personnel or an ophthalmologist who is acquainted with chemical injuries.

4. Send a copy of the MSDS with the victim. If the institution's MSDS is digital, hardcopies of the relevant information should be provided to responders. If the MSDS is not immediately available, it is vitally important that the person in charge convey the name of the chemical involved to the responders. The responders can then arrange for an MSDS to be available at the hospital, if necessary.

4- Cuts:

1. WARNING: Always wear gloves as a precaution when there is risk of contact with blood or other potentially infectious fluids to prevent the transmission of bloodborne pathogens.

2. If the injured person has experienced a minor cut, flush the wound with tepid running water to remove any possible chemical contaminants. If there is a cut on a gloved hand, remove the glove after thoroughly washing the affected area to avoid contamination of the cut with chemicals.

3. Apply a bandage and advise the victim to report any signs of infection to a physician. If there is a possibility that the wound is contaminated by broken glass or chemicals, the victim should seek immediate medical attention.

4. If the injured person has experienced a serious injury (if sutures will be necessary), call emergency personnel (911) and apply sterile gauze pads to the wound. If necessary, apply direct pressure to the wound to stop the bleeding.

5. Apply additional pads if blood soaks through the first sterile pad. If bleeding continues, encourage the victim to lie down and elevate the wound area to a position above the heart. If you are unable to stop the bleeding, remain calm and carefully explain the situation to the emergency dispatcher (911). The dispatcher will advise you on further action.

6. Send a copy of the MSDS with the victim. If the institution's MSDS is digital, hardcopies of the relevant information should be provided to responders. If the MSDS is not immediately available, it is vitally important that the person in charge convey the name of the chemical involved to the responders. The responders can then arrange for an MSDS to be available at the hospital, if necessary.

7.

5- Ingestion:

1. **Call emergency personnel (977).**
2. **Do not encourage vomiting except under the advice of a physician.**
3. **Save all chemical containers and a small amount of vomitus, if possible, for analysis.**
4. **Stay with the victim until emergency medical assistance arrives.**
5. **Send a copy of the MSDS with the victim. If the institution's MSDS is digital, hardcopies of the relevant information should be provided to responders. If the MSDS is not immediately available, it is vitally important that the person in charge convey the name of the chemical involved to the responders. The responders can then arrange for an MSDS to be available at the hospital, if necessary.**

6- If the victim is unconscious:

1. Call emergency personnel (977).

2. If it is safe for you to enter the area, place the victim on his or her back and cover with a blanket. Do not attempt to remove the victim from the area unless there is immediate danger.

3. Clear the area of any chemical spill or broken glassware.

4. If the victim begins to vomit, turn the head so that the stomach contents are not aspirated into the lungs.

5. Stay with the victim until emergency medical assistance arrives.

6. If the incident involves a chemical exposure, send a copy of the MSDS with the victim. If the institution's MSDS is digital, hardcopies of the relevant information should be provided to responders. If the MSDS is not immediately available, it is vitally important that the person in charge convey the name of the chemical involved to the responders. The responders can then arrange for an MSDS to be available at the hospital, if necessary.

7- Convulsions:

1. Call emergency personnel (977).

2. If it is safe for you to enter the area, remove anything that might cause harm to the victim. Clear the area of any chemical spills or broken glassware.

3. If the victim begins to vomit, turn the head so that the stomach contents are not aspirated into the lungs.

4. Try to protect the victim from further danger with as little interference as possible. Do not attempt to restrain the victim.

5. Stay with the victim until emergency medical assistance arrives.

6. If the incident involves a chemical exposure, send a copy of the MSDS with the victim.

8- Burns from Heat:

1. Call emergency personnel (977).

2. For first-degree burns, flush with copious amounts of tepid running water. Apply a moist dressing and bandage loosely.

3. For second-degree (with open blisters) and third-degree burns, do not flush with water. Apply a dry dressing and bandage loosely. Immediately seek medical attention.

4. Do not apply ointments or ice to the wound.

9- Cold Burns:

1. Call emergency personnel (977).

2. Do not apply heat.

3. If it is not in the area involved, loosen any clothing that may restrict circulation.

4. Cryogenic liquids produce tissue damage similar to that associated with thermal burns and cause severe deep freezing with extensive destruction of tissue.

5. Flush affected areas with large volumes of tepid water (41–46 °C [105–115 °F]) to reduce freezing.

6. Cover the affected area with a sterile protective dressing or with clean sheets if the area is large, and protect the area from further injury.

7. If the incident involves a chemical exposure, send a copy of the MSDS with the victim. If the institution's MSDS is digital, hardcopies of the relevant information should be provided to responders. If the MSDS is not immediately available, it is vitally important that the person in charge convey the name of the chemical involved to the responders. The responders can then arrange for an MSDS to be available at the hospital, if necessary.

8. E- Spill Containment

All personnel who work in a laboratory in which hazardous substances are used should be familiar with their institution's policy regarding spill control. For non-emergency[3] spills, spill control kits may be available that are tailored to the potential risk associated with the materials being used in the laboratory. These kits are used to confine and limit the spill if such actions can be taken without risk of injury or contamination. An individual should be assigned to maintain the kit. Store spill kits near areas where spills may occur. Typical spill control kits include these items:

- **spill control pillows, which are commercially available and generally can be used for absorbing solvents, acids, and caustic alkalis, but not HF;**

- **inert absorbents such as vermiculite, clay, sand, kitty litter, and Oil Dri, but not paper because it is not an inert material and should not be used to clean up oxidizing agents such as nitric acid;**
- **neutralizing agents for acid spills such as sodium carbonate and sodium bicarbonate;**
- **neutralizing agents for alkali spills such as sodium bisulfate and citric acid;**
- **large plastic scoops and other equipment such as brooms, pails, bags, and dustpans; and**
- **Appropriate PPE, warnings, barricade tapes, and protection against slips or falls on the wet floor during and after cleanup.**

F- Spill Cleanup

Specific procedures for cleaning up spills vary depending on the location of the accident, the amount and physical properties of the spilled material, the degree and type of toxicity, and the training of the personnel involved. Any cleanup should be performed while wearing appropriate PPE and in line with institutional guidance. General guidelines for handling several common incidental, non-emergency spills follow:

- **Materials of low flammability that are not volatile or that have low toxicity. This category of hazardous substances includes inorganic acids (e.g., sulfuric and nitric acid) and caustic bases (e.g., sodium and potassium hydroxide). For cleanup, appropriate PPE, including gloves, chemical splash goggles, and (if necessary) shoe coverings, should be worn. Absorption of the spilled material with an inert absorbent and appropriate disposal are recommended. The spilled chemicals can be neutralized with materials such as sodium bisulfate (for alkalis) and sodium carbonate or bicarbonate (for acids).**

- **Flammable solvents. Fast action is crucial when a flammable solvent of relatively low toxicity is spilled. This category includes acetone, petroleum ether, pentane, hexane, diethyl ether, dimethoxyethane, and tetrahydrofuran. Other personnel in the laboratory should be alerted, all flames extinguished, and any spark-producing equipment turned off. In some cases the power to the laboratory should be shut off with the circuit breaker, but the ventilation system should be kept running. The spilled solvent should be soaked up with spill absorbent or spill pillows as quickly as possible. If this cannot be done quickly, evacuation should occur, and emergency personnel (998) should be called. Used absorbent and pillows should be sealed in containers and disposed of properly. Nonsparking tools should be used in cleanup.**

