

**SOP AND SAFETY RULE ON CHEMICAL USES
AND
WASTE MANAGEMENT**



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CONTENTS

INTRODUCTION

Hazardous materials and the HGS sign

A. General waste management practices in chemistry laboratory

A1. Precautions to be taken while storing and handling chemicals

A2. Procedure for managing hazardous chemical waste materials

A3. Waste minimization

A4. Types of containers to be used for managing waste

A4.1. Solid waste

A4.2. Sample vials or small glass wastes

A4.3. Routine solid waste

A4.4. Chemically contaminated sharps

A4.5. Liquid waste

A5. how to label the containers

A6. storing waste in the lab (satellite accumulation area)

B. General safety practices followed by department

B1. Safety arrangement in laboratories

b2. common safety practices

B3. Greener practices in laboratory

b4. Personal protection practices

b5. Glassware safety

B6. chemicalsafety

B7. handling of volatile organic solvents/inorganic hazardous chemicals

C. Collection of waste and disposal

C1. organic solvents

C2. Innocuous aqueous waste

C3. Solid waste

C4. Harmful chemical waste

C5. Reuse/recycling of waste

C6. Disposal of waste



Introduction:










Proper chemical management is necessary to protect the health and safety of the university and surrounding communities and the environment. Use and disposal of chemicals without causing harm to the nature is a big challenge to the chemistry education. 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.

Chemical waste is basically a broad term and encompasses many types of materials. Material safety data sheet (MSDS) helps in identification and provides all the information of the chemical wastes that needs special disposal protocol. Those wastes are coined as hazardous waste which may be solid, liquid, or gaseous material. Examples of chemical waste include, but are not limited to unused and surplus reagent grade chemicals, intermediates and by-products generated from research & educational experiments, anything contaminated by chemicals, used oils like paraffin oil, spent solvents - including water based, pesticides, empty reagent bottles, chemically contaminated sharps, contaminated syringes and needles, finely divided powders, computer/electronic equipment, toner cartridge, ethylene glycol, resins (phenolic, epoxy, styrene), dye and glazes, degreasing solvents etc. To reduce its long-term liability, the department of chemical sciences is proactive in managing all of its chemical waste in an environmentally sound manner. Hazardous waste needs to be regulated from the moment it is generated inside the lab until it reaches its final destination for disposal or treatment at an offsite facility.

Hazardous materials and the HGS sign:

Hazardous materials/wastes are substances that are harmful to health as well as environment. 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. Some of the characteristics and their HGS (globally harmonized system) pictogram are shown below:




Flame over circle  <ul style="list-style-type: none"> • Oxidizers 	Environment (Non-Mandatory)  <ul style="list-style-type: none"> • Aquatic toxicity 	Skull and crossbones  <ul style="list-style-type: none"> • Acute toxicity (fatal or toxic)
Health hazard  <ul style="list-style-type: none"> • Carcinogen • Mutagenicity • Reproductive toxicity • Respiratory sensitizer • Target organ toxicity • Aspiration toxicity 	Flame  <ul style="list-style-type: none"> • Flammables • Pyrophorics • Self-heating • Emits flammable gas • Self-reactives • Organic peroxides 	Exclamation mark  <ul style="list-style-type: none"> • Irritant (skin and eye) • Skin sensitizer • Acute toxicity (harmful) • Narcotic effects • Respiratory tract irritant • Hazardous to ozone layer (non-mandatory)
Gas cylinder  <ul style="list-style-type: none"> • Gases under pressure 	Corrosion  <ul style="list-style-type: none"> • Skin corrosion / burns • Eye damage • Corrosive to metals 	Exploding bomb  <ul style="list-style-type: none"> • Explosives • Self-reactives • Organic peroxides

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

A. General waste management practices in chemistry laboratory

A1. 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, cause skin burns and eye damage and can lead to serious accidents. The following table lists some of the important instructions to be followed while handling and storing chemicals.

do(☐) 	Do not(×)
<ul style="list-style-type: none"> ✓ Store chemicals safely- <ul style="list-style-type: none"> -keep clean, cool - follow the instructions written in the Label or read MSDS - dry keep chemicals in their original 	<ul style="list-style-type: none"> × Do not mix chemical products without proper knowledge



Containers	
Secure storage to prevent access by vulnerable people	
✓ Read the label and follow instructions in the label of the container or MSDS	× Use chemicals if you are not trained to use them safely
✓ Keep the workplace well ventilated	× Do not leave chemical products unattended
✓ Use personal protective equipment, as required	× Do not store chemicals in unmarked containers
✓ Know what to do if you accidentally spill The chemical on yourself or others; check MSDS and consult with experts	× Do not place heavy containers on high shelves
✓ Report any dangers, spills or damaged containers and clear up spills straight away	× Do not store chemicals in bottles or containers designed for other uses (for example food and drink containers)

