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[SAFETY AT LABORATORIES]

Chapter 1: Introductions and Definitions:

1. Laboratory:

It is a space that was set for the studies and experiments for the researches and scientific discoveries and analysis that requires the usage of specific tools and equipments.

2. Work Table:

Trails and Experiments occur upon it (the height must be 80-90 cm from the ground). It must be equipped with the proper utility that is required in such labs like (water, Electricity, Butane gas, Pressed Air, etc.) and it must be designed with a proper drain.

3. Extras:

Such as: Cleaning Materials, Supply, Storage, Books, and Waste Disposal.

4. Explosive Material:

Unstable and decompose rapidly due to collision, friction, or heat generating a lot of heat and gas which may cause collisions

5. The System:

Civil Defense System issued by the royal decree # (\cdot / ρ) and dated 5/10/1406 AH and any other related regulations.

6. Designated Civil Representative:

The person or people assigned by the general directorate of civil defense to do the inspections

7. The competent Authority:

It is Ministry of the Interior (General Directorate of Civil Defense) and all general authorities that is related to the clearance of laboratories.

8. Safety in charge:

One of the lab's personal who received safety trainings.

9. Standards:

A. SASO: Standards that are issued by Saudi Standards, Metrology and quality Org.

B. ISO: it is the foreign standards that are certified by SASO (legal documents must be provided)

10. Corrosive Chemicals:

Substances that could cause burns when it touches skin or eyes and could harm respiratory system. Severity of each substance differs in accordance to its chemical and physical properties and it is divided into two sections:

A. **Initials:**

They cause general infections when exposure but causes localized wounds.

B. **Secondary:**

They cause un-localized infection besides localized wounds or localized erosive to the skin cells.

11. Flammable Liquids:

Liquids with flash point between 21 °C and 55°C

A. **Flash Point:**

It is the lowest temperature at which liquid can vaporize to form an ignitable mixture in air.

B. **Ignition Point:**

It is the lowest temperature at which liquid makes enough vapor to form an ignitable mixture in which flame is sustained even after removing the torch that caused the ignition.

C. **The ambit of explosion:**

It is the percentage volume of water vapor in the air where above it there is flammable mixture.

12. Oxidized materials:

A substance that could react exothermically with other substances

13. Poisons:

Substance that could cause severe injuries or even death when touched, inhaled, or swallowed.

14. Compressed Gases:

Pure or mixture of gases in a container where the pressure below 40 lb. / in. at 21 °C or at pressure of 104 lb. / in. at 45 °C or a flammable liquid at vapor pressure of 40 lb./ in. at higher than 38°C

15. Flammable gases:

Any gas satisfies the lowest ignition ambit.

Ch. 3: Safety Requirements and Protection:

Safety Precautions and Personal Behavior inside Labs:

1. A shower should be provided at the entrance away from any equipments and electricity socket.
2. Eye wash sinks at proper places
3. Signs and posters that shows the location of the sprinkles and showers.
4. Proper insolation for the outdoor showers so it be at normal temperature at summer and winter
5. First Aid kit must be provided with taking in consideration the hazards of the laboratory and it must be placed in a suitable and visible location
6. Floor must be clean at all times.
7. Aisles and passageways that leads to emergency exit must be clear of any obstacles and guiding lines is drone on floor leads to exit
8. Any spillage must be removed quickly especially flammable solvents, glass, Mercury, and strong acids and bases.
9. Labs must contain duct unit to suck any fume and gasses.
10. Explosive and Flammable material must be stored away from sun, heat, and any possible source of electric spark.
11. All stored materials and substances must be categorized and recorded along with the quantities, storing method, physical and chemical properties, sensitivity, flammability, water reaction, and disposal method required.
12. Gears and clothes must be provided that is suitable for the lab such as masks. Goggles, safety shoes, gloves, fire resistance blanket etc.
13. Smoking, Eating, and Drinking is strictly prohibited inside labs, and guided board is put in Arabic and English.
14. Lab must be organized and tidy at all time.
15. The one in charge must be responsible for the supervision of the entire lab.
16. When starting any work at the lab it must be organized and stepwise and working table must be clean from contaminated materials and used equipments.
17. Cleaning must be after every step of the trail.
18. Labs are for authorized people only any other must not enter. Signs must be hanged at entrance also digital cameras for the entrance and exit to insure privacy for the lab.
19. Staff is periodically checked with x ray and white blood cell count for those who work with radioactive material. All staff must be trained on first aid and how to revive the heart.
20. Unknown exposed chemicals must be treated with extreme caution.
21. Chemist supervisors must inform their staff for any possible risks.