- **Highly toxic substances. The cleanup of highly toxic substances should not be attempted alone. Emergency responders should be notified, and the appropriate EHS expert should be contacted to obtain assistance in evaluating the hazards involved. These professionals will know how to clean up the material and may perform the operation.**

- **Debris management. Debris from the cleanup should be handled as hazardous waste if the spilled material falls into that category.**

G- Handling Leaking Gas Cylinders

Leaking gas cylinders constitute serious hazards that may require an immediate evacuation of the area and a call to emergency responders. If a leak occurs, do not apply extreme tension to close a stuck valve. Wear appropriate PPE, which usually includes a self-contained breathing apparatus or an air-line respirator, when entering the area with the leak. (The following guidelines cover leaks of various types of gases:

- **Flammable, inert, or oxidizing gases. If safe to do so, move the cylinder to an isolated area, away from combustible material if the gas is flammable or an oxidizing agent. Post signs that describe the hazards and state warnings. Take care**

when moving leaking cylinders of flammable gases so that accidental ignition does not occur. If feasible, move the leaking cylinder into a laboratory chemical hood until it is exhausted.

- **Corrosive gases. Corrosive gases may increase the size of the leak as they are released, and some corrosives are also oxidants, flammable, or toxic. Move the cylinder to an isolated well-ventilated area, and, if possible, use suitable means to direct the gas into an appropriate chemical neutralizer. If there is apt to be a reaction with the neutralizer that could lead to a suck-back into the valve (e.g., aqueous acid into an ammonia tank), place a trap in the line before starting neutralization. Post signs that describe the hazards and state warnings.**

- **Toxic gases. The same procedure should be followed for toxic gases as for corrosive gases. Be sure to warn others of exposure risks. Move the cylinder to an isolated well-ventilated area. Direct the gas into an appropriate chemical neutralizer. Post signs that describe the hazards and state warnings.**

H-Handling Spills of Elemental Mercury

When spilled in a laboratory, mercury can become trapped beneath floor tiles, under cabinets, and even between walls. Even at very low levels, chronic mercury exposure can be a serious risk, especially in older laboratory facilities, where multiple historic spills may have occurred. Government and standard-setting organizations have established cleanup standards for laboratory spills. These stringent standards ensure the safety of trained laboratory personnel, students, and future occupants of the space.

A portable atomic absorption spectrophotometer with a sensitivity of at least 2 ng/m^3 or other suitable instruments are used to find mercury residues and reservoirs that result from laboratory spills, and for the final clearance survey. Follow institutional procedures in cleaning up spills. General guidelines for handling incidental, non-emergency elemental mercury spills are as follows:

- **First, isolate the spill area. Keep people from walking through and spreading the contamination.**
- **Wear protective gloves, booties, and a Tyvek® suit when necessary, while performing cleanup activities.**
- **Collect the droplets on wet toweling, which consolidates the small droplets to larger pieces, or with a piece of adhesive tape. Do not use sulfur; the practice is ineffective and the resulting waste creates a disposal problem.**

- **Consolidate large droplets by using a scraper or a piece of cardboard.**
- **Use commercial mercury spill cleanup sponges and spill control kits.**
- **Use specially designed mercury vacuum cleaners that have special collection traps and filters to prevent the emission of mercury vapors. A standard vacuum cleaner should never be used to pick up mercury.**
- **Waste mercury should be treated as a hazardous waste. Place it in a thick-walled high-density polyethylene bottle and transfer it to a central depository for reclamation.**
- **Decontaminate the exposed work surfaces and floors by using an appropriate decontamination kit.**
- **Verify decontamination to the current standards by using a portable atomic absorption spectrophotometer or other suitable instrument as described above.**

G-Preparing for Accidents with and Spills of Substances of High Toxicity

Be sure that emergency response procedures cover highly toxic substances. Spill control and appropriate emergency response kits should be nearby, and laboratory personnel should be trained in their proper use. These kits should be marked, contained, and sealed to avoid contamination and to be accessible in an emergency. Essential contents include spill control absorbents, impermeable surface covers (to prevent the spread of contamination while conducting emergency response), warning signs, emergency barriers, first-aid supplies, and antidotes. Before starting experiments, the kit contents should be validated. Safety showers, eyewash units, and fire extinguishers should be readily available nearby. Self-contained impermeable suits, a self-contained breathing apparatus, and cartridge respirators may also be appropriate for spill response preparedness, depending on the physical properties and toxicity of the materials being used

Experiments conducted with highly toxic chemicals should be carried out in work areas designed to contain accidental releases. Trays and other types of secondary containment should be used to contain inadvertent spills. Careful technique must be observed to minimize the potential for spills and releases.

Prior to work, all toxicity and emergency response information should be posted outside the immediate area to ensure accessibility in emergencies. All laboratory personnel who could potentially be exposed must be properly trained on the appropriate response in the event of an emergency. Conducting occasional emergency response drills is always a good idea.

H-Responding to Fires

Fires are one of the most common types of laboratory accidents. All personnel should be familiar with the general guidelines below to prevent and minimize injury and damage from fires. Hands-on experience with common types of extinguishers and the proper choice of extinguisher should be part of basic laboratory training

Be prepared to respond to a fire:

- **Preparation is essential! Make sure all laboratory personnel know the locations of all fire extinguishers in the laboratory, what types of fires they can be used for, and how to operate them correctly. Also ensure that they know the location of the nearest fire-alarm pull station, telephone, emergency contact list, safety showers, and emergency blankets.**

- **In case of fire, immediately notify emergency response personnel by activating the nearest fire alarm. After initial containment, it is also important to report all fires to appropriate personnel for possible follow-up action.**

- **Even though a small fire that has just started can sometimes be extinguished with a laboratory fire extinguisher, attempt to put out such fires only if you are trained to use that type of extinguisher, confident that you can do it successfully and quickly, and from a position in which you are always between the fire and an exit to avoid being trapped. Do not attempt to extinguish fires of any size if the institution's policy prohibits this. A fire can spread and surround you in seconds. Toxic gases and smoke present additional hazards. When in doubt, evacuate immediately instead of attempting to extinguish the fire. Only attempt to extinguish fires of any size if the institution's policy allows.**

- **Put out fires in small vessels by covering the vessel loosely. Never pick up a flask or container of burning material.**

- **Extinguish small fires involving reactive metals and organometallic compounds (e.g., magnesium, sodium, potassium, and metal hydrides) with Met-L-X or Met-L-Kyl extinguishers or by covering with dry sand. Apply additional fire suppression techniques if solvents or combustibles become involved. Because these fires are very difficult to extinguish, sound the fire alarms before you attempt to put out the fire.**

- **In the event of a more serious fire, evacuate the laboratory and activate the nearest fire alarm. When the fire department and emergency response team arrive, tell them what hazardous substances are in the laboratory.**
- **If a person's clothing catches fire, douse him or her immediately in a safety shower. The drop-and-roll technique is also effective. Use fire blankets only as a last resort because they tend to hold in heat and to increase the severity of burns by creating a chimney-like effect. Remove contaminated clothing quickly. Wrap the injured person in a blanket to avoid shock, and get medical attention promptly.**

I- Special Precautions for Minimizing Exposure to Highly Toxic Chemicals

The practices listed below help establish the necessary precautions to enable laboratory work with highly toxic chemicals to be conducted safely:

1. Conduct procedures involving highly toxic chemicals that can generate dust, vapors, or aerosols in a laboratory chemical hood, glovebox, or other suitable containment device.

