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Standard Operating Procedure (SOP)

on

Hazardous Waste Management for HEIs

2024

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Acronyms and Abbreviation

CDD	Construction and Demolition Debris
DLIs	Disbursement Linked Indicators
EHS EP	Environmental Health and Safety
EPA	Extraction Procedure
EPR	Environment Protection Act
ESCP	Environment Protection Regulations
GHS	Environmental and Social Commitment Plan
HEIs	Globally Harmonized System
HWM	Higher Education Institutions
IPF	Hazardous Waste Management
NEHEP	Interplanetary File System
NHEP	Nurturing Excellence in Higher Education Program
PCBs	National Higher Education Program
PPE	Polychlorinated Bi-Phenyls
PPP	Personal Protective Equipment
RBF	Polluter Pays Principle
RHM	Results-based Financing
SAA	Regulated Hazardous Materials
SOP	Satellite Accumulation Area
SWM	Standard Operating Procedure
	Solid Waste Management Act
TCLP	Toxicity Characteristic Leaching Procedure

1. Background

The Nurturing Excellence in Higher Education is a hybrid PforR with an IPF component. The PforR will strategically support a sub-set of the government's National Higher Education Program (NHEP 2021/22 - 2025/26) leveraging the Results-based Financing (RBF) and technical support. The disbursement linked indicators (DLIs) will enhance the incentive for achieving selected priority reforms.

This HWM SOP is a part of the implementing and monitoring of an Environmental and Social Commitment Plan (ESCP) for Higher Education Institutions of Nepal, and strengthening their capacities to do so. ESCP is a major component of 'Nurturing Excellence in Higher Education Project (NEHEP)', which is being initiated and conducted by the University Grants Commission with the support of the World Bank.

The principal objectives of the NEHEP are to strengthen labor market relevance and quality of higher education, boost collaborative research and innovation, and enhance equitable access for underprivileged and disaster affected groups. It aims to strategically assist Government of Nepal's National Higher Education Program through four key results areas: (a) improving employability, entrepreneurship, and collaborative research, (b) strengthening governance and financing of higher education, (c) widening access to quality higher education, and (d) extending digitization of higher education.

2. Definition of Terms in Statement

- Hazardous Waste Management Team: Refers to the group of individuals responsible for overseeing and implementing the hazardous waste management procedures within the higher education institution.
- Hazardous Waste: Refers to waste materials that are potentially harmful to human health and the environment due to their physical, chemical, or biological characteristics. Examples of hazardous waste include toxic substances, flammable materials, corrosive chemicals, and reactive compounds.
- Higher Education Institution: Denotes an organization or establishment providing postsecondary education and offering various academic programs such as universities, colleges, or research institutions.
- Personal Protective Equipment (PPE): Denotes specialized clothing and equipment used by personnel involved in handling hazardous waste to protect themselves from potential health and safety hazards.
- Spill Response Plan: A plan outlining the immediate actions to be taken in the event of a hazardous waste spill or accident, aimed at minimizing potential harm to people and the environment.
- Standard Operating Procedure: Refers to a set of documented instructions and guidelines that outline the specific steps and processes to be followed for a particular task or operation. In this case, it pertains to hazardous waste management at a higher education institution.
- Waste Disposal: Refers to the proper methods and techniques for the final disposal of hazardous waste, ensuring compliance with relevant environmental regulations and best practices.
- Waste Handling: The safe and appropriate procedures for the collection, storage, and transport of hazardous waste within the higher education institution's premises.
- Waste Identification: The process of identifying and classifying different types of waste generated within the higher education institution, including hazardous waste, non-hazardous waste, recyclables, and other waste streams.
- Waste Management: Refers to the systematic handling, storage, transportation, treatment, and disposal of waste materials to minimize their impact on human health and the environment.
- Waste Minimization: The practice of reducing the amount of hazardous waste generated within the higher education institution through source reduction, recycling, and other waste reduction strategies.

3. Introduction

3.1 Hazardous Waste Identification

Proper hazardous waste management is necessary to protect the health and safety of the University and surrounding communities and the environment. Use and disposal of hazardous wastes without causing harm to the nature is a big challenge to the education institutes. Using appropriate amount of required chemicals, regeneration of used organic solvents, designing reactions at minimum scale, and resulting minimum waste in chemical laboratory to maintain clean and green environment is a part of green chemistry practice.

Hazardous waste is basically a broad term and encompasses many types of materials. Hazardous Chemicals which have the following four characteristics are considered to be hazardous by the EPA (2076) and EPR (2020):

A. IGNITABILITY A liquid which has a flash point of less than 60 deg C is considered ignitable by the EPA. This includes almost all organic solvents. Some examples are: Ethyl ether, Methanol, Ethanol, Acetone, Toluene, Benzene, Pentane, Hexane, Skelly B, Xylene, Formaldehyde, Heptane, Ethyl Acetate, Petroleum Ether.