A2.procedureformanaginghazardouschemicalwastematerials:

- When possible, seek ways that will minimize the quantity of waste generated inside the laboratory.
- Only use appropriate containers for the storage of waste materials.
- Properly label all waste containers.
- Keep waste containers closed.
- Store chemical waste in a designated satellite accumulation area(SAA).
- Maintain a record book for the waste generated(type and quantity)at your laboratory
- Contact the concerned authority for pick-up.

A3.waste minimization:

The department 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 department 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 less 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

A4. Types of containers to be used for managing waste:

The first and foremost thing that is followed in the waste disposal is the selection of container for different wastes. Choose a container chemically compatible with the material it will hold. Chemicals must not react with, weaken, or dissolve the container or lid. Some of the container types are mentioned below:

A4.1. Solidwaste:

-for solid wastes like used silicagel, used sodiumsulphate like waste use a low density polyethylene nalgene container having proper lid.

-do not mix solids with liquid waste.

A4.2. Sample vials or small glass wastes: use a pail with a lid and line the pail with a heavy-duty plastic bag. When full, tightly seal bag with tape or bag closure tie.

A4.3. Routine solid waste: this solid waste includes any laboratory material that has come in contact with a chemical or is potentially contaminated with a chemical. Examples include gloves, bench-top paper, weighing boats and papers, paper towels, clean up material and permanently contaminated glassware and plastic ware. Use polymeric pails, cardboard boxes, or other sturdy containers having lid with proper label. Line the container with a polyethylene trash bag when the container is full, seal the bag with tape. If the container is in a cardboard box, secure the box with tape as well..



A4.4. Chemically contaminated sharps: examples of sharps include needles, syringes, razor blades, slides, scalpels, pipettes, broken plastic or glassware, micropipettes and pipette tips. Waste sharps materials should be stored in the specially designed sharp disposal container.

A4.5. Liquid waste:

a) For liquid chemical waste:

- For bulk solvent and aqueous liquid waste streams use a low density polyethylene nalgene container
- Do not use glass, plastic-coated glass or other re-used reagent chemical bottles to store or accumulate bulk liquid chemical waste.
- Chemical that should not be stored in nalgene containers are amyl chloride, bromine, butyric acid, carbon disulfide, nitrobenzene, sulfur dioxide, thionyl chloride, vinylidene chloride etc.

b) For bulk corrosive liquid waste streams:

- Use the safety containers for waste disposal
- Do not store or accumulate bulk liquid corrosive chemical waste in any other container.

A4.5.1. Special note:

- Do not use a metal container to store acids
- do not use glass or metal containers to store organic peroxides
- do not use metal containers to store picric acid and solutions of picric acid
- Do not use a glass container to store hydrofluoric acid
- Do not use metal containers for flammable liquid waste, unless proper bonding and grounding precautions are taken
- **Do not use containers that can be confused with consumer commodities like soda bottles or milk jugs.**

A5. How to label the containers:

Hazardous waste generated needs to be stored in highlight mention with the following information:

a) Date of the start of storing or date container started in lab










b) Waste provider laboratory information

c) Nature of the chemical stored:


Chemical	Approximate(%composition)

d) Is it hazardous or non-hazardous

e) If hazardous write the nature of hazards(put a tick mark)

Flammable		
Health hazards		
Corrosive		
Acute toxicity		
Oxidizer		
Explosive		
Aquatic toxicity		



Irritant(skin and eye)		
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f) Is this material: unused or virgin or is it?; used or reacted with other chemicals?

Note: write with pencil. Ink washes off easily.

A6. Storing waste in the lab(Satellite Accumulation Area):

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”.



Figure: a picture of SAA

B. General safety practices followed by department:

Some fundamental practices to safety are very essential in any laboratory where potential hazards exist which will minimize the number of common accidents that happen in laboratory. Keeping the safety of individual as well as environment in mind department has decided to follow strictly the safety practices. The laboratory safety rules are displayed in all the laboratories and workshops. All the students, researchers and faculty members should



follow the following laboratory safety rules while working in the laboratory and workshop:

B1. Safety arrangement in laboratories

Fume hoods are installed in all the laboratories to carry out reactions where possibility of evolving gases or smokes. Arrangements of burner gas (LPG) to the laboratory working tables of inorganic/organic laboratory are made available to facilitate the analysis of inorganic salt, element and functional group detection of organic compound. LPG cylinders are installed outside the department with proper arrangement. Analytical gas cylinders of sophisticated laboratories are also installed outside the department with proper control valve and regulators. Single or double cylinder attach to some of the instruments are kept inside the laboratory and fixed with the wall using belt. Fire extinguishers of different categories (CO₂ powder, mechanical foam, water type with gas cartridge) are installed at convenient places near laboratory, electric panel, etc. Demonstrations of using fire extinguishers are arranged by experienced persons periodically (yearly).

