

CHEMICAL SAFETY MANUAL



भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

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1) INTRODUCTION:

Many chemicals have properties that make them hazardous: they can represent physical hazards like fire or explosion and/or health hazards like irritation, burn and even carcinogenicity. However, there are many ways to work with chemicals which can both reduce the probability of an accident and minimize the consequences should an accident occur. Risk minimization depends on safe practices, appropriate engineering controls for chemical containment, the proper use of personal protective equipment, the use of the minimum quantity of material necessary, and/or substitution of less hazardous chemicals.

This safety manual is not a complete reference, but rather, a guide to assist faculty, researchers and students on chemical laboratory safety practices.

2. RESPONSIBILITIES

Faculty

- Must have overall responsibility for chemical safety in the laboratory.
- Must ensure that laboratory personnel know and follow the chemical safety guidelines.
- Must ensure that protective equipment is available and in working condition.
- Should ensure that appropriate training has been provided.
- Must conduct regular, formal chemical safety and housekeeping inspections in the laboratory.
- Determine the required levels of PPE and equipment as per the research work involved in the laboratory.
- Establishing standard safety operating procedures (general and protocol specific) in the laboratory

Researchers/students:

- Directly responsible for working safely and safeguarding the chemicals they use in the laboratory.

- Consulting with Principal Investigator before using the higher risk chemicals for experiments
- Plan and conduct research work in accordance with the institute's chemical safety procedures.
- Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls such as fume hoods, personal protective equipment etc.
- Report all accidents and potential chemical exposures immediately to the supervisor

Chemical /bio-safety Office:

- Develops and implements appropriate chemical hygiene policies and safe practices for the Institute
- Assisting PI or faculty in the selection of appropriate safety control requirements, which include laboratory practices, personal protective equipment and training
- Co-ordinate with the faculty in the final disposal of waste chemicals from the laboratory.
- Performing hazard assessments upon request

3) HEALTH HAZARDS:

Exposure to hazardous chemicals causes deleterious effect on human health that includes minor burns to major diseases like cancer due to prolonged exposure to certain carcinogens. The hazard associated with the chemical depends on their properties and mode of handling and their usage.

Acute Exposure: Short duration of exposure, short latency period for symptoms (e.g. hydrogen cyanide).

Chronic Exposure: Repeated or long duration chemical exposures, long latency period for symptoms. Poor clinical data often exists. Researchers must minimize their exposure to all research chemicals.

Reproductive hazards are chemicals that affect the reproductive capabilities including chromosomal damage (mutagens) and effects on the fetus (teratogens).

A mutagen affects the chromosome of exposed cells. The effect is often hereditary and becomes part of the genetic pool passed on to future generations

A teratogen (embryotoxic or fetotoxic agent) is an agent that interferes with normal embryonic development without damage to the mother or lethal effects on the fetus. Effects are not hereditary.

A sensitizer causes a majority of the exposed population to develop an allergic reaction in normal tissue after repeated exposure to a particular chemical. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock.

Types of Health hazards

- Irritants (e.g. ammonia)
- Sensitizers (e.g. formaldehyde)
- Corrosives (e.g. sulfuric acid)
- Carcinogens (e.g. benzene, methyl ether)
- Teratogens (e.g. Arsenic)
- Reproductive Health Effects (e.g. carbon disulfide, toluene, arsenic)
- Neurotoxins (e.g. mercury, carbon disulfide)
- Acutely Toxic (e.g. hydrogen cyanide)
- Physical (e.g. explosives)

4) ROUTES OF EXPOSURE

Inhalation: Inhalation is the main route of entry for the chemicals into human body. Chemicals in the forms of fumes, vapors, gases, particulates etc. inhaled through nose can cause the

damages to the respiratory system. The severity of the damage depends on the toxicity of the chemical inhaled.

Skin and Eye Contact: Skin and eye contact is the second most important routes of entry of chemicals to the human body. Splashes of chemicals cause damage to the eyes. Cuts and abrasion are means of entry of chemicals through the skin.

Injection: Rarely in the work place when a sharp object such as needle punctures the skin the chemical in the syringe have chance to enter into the blood stream.

Ingestion: When the laboratory personnel do not maintain personal hygiene (not washing hands before eating and eating /storing food in the laboratory) there is always a chance of ingestion of toxic chemicals.

Most exposure standards, Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs), are calculated using the inhalation route of exposure. They are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter (mg/m³).