B. CORROSIVITY an aqueous solution having a pH of less than or equal to 2, or greater than or equal to 12.5 is considered corrosive by the EPA. Corrosive materials also include thionyl chloride, solid, sodium hydroxide and other nonaqueous acids or bases.

C. REACTIVITY Chemicals that react violently with air or water are considered reactive by the EPA. An example is sodium metal. Reactive materials also include strong oxidizers, such as perchloric acids, and chemicals capable of detonation when subjected to an initiating source, such as old picric acid and phosphorous. Solutions of cyanide or sulfide that could generate toxic gases are also classified as a reactive by EPA.

D. TCLP (Toxicity characteristic leaching procedure) is a laboratory test to determine leaching. Chemicals characterized as toxic by the EPA may leach into the groundwater if improperly managed. EP toxic wastes include concentrated toxic metal solutions and the pesticides such as Endrin Lindane 2,4-D MethoxychlorToxaphene 2,4,5-TP Silvex etc.

A hazardous waste that displays a “Hazardous Characteristic” are not listed specifically by their chemical name but they are regulated as hazardous wastes because they exhibit one or more hazardous characteristics as mentioned above. They are also can be shown as GHS (Globally Harmonized System) pictogram (Figure1).

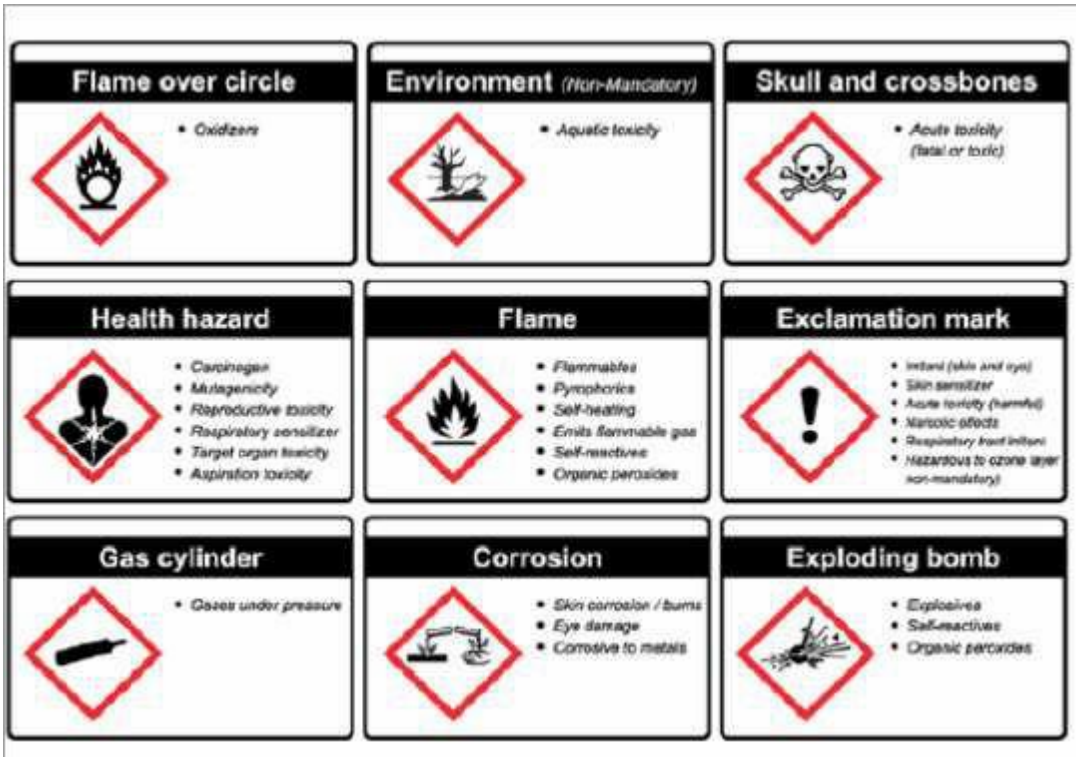

Figure 1.