B2. Common safety practices

- a) Safety rule of each laboratory is distributed among technical staff /research scholars who are responsible for monitoring of safety protocols under the supervision of assigned faculty member.
- b) Please read the labels, material safety datasheets or user manuals before use of known/unknown chemicals, equipment, or other products.
- c) Training is provided to new labs user for handling of hazardous materials.
- d) The operation of any equipment is done in working condition. New users are not allowed to run any instrument without training and permission.
- e) Fire extinguishers, first aids kits, wash basins are available in quickly accessible, visible, and designated places.
- f) Eating, drinking and storing of food items & drinks in refrigerator with hazardous chemicals are not allowed in the laboratory.
- g) Each lab keeps an emergency contact number list near the door which includes cell phone/internal landline numbers of lab-in-charge, faculty in charge, head of the department, lab users, health center, campus security officer, all lab users and fire station.
- h) Corridors and stair cases are not used as storage areas.



- i) Never work alone in a lab at night or holidays. In case of working alone, make sure that someone knows where you are and what you are doing.
- j) Do not leave any ongoing experiments unattended.

B3. Greener practices in laboratory

- a) Keep working area as in open and cleanup on completion of experiment or at the end of working hour which is very necessary with hazardous materials and equipment.
- b) Floor should maintain in free condition by falling of hazardous chemicals/broken glassware/ wires/cables/tools/ equipment.
- c) Working tables and chemical shelves are not overloaded with unused equipment, chemicals, or other materials.
- d) Each lab/workshop must maintain a log book. The responsibilities for the person entering the lab/workshop first and leaving the lab/workshop last are displayed clearly in the lab/ workshop.
- e) Switch off electrical points and ensure that water connection and burner are turned off before leaving the laboratory.
- f) Adopt greener methods to minimize hazardous waste generation of any form.
- g) Do not dispose of chemical or any waste in the sink. The waste materials should be collected in the proper waste collector to dispose off.

B4. Personal protection practices

- a) Dress properly as per requirement of the laboratory. Avoid wearing bulky or loose-fitting clothes and dangling jewelry.
- b) Aprons or laboratory coats must be worn in laboratory which will protect skin from damage of small chemicals.
- c) To protect feet from chemical splashes, wear stable hard-toe shoes in labs. No slippers, sandals, high heels or bare feet are allowed.
- d) Avoid wrist-bands, rings and wrist-watches or wrist ornaments which may become contaminated with chemicals and then react with chemicals.
- e) Use safety glasses, chemical splash goggles, and face shields to protect eyes and face from hot materials or flying particles. Since eyes can easily absorb harmful chemicals



through blood capillaries.

- f) Wear appropriate safety hand gloves to prevent contact with toxic chemicals, burn from extreme hot or cold surfaces or corrosives. Regularly change the gloves to minimize penetration of chemicals in glove materials.
- g) Wash hand properly after working even if the gloves are used. Trace amount of toxin can have very adverse effects in your health.
- h) Proper respirators must be used to prevent inhalation of hazardous chemicals, gases, or small particles.

B5. Glassware safety

- a) Carefully handle and store glassware without damage yourself.
- b) Use heavy hand gloves or towel to protect hands when deals with broken glassware. Use separate designated bin to keep the broken glassware for disposal /reuse with possible repairing.
- c) Substitute plastic ware whenever possible to decrease the risks of damage.

B6. Chemical safety: general precautions

- a) Students must be made aware about potential hazards of chemicals by the lab in-charge before begins to work in the laboratory.
- b) Display the material safety data sheets for product specific handling, storage and disposal information.
- c) Students must know about the position of fire extinguishers, spill kits and first-aid boxes nearer the lab.
- d) All chemical bottles must be properly labeled.
- e) All waste chemicals are properly removed and disposed as per disposal guidelines. If possible, try to recycle the used chemicals after treatment.
- f) Chemical works must be done inside fume hoods. Do not open chemical bottles outside fume hoods.
- g) Chemical waste must be segregated, labeled and appropriately disposed-off.
- h) Limit the amount of chemicals in the laboratory if possible, to conduct any experiment.
- i) Do not mix in compatible chemicals such as mixtures of organic solvents and acids are explosives.
- j) For preparation of aqueous solution of acids, never add water to acids. Add acids to



water to avoid exothermic reaction.

