Safety Manual

4th Edition

(August 2013)

Department of Chemistry

Faculty of Science

Chulalongkorn University

Department of Chemistry, Faculty of Science

Chulalongkorn University

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Safety Policy of the Department of Chemistry

Students and staff of the department of chemistry must be aware of and knowledgeable to the importance of chemical safety and maintaining a safe working laboratory at all times.

Strategic plan	Output	Indicator
1. Provide practical guidelines for chemical safety management including storage, handling, waste disposal, risk assessment and emergency response as a safety manual. The safety manual can be downloaded from http://www.chemistry.sc.chula.ac.th/safety/safetymanual.pdf It is mandatory that all laboratories in the department must keep a hard copy of the safety manual as a reference. The safety manual is scheduled for a revision every 2-3 years.	The department has clear and practical guidelines for chemical safety management.	Safety manual is comprehensive, up to date, and reachable by students and staffs.
2. Organize an annual chemical safety and fire extinguisher training for all students and staff who are engaging in research at the beginning of the semester. Only students and staff who pass a safety evaluation test will be permitted to perform research in laboratories. A safety evaluation test will be scheduled annually with the purpose of encouraging a safe environment.	Students and staff are aware and knowledgeable of chemical safety.	Students and staff who study the safety manual and attend safety training pass an annual evaluation test.
3. Monitor and evaluate safety conditions of all research and teaching laboratories by the safety committee and graduate students. The evaluation results will be informed to the person in charge of that laboratory every semester.	All laboratories maintain a safe working environment at all times.	Qualified laboratories report evaluation results and accident report forms to the safety committee.

The Department of Chemistry Safety Committee

1. Code of Practice for General Safety

1. Wear safety glasses and laboratory coat when working in the laboratory.
2. Protective footwear, covering the toes, the upper surface of the foot and the heel, must be worn when working in the laboratory. Sandals or high-heels over 2 inches are prohibited.
3. Long hair must be gathered and fastened. Hats, caps, scarves and the like must be removed.
4. Smoking is strictly prohibited in the building.
5. All food and drink must not be stored or consumed in the laboratory.
6. Unauthorized persons are not allowed in the laboratory unless in the presence of Safety Officer in charge.
7. For safety and security reasons, undergraduate students are not allow to perform laboratory procedures out of scheduled laboratory periods without prior consent and senior laboratory supervision, either advising professor or graduate students.
8. Working alone in the laboratory is not permitted.
9. When working in the laboratory, all entrances should not be locked.
10. Ensure that the gas isolating valves, water taps, electricity are turned off after use. Re-check before leaving the laboratory.
11. Permission from the laboratory supervisor must be obtained before any equipment or experiment is allowed to run or left unattended overnight. Apparatus left running overnight must be clearly marked with all details including emergency procedures.
12. It is mandatory that all laboratory operators are well aware of safety practices on hazardous chemical protection, possible risks involved, first-aid training, how to handle hazardous substances in case of fire and spillage as well as waste disposal management. Students who conduct research in the department must participate in a training and pass a proficiency exam about the safety knowledge and rules. General supervision by the advisor is required. Students who perform experiment in teaching classes are under the supervision by teaching lab instructors.
13. Never handle any hazardous or toxic chemicals without acquiring proper information on its properties and sufficient precautions from MSDS or other reliable sources. If in any doubt, seek guidance from the academic supervisor or the Safety Committee members.
14. No experiment can be undertaken without a thorough Risk Assessment.
15. All accidents must be reported to the laboratory supervisor and the Safety Committee so that an action can be taken to prevent any possible repetition.
16. All chemical waste disposed must follow the guideline in this safety manual.
17. All electrical equipment must be inspected on a regular basis. Power switches must be off and unplugged when not in use. Only use an extension cord with 10-Amp fuse wire. Do not overload electrical outlets.
18. Maintain good housekeeping and hygiene in the lab at all time. The Safety Committee may randomly inspect all laboratories without prior notice.
19. For emergency help, contact the laboratory supervisor, floor & department supervisors, the Safety Committee members or the security desk of Mahamakut Building (Tel. 0-2218-7529, 0-2218-7500), in a respective order indicated in this Safety Manual.

2. General Information

2.1 Building Access

Office Hours of Mahamakut Building (MHMK)

Monday - Saturday	06.00–21.00 hrs.
Sunday and public holidays	Closed

Request is required for any work outside normal working hours with signatures of advisor and Head of Department (request form available at Administrative Office, Department of Chemistry)

2.2 Chemical Safety Resources

Material Safety Data Sheets (MSDS) could be searched from:

A. Chemicals Manufacturers:

http://www.sigmaaldrich.com

http://www.merck.co.th

B. Other Websites:

http://www.msds.com

http://msds.pcd.go.th

http://www.chemtrack.org

2.3 Useful Telephone Numbers

	Numbers
Head - Department of Chemistry: Assoc. Prof. Dr.Vudichai Parasuk	0-2218-7599
Department Supervisor (Chemistry): Asst. Prof. Dr. Soamwadee Chaianansutcharit	0-2218-7602
Chairman, the Safety Committee: Prof. Dr. Tirayut Vilaivan	0-2218-7627, 083-986-8772
Secretary, the Safety Committee: Dr. Puttaruksa Varanusupakul	0-2218-7612, 089-188-7043
Building Supervisor (Faculty of Science): Mr. Narongchai Sribua	0-2218-5240
Security Desk - Mahamakut Building (MHMK)	0-2218-7500
Security Desk - Faculty of Science	0-2218-5022
Security Desk - Chulalongkorn University	0-2218-3570
Phathumwan Police Station	0-2215-2991-3, 214-1042
Bangkok Fire and Rescue Department (BFRD)	199
Chemical Emergency Hotline (Pollution Control Department)	1650

Facility: Mahamakut Building (MHMK) Faculty of Science, Chulalongkorn University, Phayathai Rd.

3. Code of Practice for Fire Accident

3.1 Types of Fires

	**Class A** Fires involve ordinary materials such as paper, wood, cloth, rubber and plastics Most appropriate extinguishing method: water
	**Class B** Fires entail flammable or combustible liquids such as oil, gasoline, greases, etc Most appropriate extinguishing method: Foam, dry chemical powder
	**Class C** Fires involve energized electrical equipment such as appliances, power tools Most appropriate extinguishing method: CO_2, Halon
	**Class D** Fires encompass combustible metals Most appropriate extinguishing method: air removal or specialized extinguishing substance depending on the type of metals

3.2 Types of Fire Extinguisher

- **Dry Chemical Powder**

  Dry chemical powder could be classified into two types: ABC and BC

  - ABC: an all-purposed fire extinguisher for common fire situations. It is useful for either class A, B or C. Specifically speaking, ABC could extinguish fires from ordinary materials such as paper, wood and plastic; flammable gas and liquids, oil, greases, kerosene; and electrical apparatus.
  - BC: an extinguisher exclusively for class B and C, or fires from flammable gas and liquids, oil, greases, kerosene; and electrical apparatus. It is not for class A fires.

- **Water-based Extinguisher**

  Suitable for class A (paper, wood, etc.) fires only, not for class B, C and D.

- **Foam-based Extinguisher**

  The foam fire extinguisher or AFFF (Aqueous Film Forming Foam) fire extinguisher is suitable for class A and B fires, not for class C as the water content is electricity conductive.

- **Volatile liquid-based extinguisher**

  This type is suitable for class A, B and C fires. It leaves no residue and is non-conductive. It is ideal for delicate or expensive apparatus such as electronic devices.

- **Carbon Dioxide Extinguisher**

  Filled with non-flammable carbon dioxide gas under high pressure, suitable for class B and C fires.

3.3 On Discovering a Fire

- Stay calm and quickly assess all risks involved.
- If you are confident that you could safely fight the fire, immediately do so. (See 3.4 - 3.5)
- Use a proper choice of laboratory extinguisher in accordance with each fire type.
- Should the initial fire fighting attempt fails, activate the closest fire alarm pull station (Figure 1) by puling the trigger (locations of fire alarm pull stations are indicated in each floor plan) and follow the evacuation instruction (No. 3.7).

Figure 1 Fire Alarm Pull Stations of Mahamakut Building

3.4 Extinguishing a Fire

- Identify the source of fire.
- Turn off the main electrical switch or cutout and gas isolator valves. Also remove flammable items from the fire area.
- Extinguish or contain the fire using proper extinguishing agents.
- If your cloth or your body catches fire, lay flat on the floor and roll about. Other people should help covering your body with wet cloth or fire blanket. **DON'T RUN!**
- If you are not confident that you could safely fight a fire, **DO NOT** attempt to!