5) HAZARDOUS CHEMICALS:

Chemicals that cause physical and health threats to the laboratory personnel and others in the organization are known as chemical hazards. Also these hazardous chemicals cause pollution in the environment if they are released directly into the water or land without treating them to reduce their hazardous properties, thus posing risks to humans, animals and plants. Following pictogram represents the main types of chemical hazards;

Source: WWW.consolidatedlable.com

TYPES OF HAZARDOUS CHEMICALS:

- Corrosives

- Flammables
- Oxidisers
- Pyrophorics
- Peroxides
- Reactive materials

CORROSIVES:

Corrosives are the chemicals that damage as soon as they come in contact with the tissues (such as skin, eyes, nose, respiratory tract; digestive tract etc.) or even metals. Most of acids and some bases are corrosive in nature. Some corrosives are toxic.

Examples:

- Acidic corrosives -Inorganic Acids: Hydrochloric acid, Nitric Acid, Sulfuric acid
- Organic Acids: Acetic Acid, Propionic acid
- Alkaline or basic corrosives: Sodium hydroxide, Potassium hydroxide
- Corrosive dehydrating agents: Phosphorous pentoxide, Calcium oxide
- Corrosive oxidizing agents: Halogen gases, Hydrogen peroxide (concentrated), Perchloric acid

Safety measures:

- Always add **ACID TO WATER**, slowly
- In general, store corrosives separately, away from general working areas.
- Incompatible corrosives must be kept separately.
- Walls, floors and shelves in corrosive storage area should be made from materials that are corrosive resist.
- Store corrosive chemical containers at a convenient height for handling, below eye level possibly.
- Wear acid resistant gloves, aprons and splash goggles when dispensing or transferring corrosives from one container to another and also while working with them.
- Work in a chemical fume hood when handling fuming acids or volatile corrosives.

- When using acids, make available suitable neutralizing agents for use in the event of spills. Acids should be neutralized with weak bases, such as sodium carbonate or bicarbonate.
- Always read MSDS and the labels on the containers before working with corrosives.

FLAMMABLES:

- Flammables are combustible liquids/solids/gases that easily burn when exposed to an ignition source. Flammables usually with flashpoint below an arbitrary temperature limit 50°C (37.8°C to 50°C). Flashpoint is the minimum temperature at which a liquid gives off enough vapor to form an ignitable mixture with air near the surface of the liquid.

Example:

- Acetone
- Toluene
- Methyl alcohol

Safety measures:

- Many flammable liquids are volatile by nature, and it is their vapors combined with air, that ignite and burn.
- Inhalation of flammable vapor may cause headache, nausea, dizziness, drowsiness and confusion etc. It may also cause irritation to the respiratory tract or eyes.
- Flammable materials should be stored in safety containers as per manufacturer's instruction, with the lid secured tightly.
- Flammable materials should be stored in well ventilated flammable-resistant cabinets and they should be stored away from any potential heat such as electrical equipment and heating units that might cause sparks.
- Flammable chemicals must not be stored along with oxidizers.

- Ensure that flammable materials requiring storage conditions at refrigerated temperatures are stored in refrigerators/freezers designed and certified for this purpose.
- In the event of a spill, the flammable liquid should be wiped dry and the windows opened.
- Exhaust fan should be ON while working with flammable materials in order to remove the vapor out of room.

OXIDISERS:

Oxidizing chemicals are materials that spontaneously evolve oxygen at room temperature or with slight heating. Oxidizers promote combustion leading to fire.

Examples:

- Ammonium per- chlorate
- Bromine
- Chromic acid
- Dibenzoyl peroxide
- Hydrogen peroxide
- Perchloric acid
- Sodium per-chlorate

Safety measures:

- Some oxidizers are highly toxic and have chronic health effects (e.g. potassium dichromate and chromic acid)
- Inhalation and contact of oxidizers cause respiratory and /or gastrointestinal tract injuries and skin contact will lead to redness and irritation and even burns.
- Work with oxidizers inside the chemical hood and wearing appropriate PPE is a must.
- Keep oxidizers away from combustible materials.

- Store oxidizers in a tray, away from non-compatible chemicals such as acids, solvents, oils and reducing agents etc.
- Do not store oxidizers in wooden cabinets
- Keep containers closed and check for leakage or damage often.
- Oxidizer waste must be separated and never to be mixed with organic waste and waste containing reducing agents.

Note: Perchloric acid is an extremely corrosive agent that demands special precaution. Heating, dehydration, combination with organic material etc. causes Perchloric acid to explosive. Any experiments requiring Perchloric acid heating should be done inside the special fume hood. For emergency assistance there should be a second person in the laboratory while working with concentrated Perchloric acid.

PYROPHORICS:

Pyrophoric liquids, solids and gasses are materials that may ignite or react violently when exposed to air. Many pyrophoric chemicals are also water reactive.