2. Check hoods for acceptable operation prior to conducting experiments with toxic chemicals. If experiments are to be ongoing over a significant period of time, the hood should be rechecked at least quarterly for proper operation and be equipped with flow-sensing devices that show at a glance or by an audible signal whether they are performing adequately. When toxic chemicals are used in a glovebox, it should be operated under negative pressure, and the gloves should be checked for integrity and appropriate composition before use. Consider if reactive or toxic effluents may be generated by the procedure. If so, scrubbing may be necessary. If dusts or aerosols are generated, consider using high-efficiency particulate air (HEPA) filters prior to discharge to the atmosphere.

3. Hoods should not be used as waste disposal devices,

4. Gloves must be worn when working with toxic liquids or solids to protect the hands and forearms. Select gloves carefully to ensure that they are impervious to the chemicals being used and are of correct thickness to allow reasonable dexterity while also ensuring adequate barrier protection.

5. Face and eye protection is necessary to prevent ingestion, inhalation, and skin absorption of toxic chemicals. Safety glasses with side shields are a minimum standard for all laboratory work. When using toxic substances that could generate

vapors, aerosols, or dusts, additional levels of protection, including full-face shields and respirators, are appropriate, depending on the degree of hazard represented. Transparent explosion shields in hoods offer additional protection from splashes. Medical certification, training, and fit-testing are required if respirators are worn.

6. Equipment used for the handling of highly toxic chemicals should be isolated from the general laboratory environment. Consider venting laboratory vacuum pumps used with these substances via high-efficiency scrubbers or an exhaust hood. Motor-driven vacuum pumps are recommended because they are easy to decontaminate (decontamination should be conducted in a designated hood).

7. Always practice good laboratory hygiene where highly toxic chemicals are handled. After using toxic materials, trained laboratory personnel should wash their face, hands, neck, and arms. Equipment (including PPE such as gloves) that might be contaminated must never be removed from the environment reserved for handling toxic materials without complete decontamination. Choose laboratory equipment and glassware that are easy to clean and decontaminate. Work surfaces should also be easy to decontaminate or covered with appropriate protective material, which can be properly disposed of

when the procedure is complete. Mixtures that contain toxic chemicals or substances of unknown toxicity must never be smelled or tasted.

8. Carefully plan the transportation of very toxic chemicals. Handling these materials outside the specially designated laboratory area should be minimized. When these materials are transported, the transporter should wear the full complement of PPE appropriate to the chemicals and the type of shipping containers being transported. Samples should be carried in unbreakable secondary containment.

J- WORKING WITH SUBSTANCES OF HIGH TOXICITY

Individuals who work with highly toxic chemicals should be thoroughly familiar with the general guidelines for the safe handling of chemicals in laboratories). They should also have acquired through training and experience the knowledge, skill, and discipline to carry out safe laboratory practices consistently.

However, these guidelines alone are not sufficient when handling substances that are known to be highly toxic and chemicals that, when combined in an experimental reaction, may generate highly toxic substances or produce new substances with the potential for high toxicity. Additional precautions are needed to set up *multiple lines of defense to minimize the risks* posed by these substances. Preparations for handling highly toxic substances must include sound and thorough planning of the experiment, an understanding of the intrinsic hazards of the substances and the risks of exposure inherent in the planned processes, selection of additional precautions that may be necessary to minimize or eliminate these risks, and review of all emergency procedures to ensure appropriate response to unexpected spills and accidents.

Each experiment must be evaluated individually because assessment of the level of risk depends on how the substance will be used. Therefore, a prudent planner does not rely solely on a list of highly toxic chemicals to determine the level of the risk; under certain conditions, chemicals not on these lists may react to form highly toxic substances.

In general, the guidelines the minimum standards for handling hazardous substances and should become standard practice when handling highly toxic substances. For example, although working alone in laboratories should be avoided, it is essential that more

than one person be present when highly toxic materials are handled. All people working in the area must be familiar with the hazards of the experiments being conducted and with the appropriate emergency response procedures.

Use engineering controls to minimize the possibility of exposure. The use of appropriate PPE to safeguard the hands, forearms, and face from exposure to chemicals is essential in handling highly toxic materials. Cleanliness, order, and general good housekeeping practices create an intrinsically safer workplace. Compliance with safety rules should be maintained scrupulously in areas where highly toxic substances are handled. Source reduction is always a prudent practice, but in the case of highly toxic chemicals it may mean the difference between working with toxicologically dangerous amounts of materials and working with quantities that can be handled safely with routine practice. Emergency response planning and training are very important when working with highly toxic compounds. Additional hazards from these materials (e.g., flammability and high vapor pressures) can complicate the situation, making operational safety all the more important.

K- Experiment Protocols Involving Highly Toxic Chemicals

Before the experiment begins, prepare an experiment plan that describes the additional safeguards that will be used for all phases of the experiment from acquisition of the chemical to its final safe disposal.

The amounts of materials used and the names of the people involved should be included in the written summary and recorded in the laboratory notebook.The planning process may demonstrate that monitoring is necessary to ensure the safety of the experimenters. Such a determination is made when there is reason to believe that exposure levels for the substances planned to be used could exceed OSHA-established regulatory action levels, similar guidelines established by other authoritative organizations, or when the exposure level is uncertain.

People who conduct the work should know the signs and symptoms of acute and chronic exposure, including delayed effects. Arrange ready access to an occupational health physician, and consult with the physician to determine if health screening or medical surveillance is appropriate.

L- Designated Areas

Experimental procedures involving highly toxic chemicals, including their transfer from storage containers to reaction vessels, should be confined to a designated work area in the laboratory. This area, which may be a laboratory chemical hood or glove box, a portion of a laboratory, or the entire laboratory module, should be recognized by everyone in the laboratory.

Post signs conspicuously to indicate the designated areas. It may also be prudent to post any relevant signs outside the laboratory door.

M- Access Control

Restrict access to laboratories where highly toxic chemicals are in use to personnel who are authorized for this laboratory work and trained in the special precautions that apply. Administrative procedures or even physical barriers may be required to prevent unauthorized personnel from entering these laboratories.

Keep laboratory doors closed and locked to limit access to unattended areas where highly toxic materials are stored or routinely handled. However, security measures must not prevent emergency exits from the laboratory. Be sure to make special arrangements for emergency response, including after normal work hours. Use locks to secure refrigerators, freezers, and other storage areas. Keep track of authorized personnel, and be sure to retrieve keys and change locks and access when these people no longer work in the area.

Keep a detailed inventory of highly toxic chemicals. The date, amount, location, and responsible individual should be recorded for all acquisitions, syntheses, access, use, transport, distribution to others, and disposal. Perform a physical inventory every year to verify active inventory records. A procedure should be in place to report security breaches, inventory discrepancies, losses, diversions, or suspected thefts.