Note: *The hazards and risks are not only limited to substances labeled as 'hazardous'.*

3.2 Applicability

As per the Environment Protection Act (EPA) 2076, Environment Protection Regulations (EPR) 2077 and Solid Waste Management Act (SWM) 2068 (2011), solid waste management is responsibility of solid waste generating organization itself. Hence fort HEI should take the responsibility of the management of all types of waste generated from the HEI. All the HEIs should committed to complying with applicable all federal and state regulations governing the storage, collection and disposal of regulated hazardous materials and hazardous (chemicals) waste generated at the HEI. In this regard this SOP is prepared to guide and facilitates the HEIs for the management of Hazardous waste. In the present context, it is not possible for complete management of HW generated from HEIs by themselves, as per today there is no officially designated body/ institute / organization for the Hazardous waste collection, proper disposal and management in Nepal. Such an entity is yet to be developed and envisioned in the country. This SOP, therefore believe in helping to develop and generate such type of business/ entrepreneur to be evolved in the country, in days to come. All the HW from the HEIs should be managed following the whole lifecycle of Solid Waste Management from generation to identification, proper handling, treatment, storage and disposal. The Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal was adopted in 1989 and entered into force in 1992. The central goal of the Basel Convention is "Environmentally sound management"(ESM).

3.3 Principles of Waste Management

This SOP follows the principle of Polluter pays principle (PPP), according to which all waste producers are legally and financially responsible for the safe handling and environmentally sound disposal of the waste they produce. The fact that the polluters should pay for the costs they impose on the environment is seen as an efficient incentive to produce less, segregate well and make the institution more committed and accountable for its management. The SOP consider the waste minimization and 3R (Reduce, Reuse and Recycle) principle of SWM. This SOP should be seen as to guide minimum requirement for the proper handling, safe storage, and management of HW from HEIs.

4. Purpose and Scope

4.1 Purpose

The purpose of this procedure is to ensure proper management of hazardous waste from activities conducted by or overseen by Management, faculties, students and laboratory assistance within the HEI premises.

4.2 Scope

This procedure applies to all hazardous waste disposal activities within the education institute. This SOP covers Hazardous wastes generated within the HEIs, that may include but not limited to the followings: Out of date chemicals, Waste from laboratory processes, Waste from maintenance processes from laboratories (Chemicals), Waste from landscaping and turf management processes (e.g. fertilizers and pesticides) (applicable for HEI's where Agricultural and Environmental studies take place), Construction and Demolition Debris (CDD), recyclable materials, lead containing materials, scrap metal, and sawdust, Spent batteries, aerosol cans, fluorescent light bulbs, and ballasts, Spent or discarded pharmaceuticals. (HEIs where Pharmacy, biotechnology, biochemistry studies going on)

The handling and disposal of Biological waste requires specialized training and facilities, and is not covered by this policy. Handling and disposal of such waste is managed by “National Healthcare Waste Management Standards and Operating Procedures 2020”; “Health Care Waste Management guideline 2071 (2014)”; The Public Health Service Act, 2075 (2018), Public Health Service Regulation 2077 (2020) and National Health Policy, 2076 (2019).

This SOP also do not cover the management of E-Wastes from HEIs. These are managed by Separate E-waste SOP.

5. Institutional Arrangement

5.1 HEI facility

Any defined space of the HEI / University, including a room, lab, series of labs, building, or controlled outdoor area.

5.2 Contact Person

- HEI should have Environmental Health and Safety (EHS) unit/ facility and EHS manager so far as possible.
- It is the responsibility of the faculty member or supervisor in charge of a HEI/University facility to assure that federal and state regulations on the use, storage, and disposal of RHM are obeyed. In the case of teaching laboratories and facilities, the department chair is responsible.
- EHS must be contacted to determine if wastes are subject to regulation and to answer any questions about the classification of waste, proper storage, handling, and disposal.
- Before a facility where RHM has been utilized is vacated for renovation, for new occupants, or upon the retirement of faculty members, the department responsible for the area must notify EHS to conduct an inspection of the facility.
- Any HM remaining in the facility must either be transferred to a facility where it can be used, or it must be disposed of as hazardous waste prior to the departure of the occupant. EHS staff can provide guidance regarding the proper disposal of any HM present.
- EHS may conduct periodic, unannounced inspections of University facilities. If RHM is not stored and labeled in a proper manner, occupants will be cited for an RHM violation and the responsible individual will be notified. If the violation is not corrected in a timely fashion, the department chair or supervisor, the dean or director of an administrative department, and/or the appropriate vice president will be notified.
- The contact persons' email and Phone no. should be making available to all.

6. Use, Storage, and Disposal of Regulated Hazardous Materials (RHM)

Use, Storage, and Disposal of Regulated Hazardous Materials in HEIs facilities are governed by the following:

6.1 Storage and Disposal

- Only use appropriate containers for the storage of HW materials.
- Properly label all HW containers.
- Keep waste containers closed.
- Store HW in a designated Satellite Accumulation Area (SAA). Satellite Accumulation Area (SAA) is a storage location at or near any point of generation where hazardous wastes initially accumulate, which is under the control of the operator of the process generating the waste. SAA should not block access to emergency equipment or exits. A container storing waste in a SAA may be “any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled”.