Examples:

- Butyllithium
- Tributylaluminum
- White phosphorus
- Magnesium amide

Safety measures:

- Wear appropriate PPE while working with the Pyrophorics which include lab coats, closed toe shoes, gloves (see the MSDS for suitable glove), safety goggles etc.
- Use fume hoods whenever work involves usage of Pyrophoric. Also flammables/combustibles must not be kept close to the Pyrophorics while working.
- Store Pyrophoric material away from heat/flames, oxidizers and water sources.
- Keep containers closed and ensure that manufacturer's labels and warnings remain intact.

- Always use secondary containers/tray while storing the pyrophorics.

PEROXIDE FORMING CHEMICALS:

Some chemicals react with atmospheric oxygen to form unstable peroxides which may detonate with extreme violence when they become concentrated by evaporation or distillation or when subjected unusual heat, shock or friction.

Example:

- Ethyl ether
- Isopropyl ether
- Tetrahydrofuran

Safety measures:

- Always wear proper PPE while working with peroxide forming chemicals
- Store these chemicals in dark, airtight amber glass bottles.
- Purchase and store small quantity (recommended). Big quantity bottle favors the formation of peroxides over the time once it is opened.
- Always write date received and the date opened in these chemical bottles.
- Crystallization, discoloration, and stratification are signs of peroxide formation.
- If evaporation or distillation of these chemicals is necessary, do not distill to a dry residue. Always leave at least 10-20% residual bottoms.
- Use fume hood or other appropriate exhaust ventilation if inhalation hazard is anticipated.

WATER/AIR REACTIVE CHEMICALS:

Some chemicals react vigorously with water or with moisture in the air.

Example:

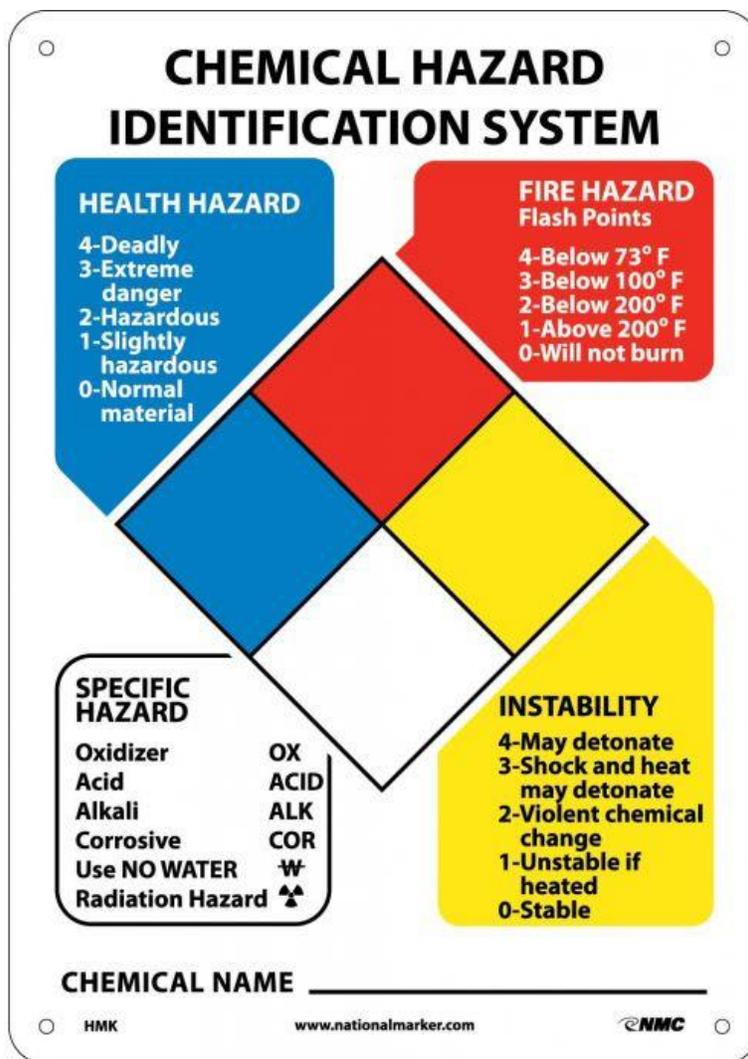
- Sodium
- Potassium
- Phosphorous

Safety measures:

- These chemicals must be kept in oil filled containers which protect them from air/moisture/water.
- If the chemicals are inadvertently exposed to moisture, excessive heat can be generated which could cause a fire, or within a confined space, an explosion due to high pressures.
- Laboratories in which reactive metals are routinely used should have fire extinguishers compulsorily.
- Work involving these materials should be conducted within a fume hood.
- Personnel must wear safety goggles or a face shield, heavy gloves and lab coat when working with these reactive materials.