3.5 Using a Fire Extinguisher

- Acknowledge the fire extinguisher locations at each floor plan. All laboratory operators should recognize all the types of fire extinguishing agents and their closest locations.
- Stand about 6-8 feet from the fire and follow the instruction in Figure 2.

1) Pull the pin and tamper seal on the fire extinguisher.

2) Direct the extinguisher nozzle at the base of the flames.

3) Depress the handle to the bottom.

4) Sweep back and forth towards the fire.

Figure 2 How to Use the Fire Extinguisher

3.6 On Hearing a Fire Alarm

- Instantly follow the evacuation instruction No. 3.7 without hesitation. Do not wait to see whether it is real or just a drill.

Figure 3 Fire Exit and Evacuation Route Signs of Mahamakut Building

3.7 Evacuation Procedure

- On hearing the alarm, turn off the main electrical switch or cutout as well as gas isolator valves.
- Quickly evacuate the building through the nearest safe, exit route with Fire Exit Sign (Figure 3). Do not collect any personal belongings. Do not use the main stairs of the building and never use an elevator.
- In fire evacuation, stay low and cover your face with a soaked towel to prevent smoke smother.
- Immediately evacuate down the building and gather outside at the assembly point designated for the building (parking lot of Anyamanee Building).
- Do not re-enter the building unless authorized by the building supervisor.
- The fire witness should stay at the assembly point to report the incident to the authorized staff.

Department of Chemistry's assembly point
is Anyamanee Parking Lot (Behind Mahamakut Bldg.)

3.8 General Practice to Prevent a Fire Accident

Matches Spark Plug

Figure 4 Various Sources of Ignition

- Do not place flammable materials close to any ignition sources (Figure 4).
- Access to exit passages, corridors, staircases, and especially emergency exits, must be kept clear at all times.
- A full fire drill should be held regularly.
- At least one person who has been trained for basic fire fighting must be designated to each laboratory.
- Limit the amount of flammable chemicals, solvents, and gases stored to the minimum required.

- Appropriate fire-fighting equipment must be provided and conspicuously located in the laboratory area and should be regularly checked.
- All laboratory operators should know all the types of fire extinguishing agents available and their closest locations.
- All heated reactions to be left unattended must be assessed for potential risks. Details of the reactions and actions required must be clearly attached.
- Use only silicone oil for oil bath, or use sand bath. Never use vegetable or mineral oil.
- Carry out periodic inspections to ensure that electrical appliances are in good conditions. Do not attempt to use equipment that is malfunctioned, broken or in unsafe condition, especially plugs and any equipment with motor.
- Before leaving the laboratory, always check that all power switches of unused appliances are off and unplugged.
- If it is necessary to use extension cords, use the ones that are equipped with a 10-Amp fuse wire.
- Do not overload electrical outlets (no more than 1000 watt/socket).
- For damaged electrical appliances, contact the designated electrician of the Chemistry Department (Mr. Kovaln Takrud-shom, Room 1229, Mahamakut Bldg.) or the Maintenance Unit (Tel. 0-2218-5510) or the supplier/representative. Never attempt to adapt or repair them by yourself.
- Station any heat generated equipment, such as an oven, in a well-ventilated area and on a stand with the height of at least 3 centimeters above the floor.
- Never keep any flammable materials, such as cloths, plastic, etc., in the oven without close supervision.
- Never use equipment that may generate flame in the building without a prior permission from the building supervisor.
- Never place a hot plate near flammable substances or ignition sources and keep any electrical wire off a hot plate while in use.
- To heat up flammable substances or any chemicals that have boiling points below 100 degrees Celsius, use hot water bath or oil bath.
- The laboratory operator must review all practices, seek laboratory supervisor’s advice and complete a risk assessment before commencing any experimental work that requires a large quantity of flammable reagents/solvents, air-or-water-sensitive substances or relates to any extreme or vigorous exothermic reaction.
- Be especially careful with disposal of flammable substances. If unsure of its properties, do not pour into water or pour water onto. Always, inform and ask for guidance from the laboratory supervisor.
- Do not throw away into trash bin any metal powder or substances that might be pyrophoric when exposed to air and humidity.
- Do not flush down the drain any flammables, especially non-soluble substances and/or in a large quantity.

4. Code of Practice for Spillage/Leakage

4.1 General Procedure for Spillage/Leakage

- Remove other people from the area.
- Immediately notify the laboratory supervisor.
- In case of spillage onto the person, follow the instruction No. 5 Personal Injuries.
- Identify the substances leaked or spilled and consult the MSDS to obtain specific information on spillage procedure and hazard involved.
- Asses all hazard possibilities from leakage/spillage and their cleaning process and prepare for any emergency.
- Spills must be cleaned up immediately. For highly dangerous substances or if the situation is uncontrollable, evacuate the affected area and immediately notify laboratory supervisor.
- A person responsible for cleaning should wear suitable protective equipment, depending on the hazard levels of spilled substances. At least, wear thick rubber gloves and respiratory protection, such as face masks that cover eyes, nose and mouth, especially when dealing with toxic gases.
- If the cleaning procedures involve water, be careful of contamination to nearby water resources (depending on the substances).

4.2 Liquid Spillage

- Use proper inert absorbents such as chemical-adsorbent spill pillows or vermiculite or non-deodorant cat sand (bentonite cat litter). Treat cleanup materials as hazardous materials and dispose them in proper containers. Never use water if the consequences are not known.
- For acid spills, neutralize with sodium hydrogen carbonate ($NaHCO_3$). For base spills, neutralize with citric acid.
- Mercury spill needs an immediate attention. Use powdered sulfur to coat mercury. Or collect the liquid mercury with a vacuum device, but never use household vacuum for this purpose. Always separate mercury waste from normal waste disposal.

4.3 Solid Spillage

- Hazardous substances, such as reactive or explosive ones, should be strictly handled in accordance with MSDS instructions.
- Non-hazardous substances could be cleaned with normal process.

4.4 Gas Leakage

- Turn off the main regulator of the gas supply and immediately notify the laboratory supervisor.
- For toxic gas leakage, activate the alarm system and evacuate people to a safe distance.
- If the regulator cannot be controlled, remove the gas cylinder to ventilated area and let the gas release. For toxic gases, follow the instruction in Table 1.
- Immediately alert the gas cylinder manufacturer/supplier.

- If the leakage is near the valve or the regulator, apply the 'contain and divert vapor' technique (Figure 5) and use suitable absorbent or burn away. For water-soluble gases, divert it to a water bucket or spray with water (be careful of consequent hazard from gas and water reaction).
- For small releases of some toxic gas, follow instruction in Table 1.

Table 1 How to Treat Small Releases of Selected Hazardous Gases

Techniques for Neutralizing and Otherwise Reducing
the Dangers from Small Releases of Selected Hazardous Gases

Gaseous Product	**Hazard Reduction Technique**
Ammonia, anhydrous	Dissolve in water, using a ratio of 100 liters of water for each liter of released ammonia.
Arsine	Discharge the escaping gas into a solution of potassium permanganate or another strong oxidizer.
Boron trichloride	Discharge the escaping gas into a 15% sodium hydroxide (caustic soda) solution.
Carbon monoxide	Flare off the escaping gas.
Chlorine	Discharge the escaping gas into 15% sodium hydroxide (caustic potash) solution or other strong alkali solution.
Fluorine	Discharge the escaping gas into a 5% to 15% potassium hydroxide (caustic potash) solution.
Fluorocarbons	Reclaim and reuse.
Hydrogen	Vent into the atmosphere.
Hydrogen fluoride	Discharge the escaping gas into a 5% to 15% potassium hydroxide (caustic potash) solution.
Hydrogen sulfide	Discharge the escaping gas into a 10% to 20% sodium hypochlorite solution.
Methyl bromide	Absorb by bubbling the gas into an organic solvent such as ethyl alcohol or toluene.
Nitric oxide	Discharge the gas into a potassium permanganate solution, or into a mixture of sodium hydroxide (caustic soda) and slaked lime.
Nitrous oxide	Vent into the atmosphere.
Phosgene	Neutralize with agricultural lime (calcium oxide) or crushed limestone (calcium carbonate).
Sulfur dioxide	Discharge into a strong sodium hydroxide (caustic soda) solution.