- ❖ Maintain a record book for the waste generated (type and quantity) at your laboratory Batteries: All waste batteries must be placed in a container such as a box or bag. Seal any leaking batteries in plastic bags ensuring there are no leaks.

  Paint Latex paint: It can be disposed in the regular garbage, provided the cans have been allowed to dry and no liquid paint residue is present. All other paints will be treated as chemical waste. Ensure cans are sealed and not leaking. For easier handling, place cans in a cardboard box.

  Aerosol Cans/Compressed Gas Cylinders: It should not be thrown out with regular garbage. Place all cans in a box and dispose as Chemical waste.

  Silica Gel Waste silica: It should be stored in plastic jugs, glass bottles and/or 20 L pails and dispose as chemical waste.

  Polychlorinated Bi-Phenyls (PCBs): DO NOT bulk any liquid potentially contaminated with PCBs. If PCBs are suspected, contact EH&S to make special arrangements for testing and transportation. Please call EH&S for the disposal of transformers, old capacitors, ballasts and other parts that could potentially contain PCBs.

7. Inspection and Monitoring

- All the activities related with Hazardous waste management within the HEI/ University premises should be periodically monitored as per requirement.
- All the activities related with Hazardous waste management within the HEI/ University premises should be regularly audit and keep the record.

8. Trainings

HEI/ University should organize regular trainings regarding HWM to all including teaching and non-teaching staffs, students etc.

9. Special Provision for HW from Laboratory

The HEIs which have Laboratories should manage HW with the guidance from Chemical laboratory guide books and are required to implement a wastewater treatment system to ensure the proper treatment of their wastewater before releasing it into public water bodies or municipal sewers or reference from another available standard guideline. For reference brief is also given in **Annex I**.

10. Other subjects which are not mentioned in SOP

The other subjects which are not mentioned in this SOP should be managed according to the country's legal practice. Respective HEI/ university can formulate additional bench marks.

ANNEX I: LABORATORY WASTE MANAGEMENT PRACTICES IN HEIs

Precautions to be taken while storing and handling chemicals: While working in a chemistry laboratory proper knowledge of safe handling of chemicals is very necessary as chemicals can cause you and others harm, cause skin allergies and asthma, because skin burns and eye damage and can lead to serious accidents.

Laboratory Chemical waste management should be developed considering the risk and hazards involved during generation of waste to human and environment. The following precautions should be undertaken.

1. **Chemical Purchasing plan**: All HEI should have chemical purchasing plan base upon Principle of Waste Minimization. The HEI is aimed to minimize the waste generation for the keeping the environment green and sustainable. To achieve the goal to minimize the volume of waste, the HEI urges all of the research labs to follow the practices mentioned below:

    a) Keep a record of chemicals (listing name, date of expiry, available quantity) in the laboratory.

    b) Do source reduction by simply ordering the smallest quantity of chemical materials required for your research

    c) Reduce the scale of laboratory experiments to reduce the volume of waste being produced whenever possible

    d) Follow protocols which generates less amount of wastes and requires a smaller number of chemicals (if possible)

    e) Substitute hazardous chemicals with non-hazardous chemicals whenever possible

    f) Share surplus chemical with other labs

    g) Avoid storing unused chemicals in the laboratory

2. **Contact persons:** In each laboratory a contact person should be designated to be facilitate as coordinator for the purchasing of chemicals, their storage, use, and generated waste management of the chemicals from the laboratory. His/ Her qualification should be mentioned. Contact persons' phone no. and email should be make available to all.

3. **Listing of Chemicals:** All the laboratory should have list of all the chemicals available in the laboratory and their possible waste generation after use and it should be easily available to all.
4. **Use of Safety Data Sheet**: All the persons who works/ and use the laboratory should follow the safety data sheet procedures for generated waste management.

5. **Storage of Chemicals**: All the chemicals should be stored according to the separation procedures employed in ANNEX I A.

6. **Chemical Handling**: Hazardous and risks chemicals are handled according to the Safety Data Sheet.

7. **Control of Laboratory Entry:** Chemicals are allowed to handled only to the respective authorized persons only. Avoid the entry of unnecessary, and unrelated persons inside the laboratory

8. **Safety Labeling:** The laboratory waste containers should be properly labeled according to the Global Harmonization System with symbol and pictures as in ANNEX I B.

9. **Substitute hazardous chemicals**: Substitute hazardous chemicals with non-hazardous chemicals whenever possible.

10. **Emergency Preparedness and Accident Handling:** Laboratory should have Emergency Preparedness and Accident Handling according to ANNEX I C.