Chemical hazard identification system: Symbols and Color Codes





Source: HMK National Marker, US

6) HANDLING OF CHEMICALS:

- Know the physical and health hazards associated with the chemicals you are using.
- Carefully read the chemical's label and material safety data sheet (MSDS) before using a chemical for the first time
- Wear appropriate PPE.
- Label all containers with chemical content.
- Wear appropriate disposable gloves to prevent skin exposure
- Wash thoroughly with soap and water after handling any chemical and whenever you leave the lab. Avoid direct contact with any chemical.

- Never smell, inhale or taste a chemical.
- Smoking, drinking, eating and the application of cosmetics is forbidden in areas where hazardous chemicals are used or stored.
- Always use chemicals with adequate ventilation or in a chemical fume hood.
- Use hazardous chemicals only as directed and for their intended purpose.
- Inspect equipment or apparatus for damage before adding a hazardous chemical.
- Use PIPETTE AID and never pipette by mouth

7) MATERIAL SAFETY DATA SHEETS (MSDS)

- ✓ Before using any chemical, read the Material Safety Data Sheet (MSDS).
- ✓ File all the MSDS of chemicals received in the laboratory, in one folder and keep it easily available to the laboratory personnel. Preferably near the telephone in the laboratory.
- ✓ An MSDS is a document that details information about chemicals and along with the container label is a good source of information for chemical safety. It provides the following information:
 - a. Identity of the chemical
 - b. The manufacturer's name and address
 - c. Hazardous ingredients
 - d. Exposure limits
 - e. Permissible Exposure Limit (PEL) or Recommended Exposure Limit (REL) – This is the amount of a chemical that a person can be exposed to, averaged over an eight hour period, before it causes him/her harm.
 - f. Short Term Exposure Limit (STEL) – This is the amount of a chemical that a person can be exposed to, averaged over a 15 minute period, before it causes him/her harm.
 - g. Immediately Dangerous to Life and Health (IDLH) – This is the amount of chemical that immediately puts a person a risk of serious injury or death. If this level is reach or exceeded, the area should be evacuated immediately!
 - h. Physical characteristics, such as:
 - i. Boiling point ii. Vapor pressure

i. Chemical hazards, including the following:

i. Flammability ii. Explosiveness iii. Reactivity

j. Health hazards, including chemicals that are:

- 1) Toxins (both acute and long-term)
- 2) Carcinogens
- 3) Reproductive Toxins
- 4) Teratogens
- 5) Mutagens
- 6) Neurotoxins
- ii. Irritants
- 6) Routes of Entry
- 7) Emergency and first-aid procedures
- 8) Proper leak, spill, and disposal techniques
- 9) Proper storage and handling procedures

8) HAZARD CONTROL:

Personal Protective Equipment (PPE): Is primary protective barrier between a chemical and person handling the chemical.

Eye protection: Splashes or spills while working with the chemical/reagents cause eye injury. To minimize the risk of eye injury, eye protection such as safety goggles or full face shield should be worn when working with the toxic chemicals.

Gloves: Disposable nitrile gloves, though useful in laboratory operations requiring manual dexterity, may not provide adequate protection against many chemicals. Although latex gloves effectively protect against pathogens, they offer little protection against most chemicals. Glove manufacturers and other organizations have provided many “glove compatibility” and “glove selection” charts that are readily available online. All gloves should be inspected for discoloration, holes, and tears prior to use. Certain chemicals might require specific type of gloves; those particulars will be included in the MSDS.

Temperature resistant gloves are useful while working with heat and cold resistant gloves are useful while working with cryogenics/liquid nitrogen.

Shoes: Sandals, flip-flops, and other open-toed shoes expose the feet to chemicals as well as sharp objects and hence closed shoes are recommended inside the laboratory.

Lab coats: Long sleeve lab coats or Aprons are to be worn at all time while conducting experiments. Lab coats should remain in the laboratory and should never be worn in common

areas (e.g., computer rooms, conference rooms, cafeteria, etc.). When working with highly volatile chemicals and pyrophorics, better to use fire resistant gowns.

Respirators: Inhalation of toxic chemicals is the main cause for health problems associated with the chemicals hence appropriate respirators must be worn if necessary.

Fume Hoods: A secondary barrier

Chemical fume hoods, when used properly, are one of the most reliable engineering controls in the laboratory:

- They protect laboratory personnel by; containing vapors, gases and fumes generated within the hood, and removing them as air flows into the hood and then out via the laboratory exhaust system.
- Contributing to laboratory ventilation as air flows through the hood
- Shielding the worker with a clear sliding window, called a sash, that contains aerosol and prevents injury from splashes, fires or minor explosions that may occur inside the hood.