(Source: J.E.Bowen, Emergency Management of Hazardous Materials Incidents, National Fire Protection Association, 1995)

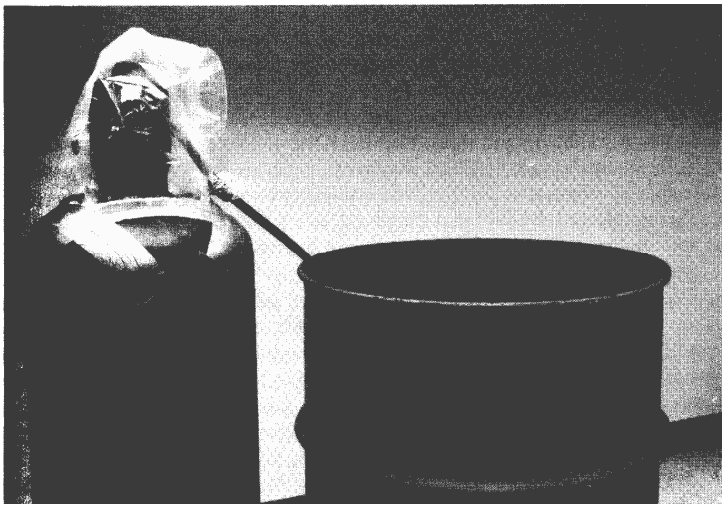


Figure 5 The "contain and divert technique" to Control Gas Leakage

4.5 General Practice to Prevent Chemical Spillage/Leakage

- Periodically inspect all chemical containers. Change and destroy old, deteriorated containers as appropriate.
- Have all gas cylinders inspected by experts every six months and keep the telephone numbers of gas distributors and inspectors close to the gas cylinders or telephones in case of emergency.
- When transporting chemical bottles for a short distance (within the laboratory area), do not carry by just holding the bottleneck or its handle, as the container may accidentally fall. Use another hand to support underneath the bottle or, preferably, use a secondary container such as a bucket.
- For a long distance transport (out of the laboratory or the chemical store), appropriate containers, such as stainless steel buckets or plastic buckets – both can be obtained from the chemical store, must be used to carry chemicals. Do NOT use baskets because they cannot provide protection in case of spill.
- Stainless steel containers should be used with non-corrosive chemicals such as organic solvents, while plastic containers should be used with corrosive chemicals like acids.
- If large amount of chemicals need to be transported, an additional cart should be used in addition to a durable basket. Do not place chemicals directly on the cart, and the responsible persons should be prepared for accidental chemical spill.
- Transfer of a large quantity of chemicals should be carried out in a suitable fume cupboard. Measures should be available in case of spillage/leakage. Avoid transferring flammable chemicals near ignition sources.
- Use only a funnel or beaker or appropriate container to decant liquid from large bottles to smaller containers.
- MSDS, protective equipment and appropriate cleaning devices must be available in the laboratory for emergency purposes.

5. Code of Practice for Personal Injuries

5.1 Treating Simple Cuts

- Remove foreign bodies (large splinters, glass, etc.) from the wound.
- Stop the bleeding by using ice cubes, applying direct firm pressure on the cuts or tying up at blood vessels leading to the cuts, with occasionally loosening to allow blood circulation.
- Wash the wound and dress with an appropriate bandage.
- Larger cuts or serious bleeding should be referred to the Medical Centre or made for direct transport to the emergency unit, Chulalongkorn Hospital.

5.2 Treating Burns Caused by Heat

- Flush with very cold water or cover with wet cloth until the burning subsides.
- Treat with a topical burn ointment or spray.
- Larger burns or serious bleeding should be referred to the Medical Centre or made for direct transport to the emergency unit, Chulalongkorn Hospital

5.3 Spillage onto a Person

- Any affected clothing should be immediately removed.
- Thoroughly and immediately wipe out or absorb all traces of contaminant.
- For water-soluble substances that do not react with water, the affected areas of the skin should be treated with liberal quantities of running water for at least 10 minutes or until it has been thoroughly cleaned. For water-insoluble substances, wash with soap. Use any closest sink or safety shower.
- For identified substances, follow the specific requirements in the MSDS or the following treatment below. For serious spillage, the person involved should immediately seek medical assistance.

For Identified Spilled Substances

- Acids: Flush the area with clean water and neutralize with diluted sodium bicarbonate solvent.
- Bases: Flush the area with clean water and neutralize with dilute acetic acid.
- Phenol: After washing the affected area with clean water, apply with bromine-saturated glycerine. Serious phenol absorption may result in (fatal) kidney failure. Immediately refer the injured to the hospital.
- Hydrofluoric acid: This acid could cause serious pain, although the pain from diluted kinds might not be immediate. Avoid the use of this acid if possible. Any laboratory required to use hydrofluoric acid should make prior emergency arrangement with the medical center. For first aid treatment, wash the spilled area with a large amount of water and rub the wound with calcium gluconate gel 2%. Medical assistance is required for every case.

5.4 Spillage into the Eyes

- Carefully wash at the nearest eye wash station with liberal quantities of water. Occasionally lift lids and hold the eye open during washing, roll the eyes for at least 10 minutes or until they are thoroughly cleaned.
- Immediately refer the person involved to the hospital.

5.5 Inhalation of Toxic Gas

Accidents from toxic gas could be prevented by using a fume cupboard. Most toxic gases (except CO) have alarming odors which laboratory operators should be able to identify. Do not continue with the work as your odor sensitivity might be impaired after breathing a certain amount of gas. If you feel uncomfortable, inform others and alert the possible leakage. Then leave the confined area for fresh air.

- Immediately remove the person injured out of affected area. Rescuers must wear adequately and suitably protective equipment, i.e. respirator. Some hazardous gases such as CO, HCN, NO, $COCl_2$ and SO_2 could penetrate through body skin, suitable personal protective equipment should be worn.
- Loosen clothing. Provide oxygen if available.
- If unconscious, arrange the person to face down and see if he or she can breathe.
- If the injured stops breathing, give artificial respiration. Avoid mouth-to-mouth method, especially with HCN inhalation as the rescuer might be intoxicated.
- Immediately refer the person involved to the nearest hospital.

Special Case

- For HCN inhalation, provide fresh air and amyl nitrite every 5 minutes. If the injured stops breathing, give artificial respiration. But avoid mouth-to-mouth method. Give heart stimulants if necessary and urgently refer the injured to hospital.

5.6 Accidental Ingestion

Strictly follow the MSDS instructions. The rule of thumb is to induce vomit so that the substance is immediately rid off from the body, either by tickling the back of the throat or drinking concentrated saline solution. Position the victim face-down with the head lower than the hip. There is an exception for an ingestion of corrosive or irritant substances that MSDS suggests not to induce vomit as it might cause more damages. In this case, consuming milk or activated carbon might be of help. For cyanides ingestion, induce vomit and provide amyl nitrite every 2-3 minutes. Also give strong coffee or tea to act as a stimulant.

*** For any chemical ingestion, the person involved must seek immediate medical assistance.**

5.7 General Practice to Prevent Accident to a Person

- The laboratory supervisor should provide personal protective equipment and first-aid kit suitably and adequately for the number of persons and hazard level involved in the laboratory.
- Wear personal protective equipment suitable for the hazard level of the work to be performed: safety glasses or goggles, laboratory coat, closed footwear and rubber gloves.
- The use of volatile or toxic chemicals must be restricted to fume-hoods. Use safety screens; wear appropriate gloves and face mask as required.
- Never store or consume any food or drink in the laboratory and do not use laboratory reagents containers for food or drink.
- Nothing shall be stored or left around sink areas for emergency use.
- Periodically inspect the safety shower and eye wash stations. Never leave anything in the areas.

6. Accident and Emergency Report

6.1 Procedure of Accident and Emergency Report

- For fire accident, follow the instruction No.3 Code of Practice on Fire Accident (Page 6).

- For non-chemical accident, inform security desk of Mahamakut Bldg./Faculty of Science

- For chemical emergency, follow the following instructions:

1. The laboratory supervisors whose names and telephone numbers are indicated in the room.

2. For any incident that takes place outside the laboratory or any emergency that might affect other laboratories, also notify floor/department supervisors (as listed in the table below).

3. If unable to contact the staff in 1-2 or if the situation is beyond control, the staff in 1-2 should alert the Chairman, the Secretary, or any members of the Safety Committee (details in Appendix 4).

4. For serious or uncontrolled incident, notify the staff and immediately evacuate the area.

5. Witnesses must explain the detail of the incident—location, chemicals involved, and other consequent hazards—to the person in charge in 1-3, at the scene in case of controlled incident, or at the assembly point in case the evacuation is required.

The person in charge in 1-2 will assess the situation and decide what should be done. If the incident could be controlled, submit a written report using Accident Report Form. If the incident is deemed uncontrollable, contact the Safety Committee for further consideration. For a serious accident, inform the exterior safety units.