11. **Hazardous Waste Separation:** Hazardous waste from the laboratory should be separated according to ANNEX I D, and disposed safely using different safe disposition methods such as with addition of water, neutralization, reuse, recovery, redistilled, solidification, incineration, deposition etc.

12. **HW Risk Assessment Procedure:** Possible risk of laboratory chemicals during use, handling and waste management to persons and environment should be assessed according to Risk Assessment Procedure given in ANNEX I E.

13. **Personal Protection Practices:** On the basis of Risk Assessment procedure as mentioned in 12. In order to safely work in the laboratory every personal (teachers, students, administrators, laboratory assistance etc.) should be provided with Safety Equipment, Personal Protective Equipment and Security Equipment as mentioned in ANNEX I F.

14. **Management of Date Expired Chemicals:** Date Expired Chemicals should be handled according to the "Safety Data Sheet" description and procedure.

15. **Transportation:** Waste transportation vehicles should have clear sign of Chemical Waste Transportation. Required precautions should be followed during Chemical waste transportation and Transporter should be well informed about the followings:

    a) Physical state of Chemical Waste
    b) Water reactivity property
    c) Water solubility
    d) pH
    e) Flammability
    f) Presence of Oxidizers

g) Presence of Sulphide and Cyanide
h) Presence of Halogens
i) Presence of Radioactive substances
j) Presence of Biological risk substances
k) Presence of Toxic substances
l) Presence of Polychloronated biphenyl
m) Presence of strong odorous substances

16. **Inspection and Monitoring:** All the procedures of management of Chemical wastes from laboratory should undertake regular inspection and monitoring through expert in respective subject.
17. **Ultimate disposal:** The disposal of HW either solid, liquid or gaseous forms made disposed according to the country's legal practice, using safe and standard procedure. Establishing a comprehensive monitoring system that traces hazardous waste from its point of origin throughout the entire process, including transportation, treatment, and ultimate disposal, thereby ensuring accountability and transparency in the management of such waste (Cradle-to-Grave Tracking).
18. **Other subjects which are not mentioned in SOP**: The other subjects which are not mentioned in this SOP should be managed according to the country's legal practice. Respective HEI/ university can formulate additional bench marks.

ANNEX I A: Examples of Incompatible Chemicals

SN	Chemicals	Incompatible with
1	Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
2	Acetone	Concentrated nitric and sulphuric acid mixtures
3	Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
4	Alkali and alkaline earth metals (such as powdered aluminum or magnesium, dioxide, halogens calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon
5	Ammonia (anhydrous)	Mercury (for example, in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
6	Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulphur, finely divided organic, combustible materials
7	Aniline	Nitric acid, hydrogen peroxide
8	Arsenical compounds	Any reducing agent
9	Azides	Acids
10	Bromine	chlorine
11	Calcium oxide	Water
12	Carbon (activated)	Calcium hypochlorite, all oxidizing agents
13	Carbon tetrachloride	Sodium
14	Chlorates	Ammonium salts, acids, powdered metals, sulphur, finely divided organic or combustible materials
15	Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
16	Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
17	Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulphide
18	Copper	Acetylene, hydrogen peroxide
19	Cumene hydroperoxide	Acids (organic or inorganic)
20	Cyanides	Acids
21	Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
22	Fluorine	All other chemicals
23	Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
24	Hydrocyanic acid	Nitric acid, alkali

25	Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
26	Hydrogen sulphide	Fuming nitric acid, oxidizing gases
27	Hypochlorites	Acids, activated carbon
28	Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
29	Mercury	Acetylene, fulminic acid, ammonia
30	Nitrates	Acids
31	Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids and gases, copper, brass, any heavy metals
32	Nitrites	Acids
33	Nitroparaffins	Inorganic bases, amines
34	Oxalic acid	Silver, mercury
35	Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases
36	Perchloric acid	Acetic anhydride bismuth and its alloys, alcohol, paper, wood, grease, oils
37	Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
38	Phosphorous (white)	Air, oxygen, alkalis, reducing agents
39	Potassium	Carbon tetrachloride, carbon dioxide, water
40	Potassium chlorate	Sulphuric and other acids
41	Potassium perchlorate (see also chlorates)	Sulphuric and other acids
42	Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulphuric acid
43	Selenides	Reducing agents
44	Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
45	Sodium	Carbon tetrachloride, carbon dioxide, water
46	Sodium nitrite	Ammonium nitrate and other ammonium salts
47	Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
48	Sulphides	Acids
49	Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
50	Tellurides	Reducing agents

NOTE — the following list is not a complete list of incompatibles; this has to be used only as a guide.