PROPER USE OF FUME HOOD:

- Know the toxic properties of the chemicals with which you work. Be able to identify signs and symptoms of overexposure (read MSDS)
- Mark six inches distance behind the sash and keep all chemicals and equipment behind that line during experiments. This will keep vapors from escaping the hood when air currents from people walking past the hood interfere with airflow at the face of the hood.
- Never use a hood unless there is some indication that it is operating. A tissue paper taped to the sash or inside the hood provides a reasonable indication of airflow.
- Wear appropriate PPE (a lab coat, gloves, and safety glasses etc.) while working in the hood.
- Never put your head inside of a fume hood.

- Visually inspect the baffles (openings at the top and rear of the hood) to be sure the slots are open and unobstructed.
- Do not use an active hood as a storage cabinet.
- Keep only the materials necessary for the experiment inside the hood
- Keep the sash clean and clear.
- Clean all chemical spills in the hood after each use.
- All electrical devices should be connected outside the hood to avoid sparks that may ignite a flammable or explosive chemical.
- DO NOT USE A FUME HOOD AS A WASTE DISPOSAL DEVICE.
- Use traps and condensers whenever possible to collect vapors and fumes.
- Never use a hood to evaporate solvents. Instead, collect the solvent and dispose of it as hazardous waste.
- DO NOT USE A FUME HOOD FOR ANY FUNCTION FOR WHICH IT IS NOT INTENDED. Certain chemicals or reactions require specially constructed hoods. Examples are perchloric acid or high-pressure reactions.

Eye Wash Station: Recommended in chemical laboratories involving usage of large volumes of toxic chemicals. Tissue damage begins immediately when a corrosive chemical comes in contact with the eyes.

- The affected area must be irrigated immediately with copious amounts of water for a minimum of 15 minutes.
- Lab coworkers are encouraged to guide the victim of a chemical splash to the eye wash site. Affected lab workers should obtain medical assistance if necessary.

Fire extinguisher: Fire extinguishers are classified by the types of fires they put out:

Types of fire:

Class A –combustible materials such as wood, paper, some plastics and textiles

Class B -flammable liquids

Class C –flammable gases

Class D- flammable metals

Class F -specific to cooking oil/fats.

According to the types of fire, specific extinguishers are used as shown in the table below;

Type Extinguisher	Fire						Comments
	CLASS A Combustible materials (e.g. paper & wood)	CLASS B Flammable liquids (e.g. paint & petrol)	CLASS C Flammable gases (e.g. butane and methane)	CLASS D Flammable metals (e.g. lithium & potassium)	Electrical Electrical equipment (e.g. computers & generators)	CLASS F Deep fat fryers (e.g. chip pans)	
Water	✓	✗	✗	✗	✗	✗	Do not use on liquid or electric fires
Foam	✓	✓	✗	✗	✗	✗	Not suited to domestic use
Dry Powder	✓	✓	✓	✓	✓	✗	Can be used safely up to 1000 volts
CO2	✗	✓	✗	✗	✓	✗	Safe on both high and low voltage
Wet Chemical	✓	✗	✗	✗	✗	✓	Use on extremely high temperatures

Source: <http://perspectivefm.co.uk/>

How to use a fire extinguisher?



Source: <http://ontariofireextinguisher.com>

Fire Blanket: Fire blankets are recommended in all laboratories that use flammable liquids very regularly. Fire blankets should be easily accessible and unobstructed. In the event that a person's body or clothing catches fire, the person should immediately drop on the floor and roll to help extinguish the fire.

A fire blanket should be used only as a last resort to help smother a body or clothing fire.

Fire blankets can also be used to keep shock victim warm.



9) STORING OF CHEMICALS:

DO NOT Store chemicals alphabetically, except within the hazard class.

Store solid chemicals as per their hazard groups such as;

- Oxidizing solids
- Flammable solids
- Water reactive solids
- All other solid

Store liquid chemicals/reagents as follows;

- acid liquids
- caustic liquids
- oxidizing liquids
- perchloric acid solutions
- flammable or combustible liquids
- all other liquids

Store compressed gases as follows:

- toxic gases
- flammable gases

- oxidizing
- inert gases
- The shelves used for the storage of chemicals should be resistant to corrosion and rusting. It should be sturdy and fixed properly.
- Larger volume bottles should be stored at ground level, easy to pick up
- Smaller volume bottles should be stored on the racks which are easily reachable by hand and must not be stored in difficult to reach- height.
- Chemical resistant trays must be used as secondary containers for corrosives, oxidizers etc.
- Only “flammable material storage refrigerators/freezers” (with no internal sparking sources) may be used to cool chemicals, not the domestic refrigerator.
- Expired chemicals and deteriorated or leaking containers must be disposed of safely.
- It is very important to know the compatibility of the chemicals- those react with one another, while storing. No two incompatible chemicals should be stored together.