B7. Handling of volatile organic solvents/inorganic hazardous chemicals

- a) Highly volatile organic solvents like acetone, ether etc. Must be used inside fume hood. Never use volatile solvents near a hot plate or electric oven.
- b) Use separate bottle to keep waste chlorinated solvents. Chlorinated solvent should not be mixed with normal solvents in waste bottles as they are easily absorbed through skin.
- c) Take special care for mixing of peroxides containing solution. Organic solvents are incompatible with peroxides.
- d) Maintain proper ventilation in the lab to reduce inhalation hazards coming from in situ prepared gasses like hydrogen sulfide and other airborne gases, vapor, dust or mist formed in contact of flammable or toxic substances.
- e) Do not store chemicals in the fume hood which may obstruct airflow. Keep the sash of hood as low as possible for effective air-flow. The user should always remain outside the hoods.
- f) Storage of chemicals must be done with labeled segregation as flammable liquids, acids, basics, oxidizers, inorganic salt/complexes etc.
- g) Limit the storage of flammable and corrosive chemicals in the lab as much as possible. Beyond the manufacturer marked expire date it may explode.
- h) Use separate cabinet for storage of flammable chemicals and corrosive chemicals. Acids and other corrosive chemicals must be stored under fume hoods in corrosive resistance plastic containers (e.g. Trays).
- i) Volatile or unstable materials may be stored in refrigerator in properly sealed condition, but not in open beaker.
- j) Chemicals that can react violently or emit hazardous fumes after mixing should not be stored near to each other.
- k) Label all open chemicals properly with date. Materials like ether, tetrahydro furan, dioxane may form peroxide after opening. Such chemicals should be used within one year only after opening the bottle.
- l) Transport chemicals in bottle, carts, buckets etc, but not in hands.
- m) Always handle inflammable liquids with great care and keep them away from naked



flames. Always handle concentrated acids and alkalis with great care.

n) Do not keep any unlabeled bottles of chemicals in work benches when you leave the lab.

C. Collection of waste and disposal

All chemical wastes are segregated at the source into compatible containers with secure screw- on tops and labeled properly. To avoid potential disposal problems, various types of waste chemicals are collected as follows:

C1. Organic solvents: organic solvents are segregated and labeled as group a, b, c, d, e etc.

Based on their nature and boiling points.

- (i) halogenated solvents (group a: examples chloroform, dichloromethane, chlorobenzene, 1,2-dichloroethane etc)
- (ii) Non-halogenated solvent (group b: examples hexane, petroleum ether, methanol, chloroform, toluene, acetone etc.)
- (iii) Single solvent (group c, d, e etc.)

C2. Innocuous aqueous waste

- (i) acidic waste $\text{pH} < 4$
- (ii) basic waste $\text{pH} > 10$
- (iii) safe soluble inorganic salt
- (iv) fine chemical waste like silica /alumina/clay

C3. Solid waste:

- i) Broken glassware are collected in plastic container for recycling/disposal
- ii) Minimum contaminated solid waste (hand gloves, empty vials/centrifuge tube, reagent bottles etc.)
- iii) Organic/inorganic compound synthesized in laboratory stored safely for reuse
- iv) Miscellaneous solid waste (paper, packing materials, filter paper, reagent bottle, plastic container, etc.)

C4. Harmful chemical waste

- (i) transition metal compounds (b) mineral oils/ hydrocarbons (c) any other hazardous waste segregated in single form

C5. Reuse/recycling of waste:

- i) Mixed organic solvents are separated by fractional distillation in the laboratory and



- reuse depending on purity/suitability.
- ii) Unitary organic solvents are distilled and reuse depending on purity
 - iii) Strong inorganic acids are stored in the laboratory and reuse for cleaning glassware etc.
 - iv) Generally, synthesized compounds are reuse in some experiments after characterization.

C6. Disposal of waste:

- i) Containers are provided in every laboratory according to requirements to store waste.
- ii) Solid waste, other than chemicals are periodically collected from the department by the disposal van of Gokul Global University for disposal.
- iii) Un-repairable equipment, furniture etc. Are disposed periodically as per purchased rule.
- iv) Acids and corrosive chemicals are neutralized with soda ash (sodium carbonate) or sodium bicarbonate and the spillage of alkali is neutralized by covering with dry sand.
- v) All biohazards materials are decontaminated before disposal.



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