ANNEX I B: Safety Labelling

Physical Hazards

SN	Hazards	Pictogram
1	**Explosive:** • Chemical that can detonate • Self-reactive • Organic Peroxide	
2	**Flammable:** • Chemical that can be ignite easily (catch fire) • Self-reactive • Organic Peroxide • Emits Flammable gas • Pyrophoric self-heating	
3	**Oxidizing:** • Chemical that can support and intensify combustion causing rapid fire on contact • Oxidizer	
4	**Compressed Gas:** • Chemical that can escape at a velocity of a missile, becoming uncontrolled rockets or pinwheels, causing explosion, harming health • Self-reactive • Organic Peroxide • Emits Flammable gas • Pyrophoric self-heating	
5	**Corrosive:** • Damage metals and living tissue on contact • Skin corrosion • serious damage to eyes • corrosive to metals	

Health Hazards

SN	Hazards	Pictogram
1	**Acute Toxicity:** • Chemical that can fatal or toxic	
2	**Harmful/Irritant:** • Chemical that are harmful on exposure, harmful if sawallowed, inheled, cause skin irritation, eye irritation, allergic skin reaction, drowsiness, dizziness. • Irritant Skin sensitizer • respiratory track irritant • Hazardious to ozone layer	
3	**Resperatory Hazard:** • Chemical that cause allergy, asthma symptom, breathing difficulties • Respiratory sensitizer • Aspiration Toxocity	
4	**Carcinogenic Hazard:** • Chemical that might cause cancer Most common are formaldehyde, Benzene, Methylene Bromide	

Environmental Hazards

SN	Hazards	Pictogram
1	**Hazard to Aquatic Environment:** • Include properties of chemicals that pose long term damaging effect to the aquatic life and environment	

General Safety Sign

SN	Hazards	Pictogram
1	**Radioactive:** • Ionizing radiation hazard. Common Sources are X-ray, medical beam cannons, particle accelerator	
2	**Fire:** • Should be used in those places where possibilities of fire are likely.	
3	**Heat Sources:** • Burn hazard come from oven, autoclave, stem pipes, hot plate etc. • Use heat resistant gloves	
4	**Electrical Hazard:** • Can cause mild tingling to death. • Device in question should be disconnected immediately • Turn off and unplug the equipment when not being used	
5	**Low Temperature:** • Crygenic hazard found in cold storage of laboratory such as liquid nitrogen, dry ice. • Wear correct PPE.	
6	**Biohazard:** • Used for laboratory equipment such as fridge or freezers that contain biohazards material such as blood samples.	
7	**Eye Wash Station:** • Indicate the location of eye wash	
8	**Safety Shower:** • Indicate the location of shower in case of splashes or spill.	

9	**HandWash Zone:** • Make the place for hand washing	
10	**First Aid Station:** • Indicates the availability of first aid kit. • Should be inspected periodically to ensure that no items are missing	
11	**Food and drink Prohibited:** • Inside the laboratory eating and drinking is not permitted. • Should not be used refrigerator and drying rack for food	
12	**Emergency Meeting Point:** • Make safe place either inside or outside the building where laboratory employee meet in actual emergency.	
13	**Safety Goggles:** • Use the safety goggles for the protection of eyes.	
14	**No open flame:** • Indicate the risk and prohibition of open flame device such as Bunsen burner, lighter, matches and any other flame producing devices.	
15	**Fire Blanket:** • Indicate the location where fire blanket is stored.	
16	**Fire Extinguisher:** • Indicate the location where Fire Extinguisher.	
17	**Laser Beam Hazard:** • Hazard from the laser beam. • Eye Protection and non-flammable clothing should always be worn in these areas.	
18	**UV Light Hazard:** • This symbol appear near UV light area.	

ANNEX I C: Emergency Preparedness and Accident Handling

1. General Emergency

Depending on the type of the emergency, there are specific guidelines to follow; however, there are a few general principles to follow for any type of emergency:

a) Keep yourself safe first and remain calm.
b) Inform people nearby of what happened.

2. Chemical Spills

Chemical spills are the most common accidents when working in a laboratory requiring chemicals. Improper or careless opening, handling, or storage of chemicals might lead to chemical spills. Large-volume spills of a non-hazardous chemical or even a small-quantity spill of a hazardous chemical spill might threaten the lives of laboratory personnel. Therefore, caution needs to be taken when working with chemicals and always wear proper personal protective equipment (PPE) to prevent bodily exposure in the case of a spill.

2.1 Chemical spilling onto surroundings

- Identify the area of the chemical spill and inform your laboratory co-workers of the spill.
- Evacuate the location and areas surrounding the spill, when necessary.

A. Identify the spilled chemicals and the amount of chemical that has spilled. Depending on the hazardous properties and quantities of the spilled chemicals, proper actions need to be taken. Refer to the chemical's safety data sheet (SDS) for hazard assessments.