GENERAL INCOMPATIBILITY BY CHEMICAL GROUPS

Acids	Alkaline, combustibles, flammables, cyanides, nitrates and reactive sulfides
Oxidisers	Organic acids, solvents
Nitrates	Acids
Ammoniated Compounds	Hypochlorites / Bleach
Organics Nitrates	Perchlorates / Oxidizers / Metals

Hence adequate care should be taken while storing such chemicals. **Annexure A** gives an elaborate list of incompatible chemicals.

10) CHEMICAL WASTE MANAGEMENT AND DISPOSAL:

Chemical Waste Disposal Plan For IITH



INSTRUCTIONS FOR WASTE CHEMICAL SEGREGATION, STORAGE AND TRANSFER

Following wastes to be stored separately:

- a) Acids
- b) Bases
- c) Solvents
- d) Waste/used oils
- e) Solids such as Agar or silica
- f) Solids- sharp containers (glass/metal sharps)

- Store liquid chemical wastes **ONLY** in either **1ltr or 2.5 ltr** bottles with waste tag [crates come with pockets of only these two sizes).
- Use separate containers for larger volumes. These containers with proper waste tag will also be considered for removal.
- Once these bottles are 80% filled, Send chemical waste removal request form along with copy of completely filled waste tag to safety office (original waste tag retained in the waste bottle).
- Only after safety office approves, transfer the bottle/s to satellite storage site (SSS)-ground floor on the day of Pick up & bottles shall be shifted to Chemical Storage Building (near STP site)

- Once in three months or whenever necessary the chemical waste from IITH shall be sent for final disposal through RAMKY.

NOTE:

- Incompatible chemical waste must not be mixed
- Best container for waste is the original chemical container or one of the same type– including the lids! ALWAYS deface the original label
- Glass containers are usually the best, metals and plastic containers are usually not recommended
- Containers must be in good condition and NO leaks - including the lids!
- Enter in the waste tag attached to the bottle with details and volume as soon as you start collecting waste.
- Half –filled bottles will not be removed
- Never carry bottles in hand- Use trolleys.
- Excess empty 1ltr/2.5 ltr bottles shall be handed over to Safety office (will be given to labs for waste storage upon request).
- **WASTE WITHOUT THE WASTE TAG WILL NOT BE REMOVED (prepare exactly same waste tags or download)**

Waste pick-up form

INDIAN INSTITUTE OF TECHNOLOGY HYDERABAD Hazardous Chemical Removal Request Form

Contact Person:		Building:	
Contact Number:		Room:	
Accumulation start Date:		Pick up date:	

Quantity: 1lt bottle : x
2.5ltr bottle ; x
Large volume (separate container): x
(Put 'x' number of containers)

Waste type: (Tick)
Liquid- Solvent
Liquid-Acid
Liquid- Base
Used oil
Solid (specify)

List major contents in the bottle:

Waste Tag attached: Yes /No (waste tag must be completely filled)

Signature (Lab in-charge) **Date:**
(This form and copy of waste tag must be emailed to safety@iith.ac.in)

Note: Containers filled 80% and more will be removed; never fill 100%; no leakage; keep bottle clean

Waste Tag Format

INDIAN INSTITUTE OF TECHNOLOGY HYDERABAD HAZARDOUS CHEMICAL WASTE TAG

Contact Person:		Building:	
Contact Number:		Room:	
Accumulation start Date:		Pick up date:	

COMPOSITION OF WASTE (Do not write the abbreviation or formula)

Chemical name	Volume	Hazard category
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Hazard category: Inflammable (IF); Corrosive (C); Reactive (R); Toxic (T); Oxidiser(O);
Other specify _____

The above mentioned information are true and accurate

Signature (lab in charge) **Date:**

(WASTE WILL NOT BE REMOVED IF ALL SECTIONS ARE NOT COMPLETED)
For further information write to safety@iith.ac.in

DRAIN DISPOSAL: Only water-soluble, non- hazardous laboratory chemicals can be disposed via drain.

The following chemicals should not be ever poured into the drain:

- Acetone or alcohols
- Volatile Organic Compounds (e.g. organic solvents)
- Organic chemicals
- Mercury and other heavy metals
- Strong acids (solutions with pH 1-3)
- Infectious/biological waste
- Radioactive waste

11) CLEAN UP PROCEDURE FOR CHEMICAL SPILLS

Small spills of chemicals that do not cause serious health problems can be cleaned by the person him/herself.