When long-term experiments involving highly toxic compounds require unattended operations, securing the laboratory from access by untrained personnel is essential. These operations should also include failsafe backup options such as shutoff devices in case a reaction overheats or pressure builds up. Additionally equipment should include interlocks that shut down experiments by turning off devices such as heating baths or reagent pumps, or that close solenoid valves if cooling water stops flowing through an apparatus or if airflow through a laboratory chemical hood becomes restricted or stops. An interlock should be constructed in such a way that if a

problem develops, it places the experiment in a safer mode and will not reset even if the hazardous condition is reversed. Protective devices should include alarms that indicate their activation. Security guards and untrained personnel should never be asked or allowed to check on the status of unattended experiments involving highly toxic materials. Warning signs on locked doors should list the trained laboratory personnel to be contacted in case an alarm sounds within the laboratory.

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Occupational Health and Safety Questionnaire for Workers in the Laboratories

No.	Question	Answer	
		Yes	No
١	Do you wash your hands before leaving the lab?		
٢	Are you wearing the right outfit in the laboratory (lab coat, glasses to protect the eyes, gloves, shoes)?		
٣	are warning signs of risk and emergency numbers declared in a clear place on the door of the lab?		
٤	Did you get the train to know the material safety card components		
٥	Are all the cans and containers in the		

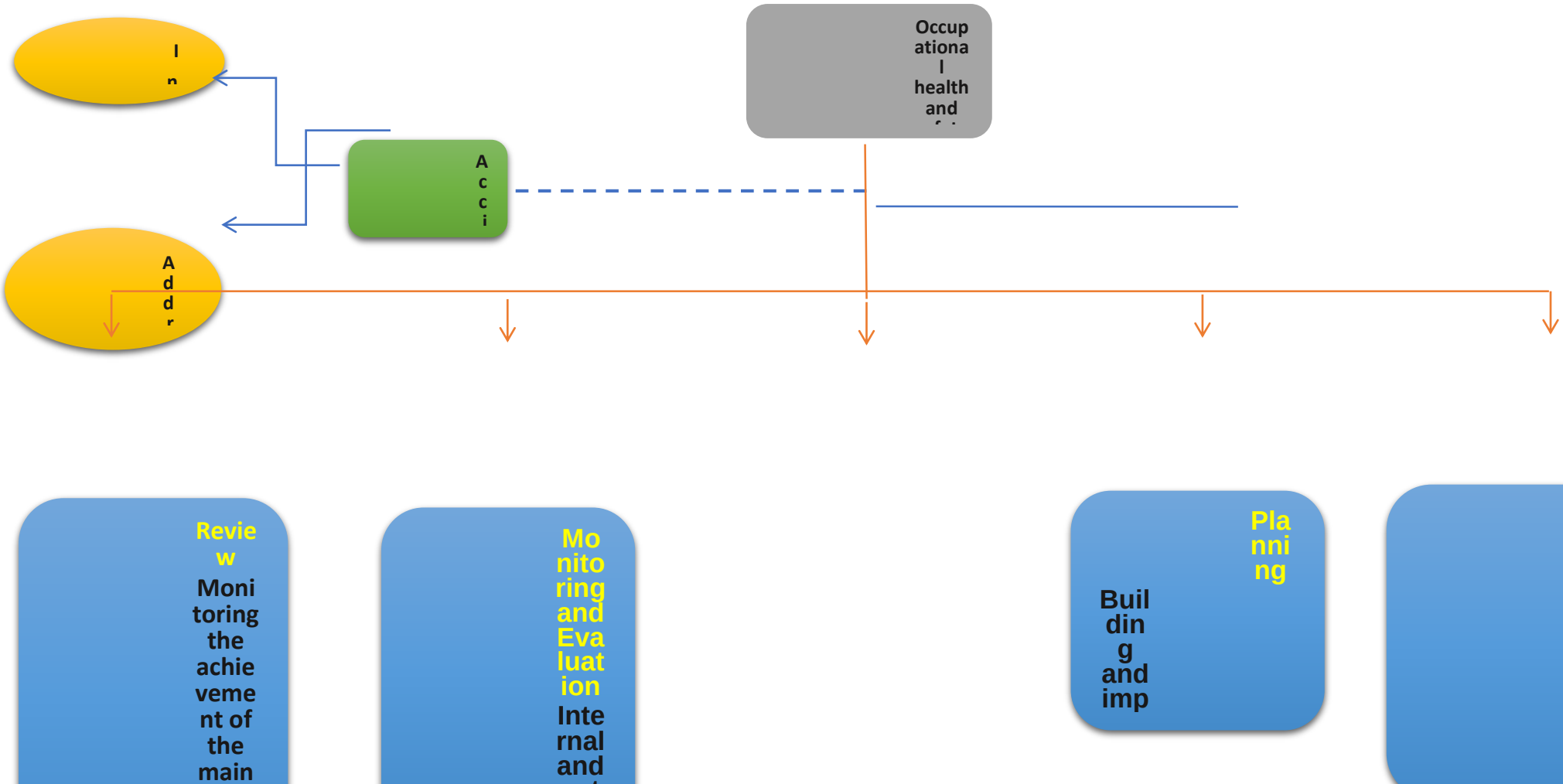
	laboratory labeled by safety data card?		
٦	**Can you easily get safety data for chemicals card in your laboratory?**		
٧	**Are chemicals and hazardous materials in your laboratory stored correctly?**		
٨	**do you know the standards and requirements for the proper handling of hazardous materials in your laboratory?**		
٩	**Is it available in your laboratory the prevention methods (washing shower, eye wash, suction gas**		