22. User must not leave the lab during the experiment before consulting the supervisor and informing him in where the experiment at. If the experiment took more than 24 hours then it must be monitored at all time with someone who is qualified and knows the procedures and risks.
23. If the user will be away from his experiment for long time then it must be stopped.
24. There must be no running in the labs and passageways.
25. Pranks and physical jokes are strictly prohibited.
26. Opening and closing doors must be with care at all times.
27. Don't start any electric device before making that it won't cause any harm to any of the staff.
28. Lab supervisor must deal with machines with extreme care when it is running.
29. Don't pipette by mouth.
30. Use lubricants to enter a glass rod in bung if necessary, don't force it.
31. Always hold rod vertically
32. Apparatus and tools must be used for they were designed for.
33. Experiments that uses toxic chemicals should be performed in a contaminated and insolated room and mask must be worn at all time.
34. When using a large quantity of flammable solutions electric heating is advised.
35. Users of the lab must know the location of the main switches in the lab for the electricity, gas and water. And a sketch of the lab with the main switches labeled must be at a proper location inside and outside the lab in case of emergency.
36. When dealing with unknown or new organic substances risk is not always clear, so handle it with care
37. Solutions that flames at a degree less than 60 °C can set to flames by electric heater that was recently turned off and still has some heat.
38. Disposing of flammable solutions must be with supervision of the lab supervisor.
39. Tubes and glass containers must be held with the proper holder and don't handle large devices with wet hands.
40. Labs must contain electric heaters instead of flame stove.
41. All chemical must be labeled with risks and preventions and how to store it and what is the proper way to extinguish it.
42. Lab must provide containers for recycling and disposal for regular trash, glass, biological, chemical, and radioactive material.

Requirements of Self Precautions:

First: Toxic Precautions:

1. Users must have access to Toxic materials index so they know what they are dealing with. Copy of that index must be available at the lab.
2. Only take the amount you require from toxic materials.
3. User must wear Proper gears when dealing with toxic material
4. Contaminated clothe must be cleaned or disposed of instantly.
5. The place must have good ventilation system
6. Periodic checkups must be done for the lab staff, and in case of toxicities, medical care is necessary.

Second: to Deal with compressed gases and chemical substances that may cause cancer and radioactive materials and explosives, user must be authorized and has clearance to use such materials.

A. Dealing with compressed gases:

1. Identify the cylinder content.
2. Identify physical and chemical properties.
3. Store the cylinders at suitable temperature
4. Never use cylinders directly, always use regulators.
5. Cylinders must be handled with care when loading and unloading.
6. Cylinders that contain flammable gases and toxic gases must be stored where there is good ventilation system.
7. Cylinders must be always at vertical standing position.

B. Precautions from hazards of Flammable materials

1. Users must only handle flammable substances under duct.
2. When dealing with such materials, turn off any source of flame.
3. Masks must be worn
4. Goggles must be worn
5. Smoking and using of torch is prohibited when there is spillage or leak.
6. Don't transfer flammables with toxic, explosives, radioactive, and oxidized materials.
7. Avoid damaged containers when loading and unloading
8. Don't store flammables with oxidized materials especially chemicals that react with it
9. Don't store flammables under direct light of Sun.
10. Don't store Flammables with acids.
11. When dealing with flammables user must know dangerous reactions with other chemicals and its physical properties.

C. In case of fire:

1. Take good care because there might be flammable materials nearby.
2. Containers must be cooled with water to prevent explosion.
3. Clear out containers from the fire.

Ch. 4: Safety Conditions at Laboratory Buildings:

Classifications of Labs:

1. Class A (High Severity):

Where you have very large quantities of flammable and combustible liquids, such liquids usually has flash point below zero and boiling point of 35 °C or less.

2. Class B (Medium Severity):

Flammable and combustible liquids are of less dangerous than class A where the flash point is less than 21 °C and includes materials that ignites at normal heat or solids that ignites when it touches water or humid air.

3. Class C (Low Severity):

Flammable Liquids are not allowed in this lab.