B. Minor spills refer to spills of less than 1 gallon of low-hazard chemicals or less than 20 mL of hazardous chemicals:

i. Wear proper PPE first before taking any action. Care should be taken to avoid bodily exposure to chemicals.
ii. If possible, modify the spill source to avoid further issues
iii. If possible, turn off any nearby heat or ignition source if the chemical is flammable.
iv. Avoid breathing any vapors from spilled chemicals. This applies especially to chemicals that are toxic and volatile
v. Locate the spill kit and use appropriate kit tools to confine and contain the spill area.
vi. Use suitable adsorbent to cover the spill and neutralize the spill, if the chemicals are acidic or basic in nature.

vii. Collect the residues and place them into in a suitable container.

C. Major spills refer to spills of larger than 1 gallon of low-hazard chemicals or larger than 20 mL of high-hazardous chemicals. If a major spill occurs:

i. Secure and evacuate the spilled area immediately.

ii. Make sure all nearby personnel are aware that a major spill has occurred. iii. Call emergency responders or Environment Health and Safety personal for help.

iv. Never attempt to clean up a major spill even when wearing PPE.

v. If possible, without exposure to the spill, shut down the power to any heat source if the spilled chemical is flammable.

vi. Help the emergency personnel identify the spilled area when they arrive.

2.2 Chemical spills onto the body

i. Wash off all chemicals spilled on a body immediately using a safety shower for at least 15 min. If clothes are saturated with spilled chemical, remove clothing immediately.

ii. If the spill splashed into eyes, use an eyewash right away for at least 15 min. Open the eyes to allow complete washing. Only attempt to remove contact lenses after eye washing has commenced. iii. If the spilled chemical is a strong acid, wipe out the residues first before washing to avoid excessive or painful burning.

iv. Remove contaminated clothing immediately to avoid further exposure to chemicals.

3. Fire or Explosion

i. Fire or explosion may occur from overheating, leakage, or spillage of flammable chemicals, or gases exposed to excessive heat, an open flame, or electric sparks in the laboratory. Be careful when working with flammable or explosive chemicals and avoid heat or electric sparks nearby. Safely operate electric equipment and any source of heat to prevent fire or explosion.

ii. In case of a fire involving an individual's clothing, do not run since it might accelerate the fire. Stop, drop onto the ground with hands covering the face, and roll to extinguish the fire. If possible, use the safety shower to extinguish the fire.

iii. In case of a lab fire or explosion, ensure your safety first and call emergency responders immediately for help.

iv. Evacuate the building safely and pull fire alarms or notify nearby people, if possible.

v. Don't use elevators. Use stairs and locate the nearest exit. vi. If possible, shut down the electric power before evacuating. vii. Use a wet towel to cover the mouth and nose, if there is heavy smoke.

viii. In case of a small fire, use a proper fire extinguisher and make sure an easy exit is available if you fail in extinguishing the fire. Here we listed the types of extinguisher and discussed the circumstances in which each extinguisher type should be use

3.1 Types of fire.

Class A: Ordinary combustible solids such as paper, wood, clothes.

Class B: Flammable liquids such as gasoline, petroleum oil and paint and flammable gases such propane, methane and butane.

Class C: Electrical equipment such as appliances, motors.

Class D: Combustible metals such as sodium, aluminum and potassium. **Class K:** Cooling oil and greases such as animal or vegetable fats.

3.2 Types of extinguisher.

i. Water and Foam: for Class A fires only. Not suitable for class B or C fires. Water and foam extinguish fire by reducing the heat and the foam helps to separate oxygen from the objects.

ii. Carbon Dioxide: for Class B and C fires. Not effective for Class A fire. Carbon dioxide extinguishes fire by separating oxygen from the object and removing heat.

iii. Dry Chemical: multipurpose dry chemical works for Class A, B and C and ordinary dry chemicals works for Class B and C only. Dry chemical extinguishes fire by interrupting the chemical reaction.

iv. Wet Chemical: for Class K fire only. Wet chemical extinguishes fire by removing heat and separates oxygen from fuel elements.

v. Clean agent: for Class B and C. Clean extinguishers used halon or halocarbon agents to interrupt the chemical reactions.

vi. Dry Powder: for Class D only. Dry powder takes away heat and separates oxygen to extinguish fire.

4. Personnel Injuries

Besides chemical spills, fire, or explosion, there are many other accidents that might happen in the lab, such as electric shock, heat burn, bleeding, or poisoning. Here are some general principles to follow for personnel injuries.

i. Assess the situation before taking any actions.

ii. Ask the person what happened to them first, if they are conscious. Look for possible signs of injury if the person is unconscious and/or unresponsive.

iii. Call local emergency responders immediately if the person is in danger.

iv. Don't move the injured personnel unless imminent danger is present.

v. If an individual has received an electrical shock, shut down the power first, if possible. Do not touch the person with bare hands. Use non-conductive material such as wood, glass, or rubber to pull the person away from the electric contact.

vi. If bleeding from minor cuts, flush with water to avoid contamination and treat with first aid supplies. If cuts are more serious, call for medical assistance.

vii. Initiate first aid to help, if possible.