6.2 Accident Report Form

Every incident or accident that is unusual for normal laboratory experiment must be reported by using the Accident Report Form (Appendix 2), which could be either requested from the laboratory supervisor or downloaded from the Safety Committee's web site: http://www.chemistry.sc.chula.ac.th/safety/safety.shtml under the menu, "Safety Forms" > Accident Report Form. Submit one copy of the completed form to the Chairman of the Safety Committee and keep one copy in the laboratory. The completed form in PDF format may be uploaded to the Safety website at http://www.chemistry.sc.chula.ac.th/safety/safety.shtml under the menu "Safety Forms > Online Accident Report-statistics to prevent the repetition of the accident with the same nature.

6.3 List of Contact Person in case of Emergency

In front of each laboratory in the Department of Chemistry, a name list and telephone numbers of at least two emergency staff must be clearly posted. These persons should be the first to be notified in case of an accident and will make necessary report to the person in charge.

7. Code of Practice in Safely using Equipment and Tools

7.1 Using Gas Cylinders

7.1.1 Gas Cylinder Hazard

Could be derived from one of the following:

- Gas Pressure: Gas stored in the cylinder is at high pressure. If the valve is broken off (such as by dropping) or if the gas is fed to a closed system that has no release channel, the high pressure involved might cause considerable damage.
- Gas Cylinder: Cylinders are generally heavy. The dropping could result in serious damage and injury. Storing, handing and transporting should be done with special care.
- Gas Nature: Hazards associated with gases vary. Some are flammable (Hydrogen, Butane), others are toxic (chlorine, carbon monoxide). Some are non-toxic but can act as asphyxiants by displacing the air (nitrogen, argon).

7.1.2 General Practice on Gas Cylinder Usage

- While in use, the gas cylinder should be secured in an upright position by belts or chains affixed to a wall.
- Gas should not be stored or located in the laboratory.
- Cylinders under transport should be mounted in a cylinder trolley with the valve cover in place.
- Select proper pressure gauges for gas content and make proper connection to outlet of regulator fitting or valve. Do not use excessive force or any lubricants when connecting the cylinder to the regulator/pressure gauge.
- Before turning on the cylinder valve, make sure that there are ways for the gas to escape (ie, not a closed system).

7.1.3 Emergency Practice

- Notify the laboratory supervisor or building supervisor.
- Immediately remove others from the affected areas.
- Try to turn off main valves, if possible.
- Identify the gas. Information is usually labeled on the cylinder or at the pressure regulator. Some gases have specific odors, such as ammonia, or could be traced with specific reactions.
- For non-toxic, non-flammable gas, be careful of asphyxiation as the leaked areas might have lower oxygen level. A respirator is extremely necessary.
- Be especially careful with ignition sources in the vicinity of leaking flammable gas.
- For toxic or corrosive gases, the "contain and divert technique" (Figure 5) is necessary to trap leaked gas and divert it to a suitable scrubber.
- Inform the gas cylinder supplier (Have the telephone numbers close at hand in case of emergency).

7.2 Using Solvent Still

- Select suitable drying agent for required solvent:

  Use CaH_2 for Hexanes, CH_2Cl_2

  Use Na for Toluene, Ether, THF

- Left-over sodium should be disposed immediately (use isopropanol). Leaving it might cause hazardous consequences.
- For other solvents, consult chemical handbooks such as D. D. Perrin and W. L. F. Amarego, *Purification of Laboratory Chemicals*, 3rd Ed., Pergamon Press, Oxford, 1988.
- Never use $LiAlH_4$ to dry solvent as the risk involved is too high.
- Never use Na to dry chlorinated solvent as it might explode.
- Distillation of a dried solvent should be operated under an inert atmosphere of nitrogen. Before turning on the valve, always make sure that the solvent still has a way for the gas to escape (i.e. not a closed system).
- All still flasks containing solvents and drying agents are dangerous. They should have clear labels stating the solvent, the drying agent, and the last date of use. Users should dispose the agent when no further use is required.
- All solvents should be distilled into a receiver containing an overflow connector when the solvent is fully collected. The volume of the still should be less than the volume of liquid in the distillation flask to prevent accidental drying out which is very dangerous.
- Solvent stills should never be left running unattended.
- Disposal of sodium (in THF still)
  - Take the remaining metallic sodium from the still and drop into a big beaker with at least 1/3 full of 2-propanol. Try to add in small pieces and wait until the reaction has ceased before adding more. Repeat the process until no more sodium can be taken out.
  - Pour 2-propanol in the flask to dissolve sodium. (Do not pour down 2-propanol without taking most of the sodium out as an uncontrollable reaction might occur.)
  - Wait until all the sodium metal is destroyed (which might take several hours). Wash the solvent down the sink with lots of water. Small amounts of ethanol could be added to accelerate the dissolution.
  - The remaining 2-propanol containing dissolved sodium should be disposed off as usual (see section 8)
- Disposal of CaH_2
  - Similar to the disposal of sodium, but use methanol instead (25 mL/g CaH_2) A small quantity of water may be added to accelerate the dissolution.

7.3 Refluxing

- Always check the correct temperature for the reflux.
- The heating mantle should fit the round bottom flask size
- Use silicone oil bath for any reflux with temperature lower than 200 °C. For higher temperature reflux, use sand bath. Do not use vegetable oil or mineral oil.

- Make sure that the water is running through the condenser at all times. For tap water, the operator must be on the watch, or have automatic heat deactivating system whenever the water stops running, or use circulating water pump. Any accidental block of the water flow during the reflux will evaporate the solvent, resulting in damages to the experiment and hazardous consequences.
- For any reflux to be left unattended, tightly secure all tube connections with a copper wiring to prevent the tubes from bursting off from the condenser. Details of the reaction and emergency response information must be clearly attached.
- Unattended overnight reflux must be conducted with special care and should be avoided if possible at all.

7.4 Reactions that Require Special Attention and Risk Assessment

1. Large-scale reactions

2. Reactions using water- or air-sensitive compounds

   Alkali metals (Li, Na, K)

   Fine metal powders (Pd, Ni, Al, Zn)

   $LiAlH_4$, NaH and other metal hydrides

   RLi, RMgX, LDA and other organometallic compounds

   Acid halides such as PCl_3, $POCl_3$, $SOCl_2$, acetyl chloride

3. Reactions using vigorous oxidizers or explosive compounds

   Azides

   Organic peroxides

   Chlorates and perchlorates

   Hydrogen peroxide (> 35 %)

   Concentrate nitric acid

   Diazomethane

4. Reactions using highly toxic compounds

   Arsenic compounds

   Mercury compounds

   Lead compounds

   Cadmium compounds

   Cyanides

5. Reactions using carcinogenic or other compounds that generate other irreversible effects

   Nickel compounds

   Formaldehyde

   Benzidine and naphthylamines

   Acrylamide

   Acrylonitrile

Epichlorohydrin and epoxides
Benzene
HMPTA
1, 2-dibromoethane
Dimethyl sulfate
Alkyl halides, sulfate, sulfonates, especially alkyl iodides and reactive halides
N-Nitroso compounds
Hydrazine and derivatives

6. Reactions carried out under unusually high or low pressures

7. Reactions involving radioactive substances

8. Reactions involving hydrogen gas

9. Reactions involving incompatible compounds, such as acid-base (concentrated or in large quantity), oxidizing and reducing agents

10. Heated reactions that will continue for a long period, such as overnight reactions or reactions to be left unattended

7.5 Risk Level and Guideline for Risk Assessment

Prior to beginning any laboratory procedure that is “a reaction that requires special attention” as described in 7.4, laboratory operators should perform a risk assessment in a Risk Assessment Form (Appendix 3). The Form should be signed by both the laboratory operator and laboratory supervisor.

The laboratory supervisor should keep one copy of the Form. The laboratory operator should keep another copy by having it fixed with the laboratory notebook, ready for immediate submission to the person in charge in case of emergency.

The experiments with level A risk include: the afore-mentioned reactions that use air-sensitive or water-sensitive substances and hydrogenation reactions at a scale higher than 10 mmol; reactions involving radioactive substances; reactions under atmospheric pressure of higher than 5 atm or less than 1 mmHg (except a vacuum distillation). These experiments should be acknowledged and signed by the lab advisor who must be presented and monitoring the experiments.

The experiments with level B risk include: the reactions that could be classified in categories 1-10 of No. 7.4, but exclusive from level A risks. The lab advisor or any person designated should sign the Risk Assessment Form and monitoring the experiment in person.