Conditions and specifications of Labs that uses Radioisotopes:

In addition to biological Labs Safety conditions, Radioisotopes Labs should be:

1. Working tables must be made of lead that prevent radiation
2. Walls and buildings must be a thick concrete with a layer of Lead
3. Doors should be enforced with a layer of lead.
4. Staff must be provided with radiation protective clothes.
5. Store rooms must be prepared to prevent radiation through the walls (thick walls with a layer of lead)
6. A Lead storage container is used for the disposal of radioactive waste, and it is kept for 10 time half-life of the radioactive matter before it goes to sewer.
7. Solid radioactive materials must be stored in its specialized store and kept for ten times the half-life.
8. Labs that use U.V. light must provide special glasses for the users.
9. Staff must be aware of all the hazards that they may encounter and knows how to deal with them.
10. Warning poster must be put on the entrance that shows that the lab Uses radioactive material and unauthorized personal must not be allowed inside, percentage of radiation exposure must be measured periodically.

11. For more information review the authorities.

Conditions and Specifications of Labs that uses Explosive Materials:

1. Working area must be divided into two sections
 - a. Contains the hazardous of containers that are ready to explode
 - b. High concentrations of materials that may cause casualties of fatal injuries for staff.
2. Reactive materials that may cause exothermic reactions like polymerization and oxidization and organic reaction etc.
3. Using or installing materials that its chemical formation causes inherent risks, but their properties are not specified.
4. Precautions must be taken to prevent high pressure reaction in machines.
5. Walls of the lab must be enforced concrete.
- 6.
7. Labs constructions must be designed in according to the lab specifications.
8. Quantities of explosive materials and flammable liquids must be maintained at minimum.
9. High sensitivity fire detectors and automatic extinguishing system must be used in the lab.
10. Enforced concrete walls and blocks must be used in the areas that use explosives.
11. Ventilation system is required in such labs.
12. Experiments on explosive must be done on a contained space.

Hazards of Environmental pollution:

Rules and regulations of general laws of Environment and instructions from proper authorities must be followed.

Safety rules of electric and mechanic installations:

1. Devices and lines of electric equipment must be designed to prevent from risks of fumes, liquid, gases and dust.
2. Electric plugs and switches positions away from spilled and leaked liquids.
3. Fixed lights and plugs must be installed in an easy access and safe position.
4. Emergency lights must be installed in case of power off and it must be tested occasionally.
5. All equipment and devices must be grounded.
6. New equipment must be inspected before installation and tested once it is installed.

7. Light switches and lights must be isolated against hazards fumes.
8. Lightning conductor must be installed in the lab and must include all the metals in the lab.
9. Affective ventilation system must be provided for the labs.
10. All electric and mechanic equipment must be designed and installed with the knowledge of maintenance department and in according to SASO specification.
11. All electric outlets must contain three lines and the ground wire must be of high quality and low resistance.

Emergency Exit:

1. All means of escape must be provided (Normal exit, Emergency exit, stairs, gathering points, etc.) for all sections that will allow evacuation of the building in two minutes at the most, and number of exit is determined in accordance to the number of staff and visitors of the lab.
2. Exits must allow all the people to escape the building or the dangerous zone to the safety, and the distance must not exceed 22 meters from any point of the building to the nearest exit.
3. Aisles and passageways must not be closed by any object and emergency doors should match the specification.
4. No less than 2 exits in each floor and in the working zones such as:
 - a. Labs that contain explosive materials.
 - b. A class A lab with an area more than 500 sq. ft.
 - c. A class B or C lab with an area more than 1000 sq. ft.
 - d. Working area is close to the main exit.
5. Exit is organized so they won't lead to a dead end and all exits goes to the safety gathering point outside the building.
6. All emergency doors open in the exit side easily.
7. Exit passage path height 2.4 meter or more and door width 100 centimeter or more and the walls and doors must be fire resistance for at least 2 hours.
8. Emergency exits and normal exits must be distinguished, and they all must have clear emergency exit plate.
9. Lights of passage paths should have two sources of electricity, one is the main electric current of the building and the other is battery that turns on in power shortage.
10. Passage ways should be designed in according to SASO in building protection, and all the floors, walls, and roof of the aisles consists of inflammable materials.