ANNEX I D: Chemical Waste Separation.

Some general guidelines for chemical waste segregation are:

1. Liquid and solid wastes should be kept separate.
2. Waste of chemicals must be placed in a non-reactive, sealed container with a screw type cap. Waste container must be kept closed. Attach a tag to each and every container of the chemical waste. The outside of the containers must be clean and free of chemical contaminants and residues. Date and label each container. All chemical waste containers must be conspicuously labelled with the following information:
    i. Hazardous waste;
    ii. Full name(s) of chemical contents and approximate percent if necessary [IUPAC and common names are acceptable, abbreviations or chemical formulas are not acceptable];
    iii. Responsible person or supervisor; and
    iv. Building, room number and contact phone number.
3. Separate wastes into the different waste categories that collect acids in a separate container from solvents, etc. Incompatible materials should not be mixed in the same container. Corrosive or reactive chemicals should not be put in metal cans.
4. For liquids, fill containers to about 90 percent of container volume. Containers should not be filled to the brim.
5. Metal barrels should not be stored outside where they will rust.
6. Smaller containers of chemicals should not be packed into a large drum for disposal.
7. Halogenated wastes should be separated from non-halogenated solvent wastes.
8. Separate organic solvents from aqueous solutions.
9. Keep acidified solvents separate from other solvents and acid wastes.
10. Strong inorganic acids or oxidizers with organic compounds should not be mixed.
11. Keep acids, bases or aqueous solutions containing heavy metals separate from other waste.
12. Avoid mixing concentrated acids and bases together in the same container.
13. Wastes containing mercury salts should be separated from all other wastes.
14. Corrosive liquids shall not be mixed with any other hazardous waste under any circumstances.
15. Keep per chloric acid and perchlorate wastes separate from other wastes.
16. Separate toxic wastes from other hazardous wastes.
17. Separate solid sludge from paint thinners by pouring off thinners into a separate waste container. Brushes, rollers, paper or other debris should not be put in paint wastes. Water and water-based paint wastes should be separated from oil-based paint wastes. Label wastes as paint stripper waste or paint sludge.
18. Flammable solvents, halogenated solvents (degreasers), water or antifreeze should not be mixed with waste oils.

ANNEX I E: Risk Assessment Procedure

1. **Identify hazards:** Identify physical and chemical hazards. Manufacturers or supplier's instructions or material safety data sheets be studied for hazard identification. Review previous accident and near miss reports.

2. **Assess the Risk:** A risk matrix can be used during a risk assessment to measure the level of risk

Risk Matrix

Likelihood		Very Likely	Likely	Unlikely	Highly Unlikely
Consequences	Fatality	High	High	High	Medium
	Major Injuries	High	High	Medium	Medium
	Minor Injuries	High	Medium	Medium	Low
	Negligible Injuries	Medium	Medium	Low	Low

3. **Implementation of control measures:** Follow the hierarchy of controls in the implementation of controls.
    a. Elimination
    b. Substitution
    c. Engineering Control
    d. Administrative Control
    e. Personal protective equipment

4. **Record the findings:** Details of any hazards noted in the risk assessment, and action taken to reduce or eliminate risk should be recorded.

5. **Review the assessment and update if necessary:** For detail assessment ISO 31000:2018 can be used.

ANNEX I F: Safety Equipment

1. Chemical spill kit
2. First aid kit
3. Fire blanket
4. Fire extinguisher
5. Fume hood
6. Safety shower
7. Pipetting device
8. Acid dispenser
9. Gas leakage detector
10. Safety Cabinet
11. Smoke Detector
12. Gas cylinder Trolley/cabinets
13. Water hose

Personal Protective Equipment

1. Gloves
2. Lab coat
3. Respirator
4. Safety glasses
5. Face shield
6. Splash goggle
7. Ear Plug
8. Shoes
9. Gas Mask
10. Helmet

Security Equipment

1. Lock
2. CC camera
3. Metal detector
4. Assess control door

References

Hazardous Waste Disposal Procedures, Queen's University Environmental Health & Safety, SOP-CHEM-01, 2009

Improve Environmental Performance in Academic Laboratories, Managing Laboratory

Hazardous Waste: An Introduction to the Academic Laboratories Rule, Subpart K, EPA, 2008.

ISO 31000: 2018

National Health Care Waste Management Standard and Operating Procedure 2020, MoHP, GoN