In case of a major spill involving a flammable or toxic chemical, immediately inform all the persons in the laboratory and in the building in order to evacuate the building. Inform the supervisor and safety office immediately, who will take necessary steps.

General solids

- Whenever there is a solid chemical (low to medium toxic) hazard spill, use dust pan/scoop/broom to clean up the spill and put the waste inside a bag and dispose into **Hazardous Chemical Waste** bins.
- Highly toxic chemical waste spills should be informed to the PI and Chemical/bio- safety office. These wastes need to be separately kept with the waste tag for the final disposal. Should not be put in the Hazardous Chemical Waste bins.

Liquid spills:

- Liquid (<100ml) can be absorbed with paper towels, sand or absorbent. However, paper towels can increase the surface area and evaporation, increasing the fire hazard.
- Once the liquid is absorbed gently put these paper towels/sand in a bag. Label bag with hazardous waste disposal tag and put it in **Hazardous Chemical Waste** bins for disposal.

- Don't leave paper towels or other materials used to clean up a spill in general trash cans in the work area, which may cause an unnecessary exposure to a fellow employee.

Acid- liquid:

- If available, neutralize with sodium bicarbonate or commercially available acid neutralizer working from the outside in.
- Using scoop, mix thoroughly to ensure neutralization.
- pH paper can be used to test completeness of neutralization. Commercial neutralizers often change colour to indicate neutralization.
- Add more neutralizer if necessary.
- Proceed as per general liquid spill clean-up

Caustics- liquid:

- If available, neutralize with citric acid or commercially available caustic neutralizer, working from the outside in.
- Using scoop, mix thoroughly to ensure neutralization.
- pH paper can be used to test completeness of neutralization. Commercial neutralizers often change colour to indicate neutralization.
- Add more neutralizer if necessary.
- Proceed as per general liquid spill clean-up

Solvents:

- If available, suppress vapours with activated charcoal or commercially available solvent neutralizer working from the outside in.
- Using scoop, mix thoroughly.
- Proceed as per general liquid spill clean-up

Spills involving Volatile and flammable:

- If a volatile, flammable or toxic material spilled, immediately warn everyone to extinguish flames and turn off spark producing equipments.
- Switch on the exhaust fan and start cleaning, if you need help ask for it.

Mercury spill:

- If available, spray mercury suppression spray into immediate air space.
- Push all mercury beads together.
- Using the aspirator, transfer mercury beads to plastic disposal container.
- Label disposal container appropriately with hazardous waste disposal tag co-ordinate with the chemical/bio-safety office for disposal.
- Cover spill area with mercury amalgamation powder.
- Allow mercury amalgamation powder/mercury spill to solidify (form amalgam).
- Use dust pan and broom or scoop to transfer amalgam into disposal container.
- Decontaminate area with mercury decontamination liquid, wipes or sponges.
- Transfer all wipes, sponges, gloves etc. used in clean-up to plastic bag, label with hazardous waste disposal tag and **Hazardous Chemical Waste bin**.

White (yellow phosphorous) spill:

- A spill of white phosphorous should be blanketed with wet sand or wet absorbent papers.
- If any phosphorous is splattered on the skin, flush skin with cold water and remove.
- Copper sulphate solution provides a visual aid in removing particles because it produces a dark color in contact with elemental phosphorous.
- Proceed as per general solid spill clean-up

Compressed gas/cryogenic liquid Leaks:

Turn off cylinder valve.

- If possible transfer cylinder to fume hood.

- Check for leaks using a non-reactive detergent solution or commercial leak detection solution. If leak is obvious omit step.
- If leak continues, and gas is inert, evacuate the area and surrounding area and treat as a complex spill. If gas is toxic, flammable or corrosive, alarm everybody in the room and building, evacuate the building and treat as a complex spill. Inform immediately to the Supervisor and chemical/bio-safety office.

NOTE: Depending on the room size and the amount of gas, an oxygen deficient atmosphere may develop. Take particular care to ensure your safety.

12) PERSONAL PROTECTION FROM CHEMICAL EXPOSURE

Chemical spill on areas like hand, leg, face, eyes:

- Immediately flush the affected area with cold water. If there is no visible burn, wash with mild soap (for hand, leg, face) and wait for some time to check for late reactions.
- If you notice redness, burning sensation, itching and pain continued for more than a day, see Medical officer promptly.

Chemical spill over large portion of body:

- Quickly remove all contaminated clothing while using the safety shower.
- No time should be wasted because of modesty!!.
- However, be careful not to spread the chemical on the skin, specially the eyes.
- Immediately flood the affected body area in cold water for at least 15 minutes.
- Never use neutralizing chemicals like creams, lotions etc.
- Get medical attention as soon as possible; at x6144

Inhalation of toxic chemicals:

- Immediately take the person to fresh air room. Check whether person is breathing or not, if the person is not breathing, immediately Cardio-Pulmonary Resuscitation (CPR) must be performed by a trained person.