8. Chemical Laboratory Waste Disposal Guideline

8.1 Definition of Waste

Chemical waste is all left-over substances in chemical laboratories: unknown chemicals, expired or deteriorated chemicals, spilled chemicals that were collected, organic solvents. In other words, everything that is no longer useful in the laboratory and must be disposed in some ways is considered hazardous waste.

The following symbols indicate the control level of chemical waste.

✓ => Disposable

 => Treat before disposing

 => Submit for proper disposal

8.2 Reusing and Recycling

The most effective laboratory waste management strategy involves waste minimization by careful planning of all experimental procedures. Waste recycling and reusing must be considered the first possible option for all waste items before any disposal, by using the following guidelines:

- Any single solvent that contains little other volatile impurities, such as solvent from the rotary evaporator or acetone used to clean glassware, could be collected and reused after a proper fractional distillation. Although the process is complicated and energy-consuming, it is worth considering with a large amount of solvent. Washing it down the drain might risk fire accident or hazardous reaction with other substances in the waste stream. It is also pollutes the environment.
- Any chemicals suspected of being deteriorated should be tested before disposal. For example, metal salts that are highly soluble in water always absorb atmospheric moisture and might appear in a liquid-like condition, but the chemical properties do not change. They might possibly be advantageous for some experiments, or usable for some kinds of experiments that do not require exact concentrations such as in qualitative analyses.
- Old and disused chemicals that seemed to be deteriorated could be purified by proper methods. The purification process can be found in reference handbooks such as D. D. Perrin and W. L. F. Amarego, *Purification of Laboratory Chemicals*, 3rd Ed., Pergamon Press, Oxford, 1988
- Unidentified chemicals or chemicals with removed or faded labels that are still in good conditions should be tested using a simple qualitative analysis to search for its identity. Every laboratory unit should try its best to identify the substance before labeling it unidentified waste as the cost of unidentified chemical waste disposal is extremely high.
- Bottles or containers of known non-hazardous chemical waste should be thoroughly washed. Containers of volatile organic solvents (boiling point below 100^{o}C) can be reused or used for other hazardous chemicals after leaving the solvents to evaporate in the fume cupboard.
- Reusing chemicals could help save money two-folded; one from the unnecessary acquisition of new chemicals and another from the disposal.

8.3 Guideline for Waste Management

Some kinds of chemical laboratory waste are not considered hazardous. Even some hazardous waste might be, after being pre-treated, disposed or eliminated in normal waste disposing process.

Waste Bin The following guideline helps decide which items should be thrown down the waste bin:

✓ Ready to be disposed:

- Used filter paper that has no organic solvents and/or toxic, corrosive, oxidizing or flammable substances
- Drying agents such as Na_2SO_4 and $MgSO_4$ that have no organic solvents and/or toxic, corrosive, oxidizing or flammable substances
- Non-hazardous salts: any salts of neither heavy metal ions nor harmful anion such as nitrate, perchlorate and cyanides, etc.

✋ Think before disposing:

- Non-hazardous and water-miscible liquid waste, including chemicals that might absorb atmospheric moisture and look liquid-like, could be flushed down the drain and followed by a large amount of water (consult MSDS first!). Hazardous liquids, however, must be sorted and separated and submitted for proper disposal.
- For clean, broken glassware from chemical laboratories, separate the repairable broken glasses such as ground glass joint or glasses with minor cracks. The rest should be kept in covered cardboard or plastic boxes for proper disposal. Do not mix with regular garbage.
- Sharp metal pieces such as razor blades and needles should be disposed in covered cardboard or plastic boxes. Do not mix with regular garbage.

☠ The following must be collected and submitted for proper disposal process. Never throw into trash bin.

- Unused silica gel or alumina from column chromatography or its lefts-over should be left in fume hood so that the vapor of such organic solvents would be exhausted.
- Broken glasses from chemically contaminated laboratory experiments such as unclean droppers, chemically contaminated glassware, and unclean bottles containing hazardous chemicals.
- All solid waste that are contaminated with organic solvents and/or toxic, corrosive, oxidizing or flammable chemicals.
- Solid waste with heavy metal contamination.

Sewer/Drain The following guideline helps decide which items should be flushed down the drain:

✓ Certain materials are suitable for drain disposal:

- Less than 50 mL of water-miscible organic solvents that are non-toxic, such as glycerol or that contain no impurity of other toxic substances.

- A small amount of water-miscible organic and non-organic substances that are not highly toxic, for example, those used in semi-micro qualitative analysis.
- Diluted acidic or basic solutions (<10 %) with the volume less than 1 Liter. For concentrated solutions, any small quantity should be diluted before flushing while large quantity should be neutralized before flushing.
- Solutions with metal ions that are not highly toxic such as Fe, Al, Mn, Zn and/or alkaline, alkaline earth ions except Be^{2+} and Ba^{2+}.

After draining, always flush with a large amount of water afterwards.

The following must be properly treated before disposing or submitting for proper disposal process. It should be stored to reach significant quantity, such as until the semester ends.

◆ Acids-Bases

Substances include: Aqueous solutions of mineral acids/bases with no heavy metal contamination.

Disposal Neutralize with sodium bicarbonate (acid) or acetic acid (base) before flushing down the drain with a large amount of water. The most economical and effective method is using other acidic or basic waste for neutralization. (be careful for highly exothermic reaction when performing a large scale neutalization)

◆ Cyanides

Substances include: Cyanide salts of alkali and alkaline earth metal ions, cyanide complexes such as $K_3Fe(CN)_6$ and organic cyanide that can release HCN such as cyanohydrin, trimethylsilyl cyanide (TMSCN) but do not include nitrile compounds (R-CN or Ar-CN).

Disposal Cyanides could be destroyed by oxidization, for example, reacting with hypochlorite solution under basic conditions. Detect free cyanide ion by using Prussian Blue Test. Those with negative results can be disposed of as aqueous waste.

◆ Air and/or Water Reactive Substances

Substances include: 1. Acid halide, anhydrous inorganic halide such as PCl_5, $SOCl_2$, $POCl_3$, $AlCl_3$, BF_3
2. Metal hydride (CaH_2, $LiAlH_4$, NaH)
3. Alkali metals (Li, Na, K)
4. Organometallic reagent such as BuLi, Grignard reagent

Disposal Decompose by reacting with water (HX/H_2 emission must be performed in fume cupboard!), ethanol or basic solution and, if necessary, neutralize before washing down the drain. Dispose lithium aluminium hydride ($LiAlH_4$)

by reacting with ethyl acetate. As the reaction would not result in H_2 gas formation, the risk from fire hazard is thus not likely.

- Sulfides or thiols

  Substances include: 1. Organic sulfide
  2. Thiols (mercaptans)

  Disposal: Destroy with oxidization. Like cyanides, react it with hypochlorite in basic condition (high pH).

- Oxidants

  Substances include: 1. Organic peroxide
  2. Inorganic/hydrogen peroxide
  3. Chromate/dichromates
  4. Permanganates

  Disposal: Destroy with reducing agent. Study for special techniques designated to each oxidants from the reference handbooks.

☠ The following must be stored for proper disposal process. Never flush down the drain.

- Oil and other petrochemical products.
- Non water-miscible organic solvents.
- Chlorinated organic solvents.
- Organic solvents that are water-soluble but highly toxic (TLV < 100 ppm) such as methanol, dioxane, acetonitrile.
- Phenol and derivatives such as cresol, resorcinol.
- Solutions containing heavy metal ions, especially highly toxic substances, such as Cr, Cu, Ba, Pb, Ni, As, Cd, Hg in any oxidation state.

8.4 Guideline for Laboratory Waste Submission to Central Waste Storage for Disposal (WasteTrack)

8.4.1 Existing Waste

- For identified compounds:
  - Follow the separate instructions in 8.4.3.
  - For expired or deteriorated chemicals that could no longer be used, properly destroy and separately dispose in accordance with waste classification in 8.4.3. Heavy metal compounds should be disposed as solid waste, if possible. In this case, throwing away the whole bottle is considered safer, even if it consumes more space.