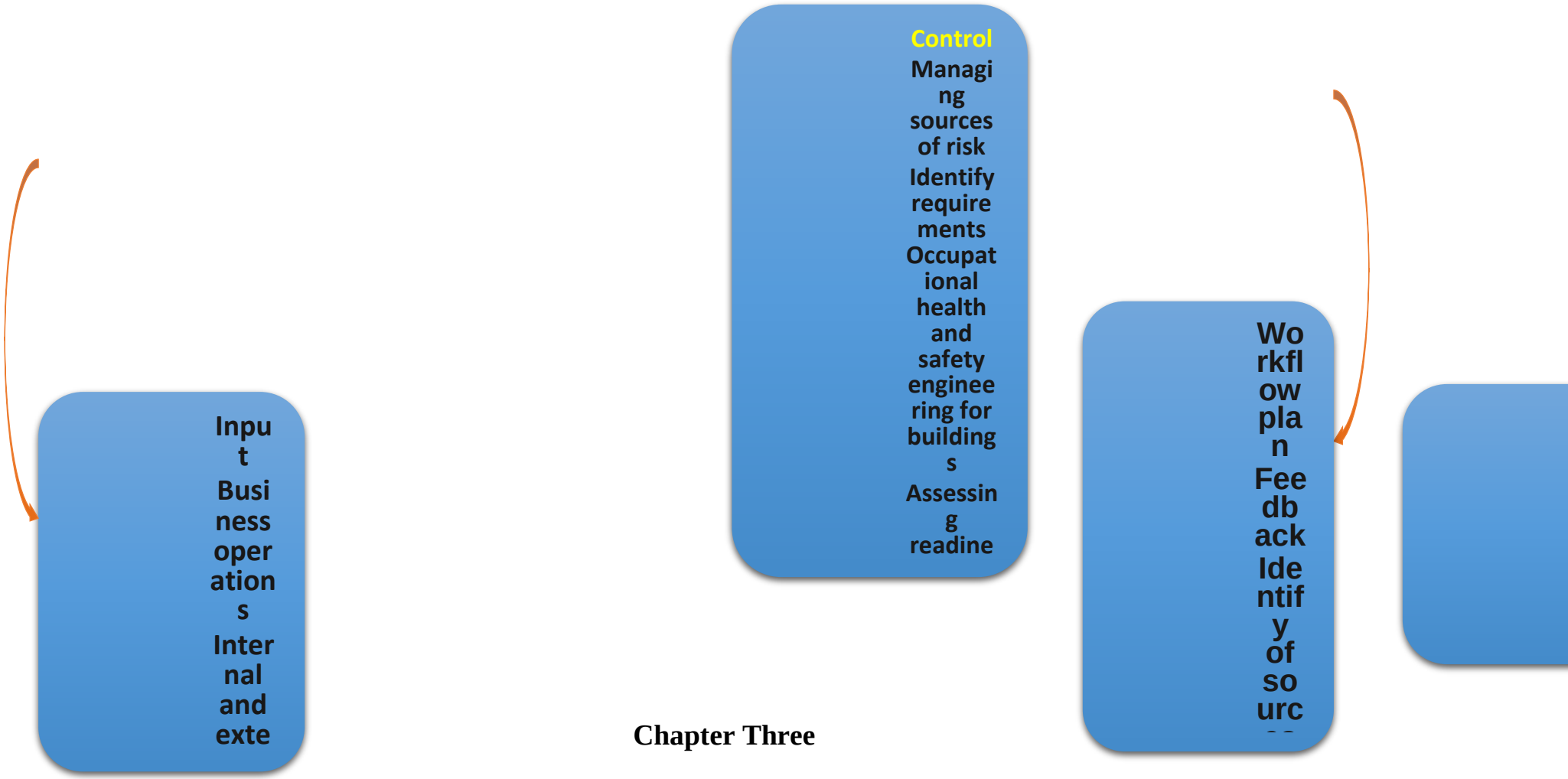
	chamber, etc.) and shown in a prominent place next to instructions to use it?		
١٠	**Did you get the training to deal with incidents of hazardous chemicals and materials in your laboratory?**		
١١	**Did you get training on the requirements to store chemical and hazardous materials?**		
١٢	**Are all the means to control sources of risk engineering work well in your laboratory?**		
١٣	**Do you know where to save your laboratory**		

	procedures manual, and learn how to use it?		
١٤	**Do you know systems and procedures for occupational health and safety management system in your laboratory?**		

❖ If the answer is **No** to one of these questions, we hope to read this manual carefully, and you can communicate with occupational health and safety department for more information.

Figure 3: The Stages Occupational health and safety Management System




Input
Business operations
Internal and exte
Control
Managing sources of risk
Identify requirements
Occupational health and safety engineering for buildings
Assessing readine
Workflow plan
Feedback
Identify of sourc

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3-4 Laboratory Chemical Safety Summary (LCSS

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3-6 Toxic Effects of Laboratory Chemical

3-1 Introduction

All organizations in different types and sizes seek to reduce risks in the operational and communal environment, as this will raise the level of productive and service efficiency, So the university seeks to reduce the risk to the employees in the work environment. To achieve this, it requires that all groups are working in harmony and cooperation in order to create a safe campus environment and make sure that the risks have been identified and evaluated properly before starting work. A key element of planning university operations is assessing the hazards and potential risks associated with the chemicals and university operations to be used toxic, flammable, reactive, and explosive chemical substances. The primary responsibility for proper hazard evaluations and risk assessments lies with the person performing the work. That being said, the responsibility is shared by the laboratory supervisor. The actual evaluations and assessments may be performed by trained personnel, but these should be checked and authorized by the work area supervisors. The supervisor is also responsible for ensuring that everyone involved in work and those nearby understand the evaluations and assessments. As well as the supervisors must ensure that all staff involved have received sufficient training to perform the work assigned to them, and skills and knowledge to identify and manage risks which are necessary for planning and achieving work.

Additionally, specialists in Department of Occupational and Environmental Health can be consulted in order to advise workers and their supervisors on how to assess and manage risk, according to the requirements of the regulations approved by the competent authorities.

3.2 Risk Management:

In risk assessment terminology, **hazard** is defined as any source of **potential** damage, harm or adverse health effects on something or someone. **Risk** is the combination of the likelihood of the occurrence of a harm and the severity of that harm. Occupational ill health refers to all health problems in the work environment. The term covers health problems workers bring to the workplace, as well as health issues caused or made worse by work. Risk Assessment: Is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm and the likelihood of this occurring.

As it is stated in the Report of the World Day for Safety and Health at work in 2011, the primary purpose of the occupational health and safety is to manage occupational risk. Therefore, it is necessary to identify risk sources and evaluate the risk level to determine the

expected damage that workers or physical environment can be exposed to, to take control procedure of risk sources with high efficient. To simplify the risk management process, Occupational Safety and Health Unit in the United Kingdom developed a style of Five steps to assess risks:

Step 1: Identify the hazards
Step 2: Decide who might be harmed and how
Step 3: Evaluate the risks and decide on control measures
Step 4: Record your findings
Step 5: Review your assessment and update as and when necessary

3-3 Material Safety Data Sheets (MSDSs)

Beginning in 1991, every laboratory in which hazardous chemicals are used has been required by federal regulations (Occupational Safety and Health Administration [OSHA] Occupational Exposure to Hazardous Chemicals in Laboratories, 29 CFR § 1910.1450) to have a written handbook, which includes provisions capable of protecting personnel from the "health hazards presented by hazardous chemicals used in that particular workplace." All laboratory personnel should be familiar with and have ready access to their institution's handbook. In some laboratories, handbooks include standard operating procedures for work with specific chemical substances, and the handbook may be sufficient as the primary source of information used for risk assessment and experiment planning. However, most handbooks provide only general procedures for handling chemicals, and prudent experiment planning requires that laboratory personnel

consult additional sources for information on the properties of the substances that will be encountered in the proposed experiment. Many laboratories require documentation of specific hazards and controls for a proposed experiment.

Originally, the principal audience for MSDSs was constituted of health and safety professionals (who are responsible for formulating safe workplace practices), medical personnel (who direct medical surveillance programs and treat exposed workers), and emergency responders (e.g., fire department personnel). With the promulgation of federal regulations such as the OSHA Hazard Communication Standard (29 CFR § 1910.1200) and the OSHA Laboratory Standard (29 CFR § 1910.1450), the audience for MSDSs has expanded to include trained laboratory personnel in industrial and academic laboratories. However, not all MSDSs are written to meet the requirements of this new audience effectively.