Fire Fighting Supplies:

1. Hoses systems with 30 meter or less distance between the two hoses, one hose should cover at least 150 sq. m.
2. Signs and plates that show the location of the hose for easy access and use.
3. Hose must be put in a position that will allow reaching every part of the floor.
4. Pressure at the end must not be less than 2.1 bars.
5. Water source should supply 380 liter/min to the hoses.
6. Labs must be provided with proper fire extinguishers (6 kg chemical powder), one every 100 sq. m. of the lab.
7. Location of the extinguishers must be close to the exits and to the reach and civil defense is consulted in their number and location.
8. Extinguisher must be at clear and visible location.
9. Every extinguisher must have use instructions.
10. The extinguishing material must match the fire that may be caused in the facility.
11. Automatic extinguishing system for labs of class A and B, while for C class you can use Hoses.
12. Fire alarm and detection is designed for all the labs and it is connected to a monitoring room, and in case of alarm it should make a sound and flashes, also it can be set manually.
13. Other automatic extinguishers are used instead of sprinklers when needed.
14. Sprinklers are to be connected to the alarm system.
15. Lab owners are responsible to present a full study done by the authorized offices that should include a whole set up of the equipments, fire alarm, extinguishers and evacuation plan to the administration of civil defense.
16. All safety systems and equipments must match the standards given by SASO.

Evacuation plan:

First: Labs director in cooperation with safety director should lay an evacuation Plan that includes:

1. Notifying the civil defense squad and the proper authorities about fire directly.
2. Setting the rules of the special arrangements in the lab.
3. Setting the evacuation plan and the way of involvement to ensure staff and colleagues safety.
4. Minimizing the possibilities of accidents and achieving highest level of safety.
5. Minimizing the losses of people and properties in fire.
6. The plan should include how it will contain hazardous situations of fire such as toxic gases and pollution.
7. Reporting every accident directly and keeping a log of every incident.

8. Evaluate safety procedures when there is law activity to view problems and notes and fix them.
9. Sitting rally points.
10. Evaluating staff injuries and provide first aid.

Second: Plan's specifics:

1. The plan must contain all the documents and necessary information to control all accidents and covers all possibilities.
2. A log of all safety equipments and rescue must be available in the lab. It should also contain detailed plans showing the names of safety in charge and team and their schedule and tasks.
3. Signboards must be hanged in a visible location demonstrating the followed procedures in case of accidents; also it shows the emergency numbers.
4. Safety in charge must alter and develop the plan if there is a hole in applied training.
5. Civil defense must have a copy of the plan after the verification.

Third: Executing the plan:

In executing the plan you must:

1. Specify sensitive and dangerous points.
2. Specify locations of fire hazards and explosions.
3. Limit emergency situations such as: leak, poisoning, chemical reaction etc.
4. Determine the severity of fire.
5. Determine the interventions tools for each case.
6. Check and control the information of operation and devices functions.
7. Listen to the suggestions from other departments in relations regarding the plan. Departments such as; operation, maintenance, monitoring, etc.

Fourth: Plan training:

1. All staff must be trained.
2. Plan drills every 3 months.

Safety team duties in case of accidents:

1. **Defusing:** stop the work at the lab and defuse any unusual cause discovered
 - A. Start the alarm and call civil defense team.
 - B. Cut the power and gas sources and remove any flammable substance from the area.
 - C. Evacuating personal from lab.
 - D. Follow the evacuation plan and emergency exits.
 - E. Provide necessary information to the civil defense team about the location and nature of the incident.

2. **Fighting: when safety team discovers fire they should:**
 - A. Apply safety drills as practiced.
 - B. Fights the fire with the available tools and wait for help.
 - C. Keeping an eye on the area after extinguishing the fire for any possibilities of reigniting.
3. **Preventing fire from Spreading:**
 - A. Closing doors and windows at the area of the fire after evacuating everyone.
 - B. Shutting down elevators.
 - C. Clearing the area from any flammable and explosive substances.

In case of electric interference in the Rescue:

1. Cut the power source by the trained safety personals and notifying electric maintenance crew.
2. Rid the victim by insulated material if it was not possible to cut the power or it was difficult.
3. Perform first aid to the victim such as CPR and Artificial respiration.
4. CO₂ Extinguishers are better use in these cases.
5. Intervention equipments must be close to the hazardous areas.

Classification of fire at the lab:

1. Chemical fire:

Suitable material is used to extinguish that fire in accordance to the instructions on the substances container. Lab supervisor must make sure not to accept any chemicals that don't have labels of the substance name and properties and method of extinguishing.

2. Other substances

Fire Type	Extinguisher
Solid material such as wood, paper, Hay, etc.	Water
Flammable liquids like gasoline and diesel	CO ₂ foam and dry powder
Fire caused by Electricity	CO ₂ and dry powder
Metals burn such as Na, Mg, and Li	Metal specialized powder (non reactable)