- For unidentified compounds:

- For usable chemicals that have removed or faded labels, try to analyze and test the chemical properties by using a proper qualitative analysis or appropriate spectroscopic techniques.
- For waste chemicals, try to categorize them by testing their properties as follows (See Figure 6 for details):

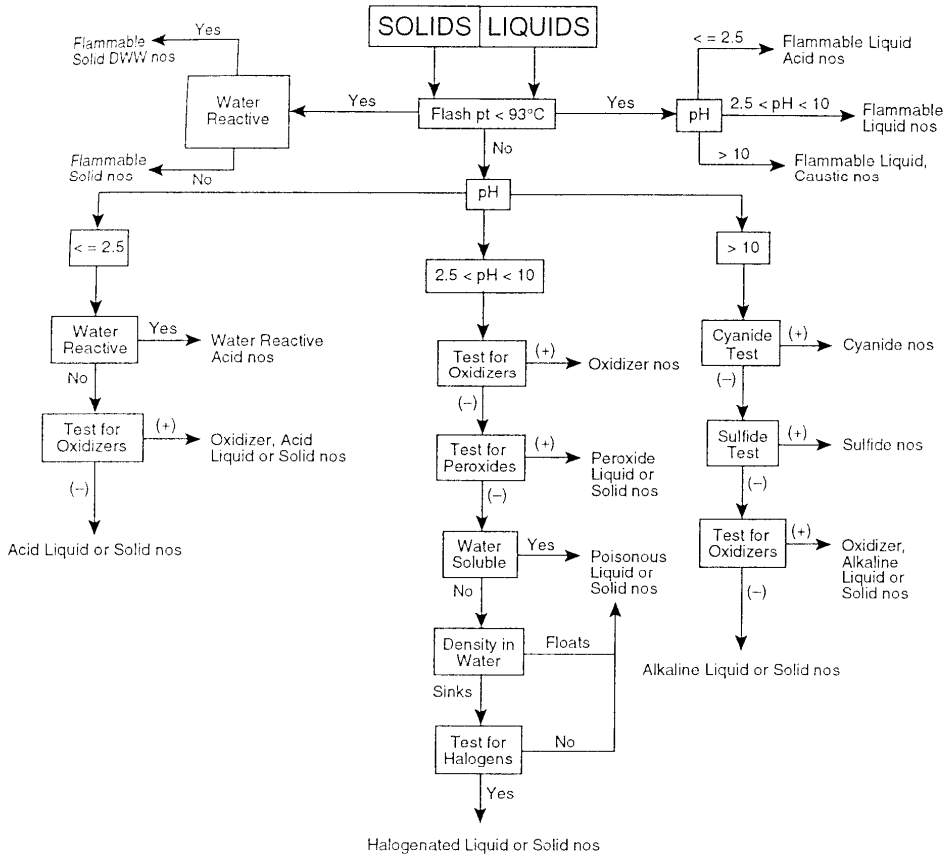


FIGURE 1 Flow chart for categorizing unknown chemicals. This decision tree shows the sequence of tests that may need to be performed to determine the appropriate hazard category of an unknown chemical. DWW, dangerous when wet; nos, not otherwise specified.

Figure 6 Guideline for chemical waste categorization (Source: Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Academy Press, 1995.)

Use only a small amount of substances for the test and wear suitable protective equipment: rubber gloves, gown, goggles, safety shield and/or face shield and respirator. All chemicals should be treated as highly hazardous. Always remember that danger might incur from an event as insignificant as opening a bottle.

1. **Physical appearances**
2. **Reaction with water:** Slowly put the substance dropwise into water and observe the reactions, e.g. temperature, gas emission, or flame.
3. **Solubility:** If there is no reaction with water, observe further for the solubility of the substance. For a non-soluble substance, note whether it is lighter or heavier than water. For example, most halogenated organic solvents are usually heavier than water.

4. **pH:** For soluble or partially soluble substance, measure the pH of solution.
5. **Flammability:** Put 5-6 drops of the substance on crucible lids. Ignite and observe the characteristics of flame.
6. **Oxidizing agents:** Put a small amount of the substance in 10% sodium iodide solution acidified with 1 M HCl or test with starch-iodide paper after acidified with 1 M HCl.
7. **Inorganic sulfide:** For a soluble substance with pH>10, test for sulfide by adding 2-3 droplets of concentrated HCl acid and test for gas formation by using filter paper strips soaked in lead(II) acetate (Perform in the fume cupboard!).
8. **Inorganic cyanide:** For a water soluble substance with pH>10, test for cyanide using Prussian Blue Test.
9. **Halogen:** Burn a clean copper wire until it becomes red-hot with colorless flame. Dip the wire in the substance and burn it again. If the substance has halogen compound, the flame will become greenish. Other elements such as N, S, P could also result in greenish flame.

- Substances that could finally be categorized should be disposed as suggested in No. 8.4.3, or properly treated before disposal.
- Only unidentified substances should be treated as hazardous waste. Be fully aware that the disposing cost of unidentified waste is very much higher than identified ones (keep in mind that WasteTrack program does not accept unidentified wastes).

8.4.2 Newly-generated Waste

Since the beginning of Waste Classification Program, unidentified waste should no longer exist in the Department of Chemistry. Any laboratory generating such waste must be responsible for the qualitative analysis of such unknown waste before directing to a proper disposal.

** Waste container to be sent for a proper disposal need to be labeled with Waste Disposal Request Form*

8.4.3 Classification of Hazardous Waste

Apply the provision in Chulalongkorn University's Central Waste Disposal System (Wastetrack: http://chemtrack.chula.ac.th/wastetrack) which 14 waste classifications (I-XIV). Detail is as follows:

I Special waste (that could not be classified into II-XIV such as mixture of organic substance and water)

II Cyanide waste (in any state)

III Oxidizing aqueous waste except chromate/dichromate

IV Mercury waste (in any state)

V Aqueous waste containing chromate/dichromate

VI Aqueous waste containing heavy metal

VII Acidic aqueous waste

VIII Basic aqueous waste

IX Liquid waste from petroleum products and hydrocarbon

X Oxygenated inorganic liquid waste

XI Organic liquid waste containing NPS (Nitrogen, Phosphorus, Sulfur)

XII Halogenated liquid waste

XIII a) Combustible Solid b) Non-combustible Solid

XIV Aqueous waste with organic or non-toxic salt less than 5 percent

Guideline for classification should be considered according to the Flowchart in Figure 7

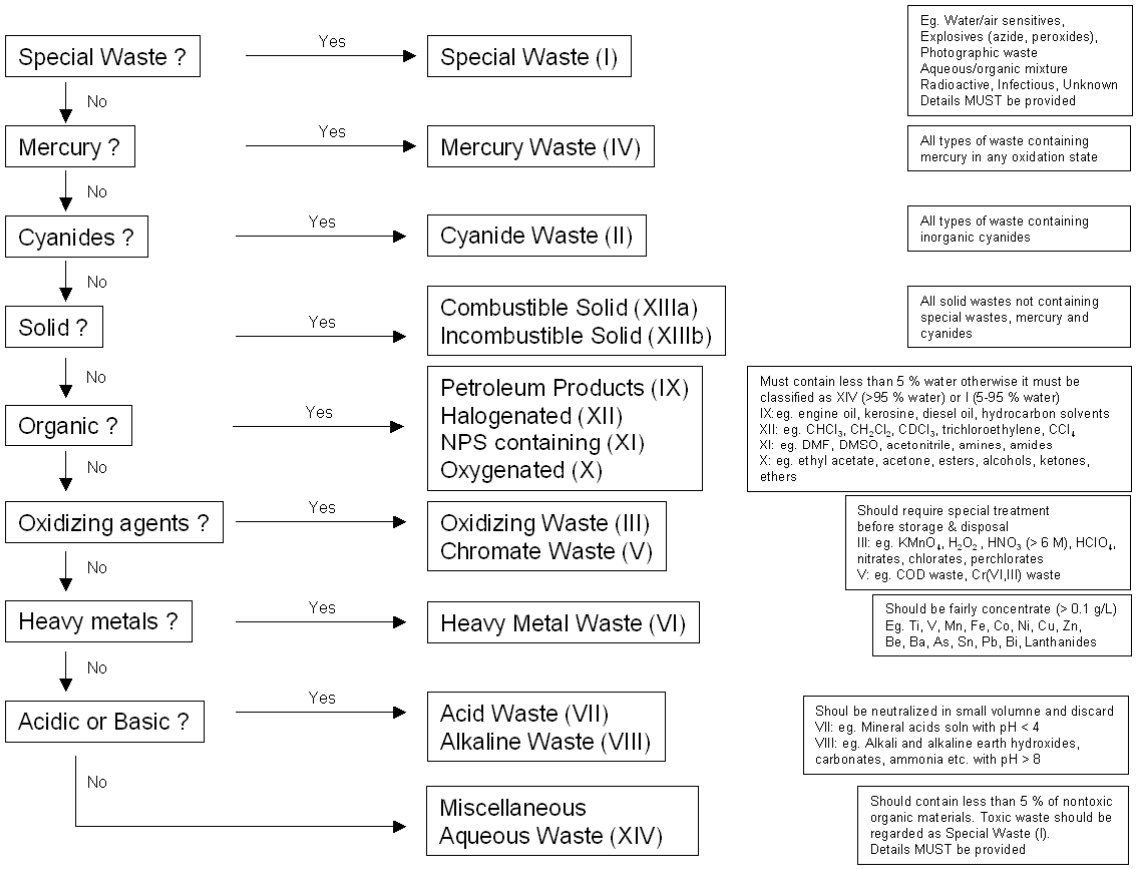


Figure 7 WasteTrack Classification of Hazardous Waste

Chemical wastes from different classifications should be separated (using the guideline in this flowchart) such as water-organic solvents; chlorinated or non-chlorinated solvents; mercury and other heavy metals waste; waste with cyanides and without cyanides, etc.