In summary, among the currently available resources, MSDSs remain the best single source of information for the purpose of evaluating the hazards and assessing the risks of chemical substances. However, laboratory personnel should recognize the limitations of MSDSs as applied to laboratory-scale operations. If MSDSs are not adequate, specific laboratory operating procedures should be available for the specific laboratory manipulations to be employed:

1. **The quality of MSDSs produced by different chemical suppliers varies widely. The utility of some MSDSs is compromised by vague and unqualified generalizations and internal inconsistencies.**

2. **Unique morphology of solid hazardous chemicals may not be addressed in MSDSs; for example, an MSDS for nano-size titanium dioxide may not present the unique toxicity considerations for these ultrafine particulates.**

3. **MSDSs must describe control measures and precautions for work on a variety of scales, ranging from microscale laboratory experiments to large manufacturing operations. Some procedures outlined in an MSDS may therefore be unnecessary or inappropriate for laboratory-scale work. An unfortunate consequence of this problem is that it tends to breed a lack of confidence in the relevance of the MSDS to laboratory-scale work.**

4. **Many MSDSs comprehensively list all conceivable health hazards associated with a substance without differentiating which are most significant and which are most likely to actually be encountered. As a result, trained laboratory personnel may not distinguish highly hazardous materials from moderately hazardous and relatively harmless ones.**

From the above, lab supervisor involvement process depends on conducting experiments on the training level and efficiency of the personnel involved in performing experiments. In addition, you can consult specialists in the university environmental and occupational health management, in order to advise the workers in laboratories and their supervisors on how to assess risks according to the requirements of the regulations approved by the competent authorities. [٣]

OSHA regulations require that manufacturers and distributors of hazardous chemicals provide users with material safety data sheets (MSDSs),[1] which are designed to provide the information needed to protect users from any hazards that may be associated with the product.

MSDSs have become the primary vehicle through which the potential hazards of materials obtained from commercial sources are communicated to trained laboratory personnel. Institutions are required by law (OSHA Hazard Communication Standard) to retain and make readily available the MSDSs provided by chemical suppliers.

The MSDSs themselves may be electronic or on paper, as long as employees have unrestricted access to the documents. As the first step in risk assessment, trained laboratory personnel should examine any plan for a proposed experiment and identify the chemicals with toxicological properties they are not familiar with from previous experience. The MSDS for each unfamiliar chemical should be examined. Procedures for accessing MSDS files vary from institution to institution. In some cases, MSDS files are present in each laboratory, but often complete files of MSDSs are maintained only in a central location, such as the institution's EHS office. Many laboratories are able to access MSDSs electronically, either from CD-ROM disks, via the internet, or from other computer networks. Laboratory personnel can always contact the chemical supplier directly and request that an MSDS be sent by mail.

MSDSs are technical documents, several pages long, typically beginning with a compilation of data on the physical, chemical, and toxicological properties of the substance and providing concise suggestions for handling, storage, and disposal. Finally, emergency and first-aid procedures are usually outlined. At present, there is no required format for an MSDS; however, OSHA recommends the general 16-part format created by the American National Standards Institute (ANSI Z400.1). The information typically found in an MSDS follows:

1. **Supplier (with address and phone number) and date MSDS was prepared or revised. Toxicity data and exposure limits sometimes undergo revision, and for this reason MSDSs should be reviewed periodically to check that they contain up-to-date**

information. Phone numbers are provided so that, if necessary, users can contact the supplier to obtain additional information on hazards and emergency procedures.

2. **Chemical. For products that are mixtures, this section may include the identity of most but not every ingredient. Hazardous chemicals must be identified. Common synonyms are usually listed.**

3. **Physical and chemical properties. Data such as melting point, boiling point, and molecular weight are included here.**

4. **Physical hazards. This section provides data related to flammability, reactivity, and explosion hazards.**

5. **Toxicity data. OSHA, the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH) exposure limits are listed. Many MSDSs provide lengthy and comprehensive compilations of toxicity data and even references to applicable federal standards and regulations.**

6. **Health hazards. Acute and chronic health hazards are listed, together with the signs and symptoms of exposure. The primary routes of entry of the substance into the body are also described. In addition, potential carcinogens are explicitly identified. In some MSDSs, this list of toxic effects is quite lengthy and includes every possible harmful effect the substance has under the conditions of every conceivable use.**

7. **Storage and handling procedures. This section usually consists of a list of precautions to be taken in handling and storing the material. Particular attention is devoted to listing appropriate control measures, such as the use of engineering**

controls and personal protective equipment necessary to prevent harmful exposures. Because an MSDS is written to address the largest scale at which the material could conceivably be used, the procedures recommended may involve more stringent precautions than are necessary in the context of laboratory use.

8. **Emergency and first-aid procedures. This section usually includes recommendations for firefighting procedures, first-aid treatment, and steps to be taken if the material is released or spilled. Again, the measures outlined here are chosen to encompass worst-case scenarios, including accidents on a larger scale than are likely to occur in a laboratory.**

9. **Disposal considerations. Some MSDSs provide guidelines for the proper disposal of waste material. Others direct the users to dispose of the material in accordance with federal, state, and local guidelines.**

10. **Transportation information. This chapter only evaluates the hazards and assesses the risks associated with chemicals *in the context of laboratory use*. MSDSs, in contrast, must address the hazards associated with chemicals in all possible situations, including industrial manufacturing operations and large-scale transportation accidents. For this reason, some of the information in an MSDS may not be relevant to the handling and use of that chemical in a laboratory. For example, most MSDSs stipulate that self-contained breathing apparatus and heavy rubber gloves and boots be worn in cleaning up spills, even of relatively nontoxic materials such as acetone. Such precautions, however, might be unnecessary in laboratory-scale spills of acetone and other substances of low toxicity.**

11. Requirements for the disposal of waste:

Material Safety Data Sheet provides guidelines for proper disposal of waste resulting from use of the material according to adopted regulations and instructions.

12. Limits:

Hazardous chemicals are characterized by what is known as the limits in addition to the of Permissible Exposure Limits PEL, and the Threshold Limits Values TLV which are concentrations part per million or mg per cubic meter) mg / m 3 (which should not be exceeded during the period of time, usually 15 minutes.

13. Installation of mixtures:

It includes all hazardous ingredients with concentrations higher than 1%, and all the carcinogens in concentrations higher than 0.1%.

14. Control standards:

They include a list of protection clothes, gloves and tools for protecting respiratory. If it is necessary to deal with the substance in the degassing closet or in the Glove Box or in an additional ventilation system, such recommendation has been placed under this section or under this title). Note here that the use of most of the breathing masks requires training and examination by a specialist).

15. The Risk of Fire or Explosion Information:

It clarifies whether the chemical is depending on the physical state (solid - liquid - gaseous) flammable or explosive, and products of combustion or explosion, as some chemicals ignite without a spark or flame or any ignition source else. As summarized below, some of the physical properties affecting the combustion or explosion of chemicals:

a. Flash Degree: lower temperature that released chemical vapors at concentrations of atmospheric air minimums to ignite the flame.

B. The degree of self-ignition: it is the less temperature when chemical self-ignites.

C. Ignition limits: all chemicals, flammable and volatile (removable evaporation), a concentration of minimum and maximum in the air, so that higher or lower cannot be ignited. The limits of ignition are approximate values expressed in percentages by volume in air at atmospheric pressure and ambient temperature, and it should be noted here that the higher the temperature, the limits of the minimum ignition less and the limits of the upper ignition increases, and also the increase in pressure causes the decrease in the range of minimum ignition and an increase in the upper limits of ignition.

3-4 Laboratory Chemical Safety Summaries (LCSSs)

As discussed above, although MSDSs are invaluable resources, they suffer some limitations as applied to risk assessment in the specific context of the laboratory. Committee-generated LCSSs, which are tailored to trained laboratory personnel, are on the CD accompanying this book. As indicated in their name, LCSSs provide information on chemicals in the context of laboratory use. These documents are summaries and are not intended to be comprehensive or to fulfill the needs of all conceivable users of a chemical. In conjunction with the guidelines described in this chapter, the LCSS gives essential information required to assess the risks associated with the use of a particular chemical in the laboratory.