- Meanwhile other persons should try to get the medical help for the affected person by contacting Medical officer at extension: x6144

(It is recommended that every person should get training on how to perform CPR- a life saving procedure).

13) GOOD CHEMISTRY LABORATORY PRACTICES:

- All chemicals/reagents must be considered as potential sources of hazards and handled carefully.
- Good housekeeping is necessary for the laboratory safety
- Handling or consuming food or drinks and application of cosmetics in laboratories are prohibited.
- Good personal hygiene such as washing hands thoroughly before handling or consuming food or drinks must be practiced.
- Never store food/drinks in the laboratory refrigerators.
- READ the Material Safety Data Sheet (MSDS), of every chemical that you are handling.
- ALL MSDS should be safely kept in a file and it should be easily available to the lab personnel-preferably near the telephone.
- Single person working in the laboratory with potential toxic chemicals shall be avoided, a second person in the vicinity always safe.
- Proper personnel protective equipment must be worn inside the laboratory.
- Use the fume hoods when toxic/ irritating/ volatile chemicals are involved.
- Mouth pipetting prohibited; use PIPETTE AIDS always. Never taste/smell the chemicals.
- Never direct the open end of test tube towards yourself or anyone else while working with the reagents
- Never pour water into concentrated acid; always add ACID to WATER, slowly.
- Never return unused chemicals to their original container, because it might contaminate.
- Whenever possible substitution of less hazardous chemicals recommended.
- Mark the date on all containers of chemicals upon receipt and again when opened.

- No two incompatible chemicals/reagents should be stored together and discarded together.
- Safety carriers should be used for transporting glass or plastic containers with a capacity of two liters or greater
- A suitable fire extinguisher should be located close to each laboratory
- Emergency procedures should be posted in each laboratory giving telephone numbers of, Health center; ambulance; Supervisor; Safety coordinator; Security office etc.
- All safety equipments shall be maintained in good operating condition and be regularly inspected for correct operation in accordance with the manufacturer's instructions and record of such checks/inspections should be maintained.
- Spills should be cleaned immediately and thoroughly. The nature of spills should be ascertained and spills treated accordingly.
- All the exits are to be kept free of obstructions to facilitate quick escape in an emergency.
- Chemical wastes should be segregated category-wise and properly disposed off as per approved procedures.
- Each lab should have an area with receptacles for collecting waste.
- Gas cylinders should never be dragged while transporting; when kept vertical, they should be chained to avoid their fall. While storage the valve cap should be in place. Pressure regulators specific to the gas only should be used.
- All unsafe conditions and unsafe practices by fellow workers, which are likely to cause an accident, should be reported to the supervisor.
- All accidents should be reported to the supervisor.

14) Annexure A

Chemical	Incompatible with
Acetic Acid	Chromic acid, nitric acid, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric acid and sulfuric acid mixtures
Alkali, alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, i.e., powdered aluminum or magnesium, carbon dioxide, halogens, calcium,

	lithium, sodium, potassium
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, anhydrous HF
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organics or combustibles
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agents
Bromine	See chlorine
Calcium Oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Everything
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxide, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water

Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartartic acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrate	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydrite, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

Source: <https://www.grainger.com/content/qt-health-chemical-compatibility-181>

Annexure B

Potentially Explosive Combinations of Common Reagents:

Acetone + chloroform in the presence of base
 Acetylene + copper, silver, mercury or their salts
 Ammonia (including aqueous solutions) + Cl₂, Br₂, or I₂
 Carbon disulfide + sodium azide
 Chlorine + alcohol
 Chloroform or carbon tetrachloride + powdered Al or Mg
 Decolorizing carbon + oxidizing agent
 Diethyl ether + chlorine (including a chlorine atmosphere)
 Dimethyl sulfoxide + CrO₃
 Ethanol + calcium hypochlorite
 Ethanol + silver nitrate
 Nitric acid + acetic anhydride or acetic acid

REFERENCES:

- Indian Standard code of practice in chemical laboratories ; IS 4209 : 2013
- Laboratory safety guidance: Occupational safety and health administration, USA
- Encyclopedia of occupational health and safety –International Labour organization
- Chemical safety manual for small businesses- American chemical society.
- Chemical safety practices and recommendations- American chemical society
- Chemical Laboratory Safety and Security -A Guide to Prudent Chemical Management; Lisa Moran and Tina Masciangioli, The National Academies Press, Washington