Any mixed chemicals must be classified by a more hazardous class. For example, if a cyanide waste is mixed with a non-cyanide waste, the mixture should be treated as cyanide waste (which has higher disposal cost). Generation of a waste mixture that contains water and organic solvent in the range of 5-95% should be avoided since it will be classified as special waste. However for reverse phase HPLC solvent, classification can be done by considering its component. If water is a major component, the mixture should be treated as miscellaneous aqueous waste (XIV). If organic solvent is a major component, the waste will be treated according to that organic solvent such as methanol-Oxygenated (X), acetonitrile-NPS (XI).

Mixing wastes from different classifications might result in highly hazardous consequences. For example, mixing nitric acid with an organic substance in a 2.5-liter bottle might cause a severe explosive reaction and the toxic gas emission might harm or kill people who are in the vicinity.

8.4.4 Containers for Hazardous Waste Disposal Used in the Department of Chemistry

Use containers that made of materials appropriate for each class of waste (e.g. do not use metal container with corrosive substances, do not use plastic container with oxidants, etc.) The approved standard containers are: 20-liter plastic gallon, glass bottles of 1.0 L (GB1), 2.5 L (GB2.5), 4.0 L (GB4), 18-liter (MC18) tin can or thick plastic bags (BG1-BG5) (For plastic bags, identify the weight of disposed substance in kilogram. Fractions of one kilogram should be counted as one. But never allow any bags to be heavier than 5 kilograms.) Capacity of the waste container is measured by the container's size. Therefore, containers should not be submitted for disposal before they become full. However, do not overfill the containers as it could cause an explosion. Always allow enough air space for vapor expansion.

All waste containers must be labeled with a laboratory reference number that could be traced back. The waste containers should be stored in the laboratory until the pick up date and time is announced by the Central Waste Disposal Unit (WasteTrack Program). Usually, a waste collection is scheduled in every one or two months. Waste Disposal Form should be turned in around the 20th and pick up the waste around the 25th of the month. The sender should fill the Waste Disposal Form and submit it to the WasteTrack Program coordinator for the Department of Chemistry (Prof. Dr. Tirayut Vilaivan). The Program will issue a new reference number (WasteTrackID) to be put on the container's label. At an appointed date and time which will be officially announced, take your waste to the pick up point for collection. The Program will not accept any waste containers that have no reference numbers. Ensure that the covers or lids of any hazardous waste containers are secured before removing. In transferring waste to the collection area, any liquid bucket should have an extra secondary container to minimize spillage. Use suitable trolley and freight elevator to transfer waste containers. Never use a passenger elevator. For any spillage, follow the instruction in No. 4 and immediately notify the person in charge.

For Waste Disposal Form and guideline to fill the form, please refer to Appendix 1 or the Safety Committee's web site: http://www.chemistry.sc.chula.ac.th/safety/safety.shtml under Menu Safety Forms > Waste Disposal Form.

9. Chemical Storage

9.1 Hazard Data and Symbols

Chemical storage should be arranged with the idea to keep it in an orderly, easy-to-locate and safely fashion. The information on properties of the substances, which would be useful in assigning the right location and storing method, could be retrieved from chemical labels, MSDS, and other references such chemical vendor's website. For any substances that such information is not available, use a chemist's common sense or seek advice from the laboratory advisor.

9.1.1 The National Fire Protection Association (NFPA) Symbol System

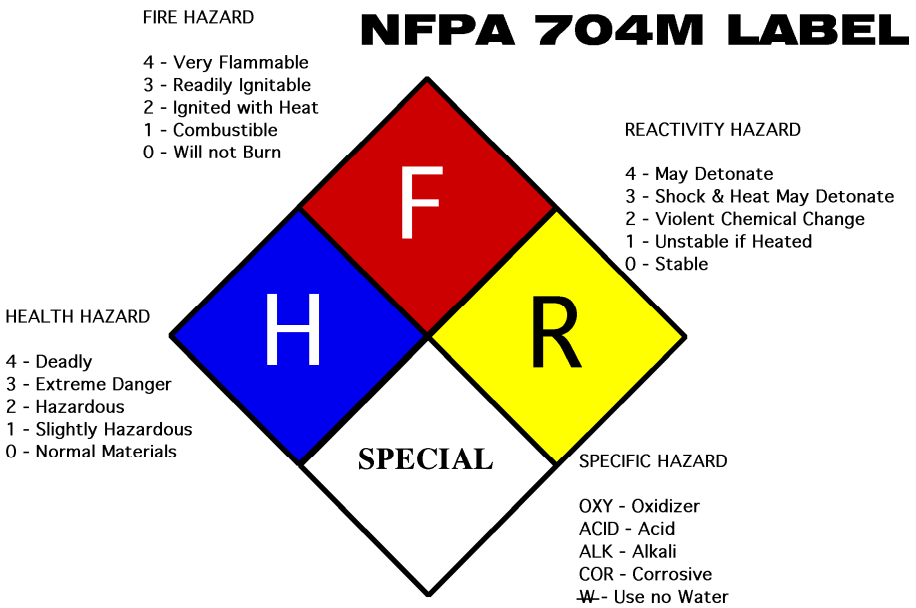


Figure 8 NFPA diamond-shaped labels for hazardous chemicals and substances

9.1.2 UN Labels Pictograms

The UN chemical classification has 9 classes of hazardous substances. The hazard symbol will be displayed in diamond-shaped squares. See Figure 9.

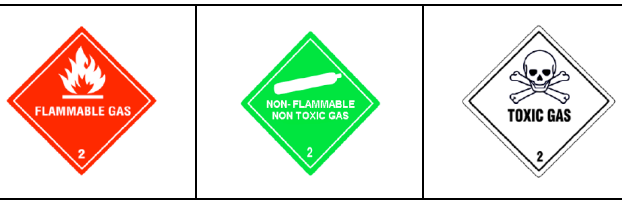
9.1.3 The EEC (European Economic Community) Classification

Directive 67/548/EEC introduced common provisions on the classification of dangerous substances. The black hazard symbol will be displayed in framed square with orange background. See Figure 10.

Class E	explosive.	Symbol with the word 'explosive'
Class F/F^{+}	flammable/highly flammable	Symbol of a flame in a flame
Class O	oxidizing agent	Symbol of a circle under a flame
Class T/T^{+}	toxic/highly toxic	Symbol of a skull and cross bone
Class X_n	harmful	Symbol of a cross and 'h'
Class X_i	irritant	Symbol of across and 'i'
Class C	corrosive	symbol of a droplet from tube on a hand and metal
Class N	Eco-toxic	Symbol of a dead tree and a dead fish

Class 1 Explosives

Class 2 Gases



Class 3 Flammable Liquids

Class 4 Flammable Solids

Class 5 Oxidising Agents and Organic Peroxides)

Class 6 Toxic/Poisonous and Infectious Substances

Class 7 Radioactive

Class 8 Corrosives

Class 9 Miscellaneous Dangerous Goods

Figure 9 UN diamond-shaped labels for hazardous chemicals and substances

Class	Symbol	Hazardous risk	Symbol
Explosive		Flammable	
Oxidizing		Toxic	
Harmful		Irritant	
Corrosive		Eco-toxic (dangerous for the environment)	

Figure 10 EEC labels for hazardous chemicals and substances

9.1.4 The GHS (Globally Harmonized System of Classification and Labelling of Chemicals) system

The GHS is a new system approved by the UN to standardize a classicfication and labelling of chemicals around the world. Chemical vendors and importers have gradually adopted this system thus it is necessary to understand the system. In most parts, GHS classifications are similar to that of UN system (9.1.2) with only few exceptions such as GHS stops using number to identify class and hazardous risk and also switches older symbols to better self-defined symbols and descriptions.