The format, organization, and contents of LCSSs are described in detail in the introduction on the CD. Included in an LCSS are the key physical, chemical, and toxicological data necessary to evaluate the relative degree of hazard posed by a substance. LCSSs also contain a

concise critical discussion, presented in a style readily understandable to trained laboratory personnel, of the toxicity, flammability, reactivity, and explosivity of the chemical; recommendations for the handling, storage, and disposal of the title substance; and first-aid and emergency response procedures.

The CD contains LCSSs for 91 chemical substances. Several criteria were used in selecting these chemicals, the most important consideration being whether the substance is commonly used in laboratories. Preference was also given to materials that pose relatively serious hazards. Finally, an effort was made to select chemicals representing a variety of classes of substances, so as to provide models for the future development of additional LCSSs. A blank copy of the form is provided for development of laboratory-specific LCSSs.

3-5 Labels

Commercial suppliers are required by law (OSHA Hazard Communication Standard) to provide their chemicals in containers with precautionary labels. Labels usually present concise and nontechnical summaries of the principal hazards associated with their contents. Note that precautionary labels do not replace MSDSs and LCSSs as the primary sources of information for risk assessment in the laboratory. However, labels serve as valuable reminders of the key hazards associated with the substance. As with the MSDS, the quality of information presented on a label can be inconsistent. Additionally, labeling is not always required for chemicals transferred between laboratories within the same building.

a. The name of the chemical substance contained inside the packaging / bottle.

B. One of the three cautionary words: danger, warning or careful to refer to the degree of seriousness or the dangers of the chemical. Risk or expected of the chemical hazards when handling them and draw a logo indicating the danger.

C. Safety standards that will protect users of the material from the harmful effects of the hazardous substance

D. First aid if necessary to mitigate or prevent an aggravation of the injury by providing medical assistance and

E. Instructions in case of a fire.

F. Ways and instructions to deal with the spilled of the chemical.

G. The necessary instructions in case of a chemical needs special handling or storage of private roads.

H. The name, address and phone number of the manufacturer or supplier company.

3-6Toxic Effects of Laboratory Chemical

The chemicals encountered in the laboratory have a broad spectrum of physical, chemical, and toxicological properties and physiological effects. The risks associated with chemicals must be well understood prior to their use in an experiment. The risk of toxic effects is related to both the extent of exposure and the inherent toxicity of a chemical. As discussed in detail below, extent of exposure is determined by the dose, the duration and frequency of exposure, and the route of exposure. Exposure to even large doses of chemicals

with little inherent toxicity, such as phosphate buffer, presents low risk. In contrast, even small quantities of chemicals with high inherent toxicity or corrosively may cause significant adverse effects. The duration and frequency of exposure are also critical factors in determining whether a chemical will produce harmful effects. A single exposure to some chemicals is sufficient to produce an adverse health effect; for other chemicals repeated exposure is required to produce toxic effects. For most substances, the route of exposure (through the skin, the eyes, the gastrointestinal tract, or the respiratory tract) is also an important consideration in risk assessment. For chemicals that are systemic toxicants, the internal dose to the target organ is a critical factor. Exposure to acute toxicants can be guided by well-defined toxicity parameters based on animal studies and often human exposure from accidental poisoning. The analogous quantitative data needed to make decisions about the neurotoxicity and immunogenicity of various chemicals is often unavailable.

When considering possible toxicity hazards while planning an experiment, recognizing that *the combination of the toxic effects of two substances may be significantly greater than the toxic effect of either substance alone* is important. Because most chemical reactions produce mixtures of substances with combined toxicities that have never been evaluated, it is prudent to assume that mixtures of different substances (i.e., chemical reaction mixtures) will be more toxic than their most toxic ingredient. Furthermore, chemical reactions involving two or more substances may form reaction products that are significantly more toxic than the starting reactants. This possibility of generating toxic reaction products may not be anticipated by trained laboratory personnel in cases where the reactants are mixed unintentionally.

Risk Assessment in the Work Environment Form

Date:	**Position / type of work:**					
Audit/adoption	**Evaluator Name:**					
Implementation date:	**Control devices**	**Sev**	**Lik**	**S x L**	**Risk Source**	**Activity**

				= R		

Chapter 4

Waste Management in laboratories

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4-1 Introduction

4-2 Waste Characterization

4-3 Multi-Hazardous Waste

4-4 General requirements for the disposal of hazardous waste

4-5 Collection of Waste **in laboratories.**

4-6 Collection of Waste in a Central Area

4-1 Introduction

This chapter presents methods for the management and ultimate disposal of laboratory waste that may present chemical hazards, which the wrong handle of them may cause creating high risk sources to public health and the environment. As well as those multi-hazardous wastes which contain some combination of chemical, radioactive, and biological hazards. The best strategy for managing laboratory waste aims to maximize safety and minimize environmental impact. This strategy includes hierarchy for managing chemicals and waste to accomplish these objectives.

The initial responsibility for implementing this hierarchy rests with trained laboratory personnel. These individuals are in the best position to know the chemical and physical properties of the materials they have used or synthesized. They are responsible for evaluating hazards, providing information necessary to make an accurate waste determination, and assisting in the evaluation of appropriate strategies for management, minimization, and disposal.

The overriding principle governing the prudent handling of laboratory waste is that *no activity should begin unless a plan for the disposal of nonhazardous and hazardous waste has been formulated*. Application of this simple principle ensures that the numerous state and federal regulatory requirements for waste handling are met and avoids unexpected difficulties, such as the generation of a form of waste (e.g., chemical, radioactive, biological) that the institution is not prepared to deal with.

There are four tiers to waste management to reduce its environmental impact:

1-pollution prevention and source reduction;

2- Reuse or redistribution of unwanted, surplus materials;

3-treatment, reclamation, and recycling of materials within the waste;

4-and disposal through incineration, treatment, or land burial

The first tier of this strategic hierarchy incorporates the principles of green chemistry pollution prevention and source reduction. Clearly, the best approach to laboratory waste is preventing its generation. Examples include reducing the scale of laboratory operations, reducing the formation of waste during laboratory operations, and substituting nonhazardous or less hazardous chemicals in chemical procedures.

The second strategic tier is to reuse unwanted material, redistribute surplus chemicals, and reduce hazards. Practices that implement this strategy include purchasing only what is needed, keeping chemical inventories to prevent the purchase of duplicates, and reusing excess materials. Sanitary sewer disposal of certain aqueous liquids is considered within this tier, although there are many restrictions At this tier it is important for laboratory personnel and

environmental health and safety staff to work cooperatively to determine the point at which the chemical becomes regulated as a waste and to ensure that requirements are met.

The third strategic tier also provides safety and environmental benefits .If waste cannot be prevented or minimized, the organization should consider recycling chemicals that can be recovered safely from the waste and the potential for recovering energy from the waste (e.g., using solvent as a fuel).

The fourth strategic tier for managing laboratory waste includes incineration, other treatment methods, and land disposal. Decisions within this tier consider the environmental fate of the waste and its constituents and process byproducts after it leaves the institution or firm. As with other tiers, the goal is to minimize risk to health and the environment. Land disposal is the least desirable disposal method. Although modern hazardous waste landfills can contain waste for many decades, there is always a future risk of leaking, contaminated runoff or other harmful releases to the environment.

4-2 Characterization of Waste

Waste is defined as materials that must be disposed, intended to be disposed, or no longer valid for any other use. The material is called waste after leaving the lab, but the institution often has a way to re-use or re-distribute materials to be used for other procedures, It is noted that some organizations may consider some materials as waste if they are left for long periods or in their nature like waste. The great variety of laboratory experimental or newly synthesized waste makes waste categorization challenging. Categorization procedures must account for the common laboratory waste management practices of placing small containers of waste chemicals into a larger over pack drum, and combining of many solvents and solutes into a single drum of flammable liquids. There are several acceptable information sources for waste characterization, including the identity of the source or raw materials, in-laboratory test procedures, and analysis by an environmental laboratory. *Generator knowledge* can be used for waste characterization, such as the knowledge of waste characteristics and constituents by laboratory personnel who conducted the process, procedure, or experiment

4.3 Multihazardous Waste

Multihazardous waste is a waste that presents any combination of chemical, radioactive, or biological hazards. The management of multi-hazardous waste is particularly challenging for research laboratories where there are frequent changes in protocols, procedures, materials, and waste generating processes. These difficult and complex management issues can also make it difficult to promote and sustain prudent pollution prevention practices. The pollution prevention

act emphasizes source reduction as the most desirable approach for preventing or reducing pollution. The policy created a new hierarchy for the management of hazardous wastes. Such efforts are considered successful when the researchers and Staff of the environmental and occupational health management work to evaluate laboratory operations.

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The best methods that achieve reduction in the mixed waste is to modify and improve laboratory operations or to use alternative materials. Such simple operational improvements may reduce the multiple risks of waste, thus, it is necessary to supply the chemical, radiological and biological substances in limited quantities for a planned experiment to avoid the production of a large surplus, which may end up in the waste containers, so it is necessary to adopt measures that help in preventing mixing radioactive waste with other waste.

The application of sound and effective management system for such waste is very necessary to protect public health and safety of the environment. It is necessary to apply the following hierarchy to reduce of multi-hazardous waste production:

- **Source reduction.**
- **Recycling.**
- **Treatment.**
- **Disposal.**

Prudent waste management methods include a commitment by senior management to develop and support a waste minimization program. The program development should involve experienced laboratory personnel in planning waste minimization strategies and identifying source reduction options, such as incorporating pollution prevention goals into project proposals. Training of laboratory personnel to recognize opportunities for source reduction, reviewing research proposals to ensure adoption of available source reduction strategies, improving compliance with regulatory requirements, and institutional policy are among the new management initiatives at research institutions promoting pollution prevention. Multihazardous waste requires complex attention because of its combination of hazards and regulatory controls. A primary purpose of the risk assessment is to determine which hazardous constituent of the multi-hazardous waste presents the greatest risk. This knowledge can help identify source reduction and treatment possibilities to reduce the risk of the waste. An assessment that determines that a waste constituent does not present a significant risk may provide an opportunity for regulatory flexibility. Waste management options include recycling, laboratory methods, management at institutional waste facilities, and treatment and disposal at commercial sites. Options can vary considerably between laboratories depending upon institutional capabilities and state and local laws. It may be appropriate to manage the waste in order of risk priority, from high to low risk. Options must be compatible with all hazards, and combinations of waste management methods may be limited by their order of application

4-4 General Requirements for the Disposal of Hazardous Waste:

The proper handling of hazardous in academic laboratories waste is an important and essential factor to reduce the negative effects of these wastes on public health and the environment, and all laboratory personnel in different categories must be aware of their responsibilities on the need to comply with regulations and instructions for proper disposal of hazardous waste. Each kind of waste must be put in the allocated container, and it is prohibited to dispose hazardous liquid waste in the wash basin or in sewage banks except for authorized persons, for example, water and aqueous solutions of sodium chloride, sugar and soap in the laboratory can be disposed directly into the drainage basins. Thus, the need to develop a plan for laboratories management and performance evaluation consists of:

1. Training requirements,

2. Hazardous waste determinations

3. laboratory cleanouts
4. container standards
5. labeling standards,

6. removal frequency of unwanted chemicals,

7. Emergency plan.

4-5 Collection of Waste in Laboratories

Laboratory experiments generate a great variety of waste, including used disposable laboratory ware, so begin no activity unless a plan for disposal of all waste, hazardous and nonhazardous, has been formulated. The accumulation and temporary storage of waste in the laboratory is called *satellite accumulation.* Each category of waste has certain precautions and appropriate disposal methods. Below is a list of requirements and good practices for accumulating chemical waste in the laboratory:

- **Collect hazardous or flammable waste solvents in an appropriate container pending transfer to the institution's central facility or satellite site for chemical waste handling or pickup by commercial disposal firm. Often, different kinds of waste are accumulated within a common container.**
- **Take care not to mix incompatible waste. This is a special concern with commingled waste solvents, which must be chemically compatible to ensure that heat generation, gas evolution, or another reaction does not occur.**

- **Keep wastes segregated by how they will be managed**

- **Collect waste in dependable containers that are compatible with their contents. Separate containers of incompatible materials physically or otherwise stored in a protective manner.**
- **Use an appropriate container for the collection of liquid waste. Do not use galvanized steel safety cans for halogenated waste solvents because they tend to corrode and leak.**
- **Clearly and securely label waste containers with their contents.**

Trained laboratory personnel, who are most familiar with the waste and its generation, need to be actively involved in waste identification and management decisions, so that the waste is managed safely and efficiently. Often the appropriate time to decide to recycle or reuse surplus materials is shortly after the waste is generated, rather than when they are sent for disposal. Once combined with other waste materials, recycling or reuse may be more difficult. Evaluate all the costs and benefits of either decision at this time.

4-6 Collection of Waste in a Central Area

The central accumulation area is an important component in the organization's chemical management plan. In addition to being the primary location where waste management occurs, it may also be the location where excess

chemicals are held for possible redistribution. Along with the laboratory, the central accumulation area is often where hazard reduction of waste takes place through allowable on-site treatment processes. The central accumulation area is often the appropriate place to accomplish considerable cost savings by commingling (i.e., combining) similar waste materials. This is the process where compatible wastes from various sources are combined prior to disposal.

In some cases the disposal method and ultimate fate of the waste require that different wastes not be accumulated together. It is important to know that compatible wastes from various sources are combined prior to disposal, because mixing waste requires transfer of waste between containers, the identity of all materials must be known and their compatibility understood. Although these procedures are very cost-effective, they require additional safety precautions, including the use of personal protective equipment and special and engineering controls.

Central accumulation areas should have fire suppression systems, ventilation, and dikes to avoid sewer contamination in case of a spill.

Employees must be trained in correct handling of the materials as well as contingency planning and emergency response. The area should be secure, and employees should be encouraged to report any suspicious activity. Employees should know how to activate alarms, how to use fire extinguishers and other emergency response equipment, how to exit, and the location of the exterior assembly point. Be sure to document training and provide periodic refreshers.

Transportation of waste from laboratories (satellite accumulation areas) to the central accumulation area also requires specific attention to safety. Transport materials in appropriate and clearly labeled containers. Make provision for spill control in case of an accident during transportation and handling. Larger institutions are advised to have an internal tracking system to follow the movement of waste. To dispose of non-hazardous waste, it is essential when mixing different types of waste, dealing with the mix as a hazardous waste, and some laboratory waste is not hazardous, but it should be managed safely and disposed according to adopted regulations and instructions.