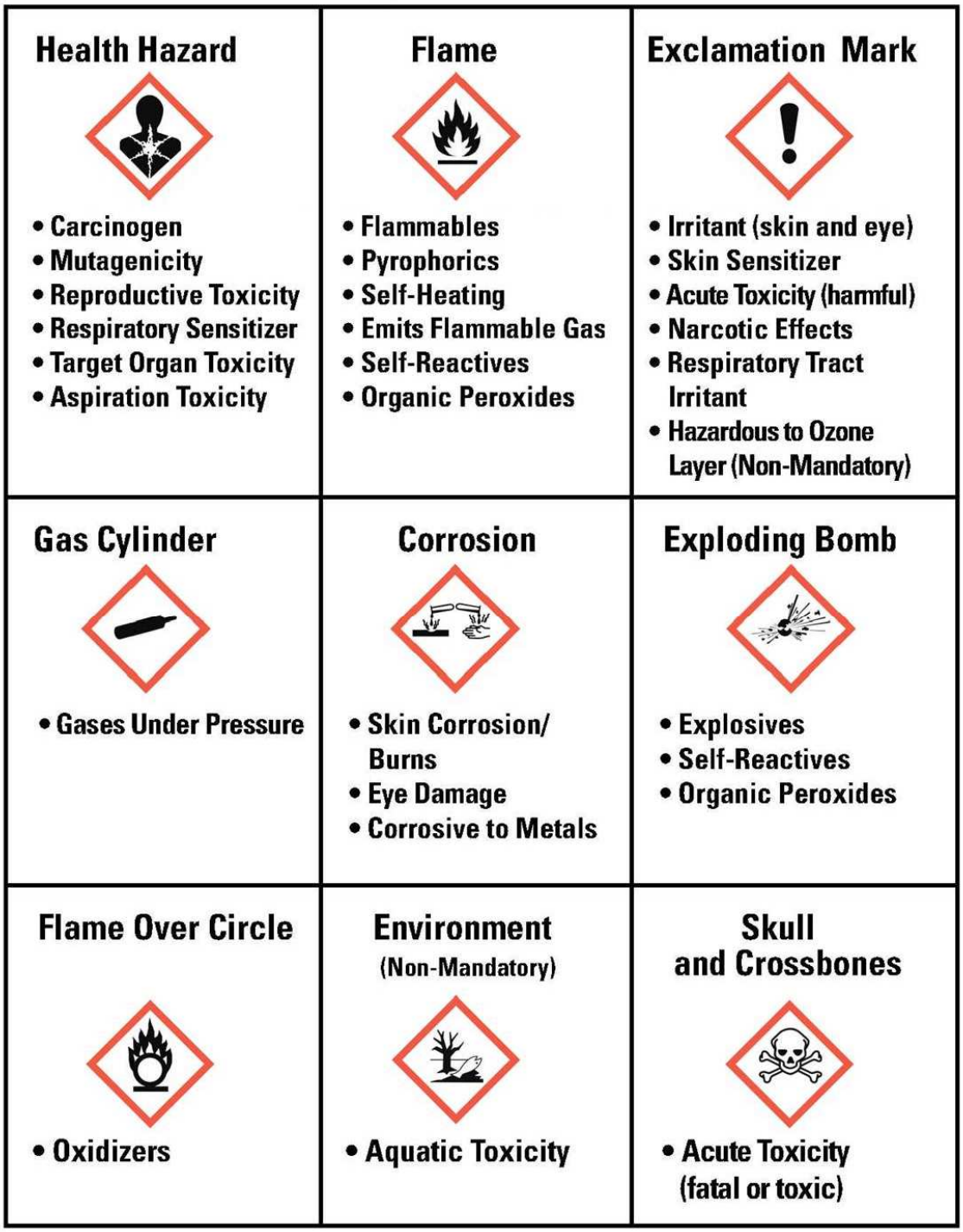


Figure 11 GHS labels for hazardous chemicals and substances

(source: http://fac.hsu.edu/wrayjones/NFPA%20Label.htm)

9.2 Code of Practice in Chemical Storage

- The laboratory should have the up-to-date inventory of all chemical substances in its possession, either in the form of a hard copy or an electronic database that is frequently updated. And within 2008, all laboratories of the Department of Chemistry that have acquired and/or stored chemicals are to be registered with Chulalongkorn University's chemical management system (ChemTrack: http://chemtrack.chula.ac.th). The data should be frequently updated.
- Substance containers shall remain clearly and legibly labeled as prepared by the manufacturer. Information on any label must include:
  - Name and chemical formula;
  - Risk phrases and Safety phrases;
  - Dangerous goods classification and risk labels;
  - Specific warnings
  - Emergency procedures;
  - Precautions for safe use and handling;
  - Date of Receipt or Expiry Date.
- Have a systematic filing or computer server that collect MSDS information of all chemicals used in the laboratories for easy reference in case of emergency
- Store chemicals by flammability and water-reactivity classification:

  Class 1 flammable or combustible and not highly toxic and compatible with water
  Class 2 flammable or combustible and not highly toxic and incompatible with water
  Class 3 oxidizers and non-flammables, compatible with water
  Class 4 oxidizers and non-flammables, incompatible with water
  Class 5 air sensitive
  Class 6 chemicals requiring refrigeration
  Class 7 compressed gas cylinders, separated as to oxidizers, reducers, corrosives, toxics
  Class 8 unstable chemicals/explosives

  In practice, it is generally sufficient to separate substances that are flammable, corrosive, or require special care (e.g. refrigeration). The sub-categories might be required, depending on the states of the substances.
- Never keep any food or drink in a refrigerator used for chemical storage.
- Flammable substances should be stored away from ignition sources. All electronic switches in the chemical store room must be spark-safe.
- Avoid exposure of chemicals to heat or direct sunlight, which may lead to an undesired reaction or the degradation of the chemicals. They should be stored in the refrigerator or any appropriate container as indicated by the manufacturers.
- Low boiling point solvents should be kept in a well-ventilated area and away from direct sunlight.
- Do not store large amounts of unnecessary chemicals in the laboratory.
- Compressed gas cylinders should be stored outside the laboratory with a connecting tube for usage inside the room. The gas cylinders must be in an upright position and firmly secured by restraining chains.

- Some chemicals require special storage:
  - Hydrofluoric Acid: stored in an acid-resistant plastic container. Do not glass or metal ware.
  - White phosphorus: stored under water.
  - Sodium and other alkali metals: stored in oil.
  - Picric: stored under water.
  - Ether: in amber bottles.
  - Peroxide, organometallics: in the refrigerator.
- The laboratory should provide suitable containers for all chemicals storage and protective equipment for emergency such as fire extinguishers, personal protection equipment, and chemical absorbents in an adequate amount for types and hazard levels of the chemicals stored.
- The “Chemical Storage and Safety” survey form may be consulted. See Chemicals and Safety Handbook by Pichai Tovivich, Supawan Tantayanon, and Prapaipit Chamsuksai, Department of Chemistry, Faculty of Science, Chulalongkorn University.

Prepared by Prof. Dr. Tirayut Vilaivan and the Safety Committee

1 June 2004

1st Revision 8 August 2005

2nd Revision 21 February 2007

3rd Revision 20 May 2008

4th Revision 14 August, 2013

Information on Waste Disposal Sender

Lab Register No. _____ Department _____Chemistry____ Fac/Ins __Science___ Date _____

Lab No. _____ Building ____Mahamakut ____ Lab advisor/supervisor _____ Tel. _____

Lab Type ☐ Research lab ☐ Instrumental lab ☐ Teaching lab

Source of expense ☐ Research Fund ☐ Faculty/Institute ☐ Department ☐ Others _____

Waste Information

WasteTrackID	Type*	Name and Description	Container*

* Please read the safety guide before filling the form. WasteTrack will not process any form that is incomplete, incorrect or has not complied with the regulations.

Sender _____ Lab Personnel _____ Lab Advisor _____

(Tel._____) (Tel._____) (Tel. _____)

Inspector _____

(Tel. _____)

Guide to Filling out the Form

1. Lab Register No: Use the acronym of the research unit, subject code, lab advisor's initials, or name registered with the WasteTrack Program. Also complete all information on waste disposal sender section.

2. Waste container: each item (container) must be listed separately.

3. WasteTrackID: Put a reference number that could be tracked back. After registration, WasteTrack will issue a new reference number to be put on the container labels. WasteTrack will not accept waste containers that have no reference numbers supplied by WasteTrack.

4. Type of Waste: Specify classification number of each waste according to the Flowchart below. For waste classification I to XIV, give all waste detail in 'Name and Description' column. Keep in mind that waste that is classified as 'unknown waste' would have a highly expensive disposal cost.

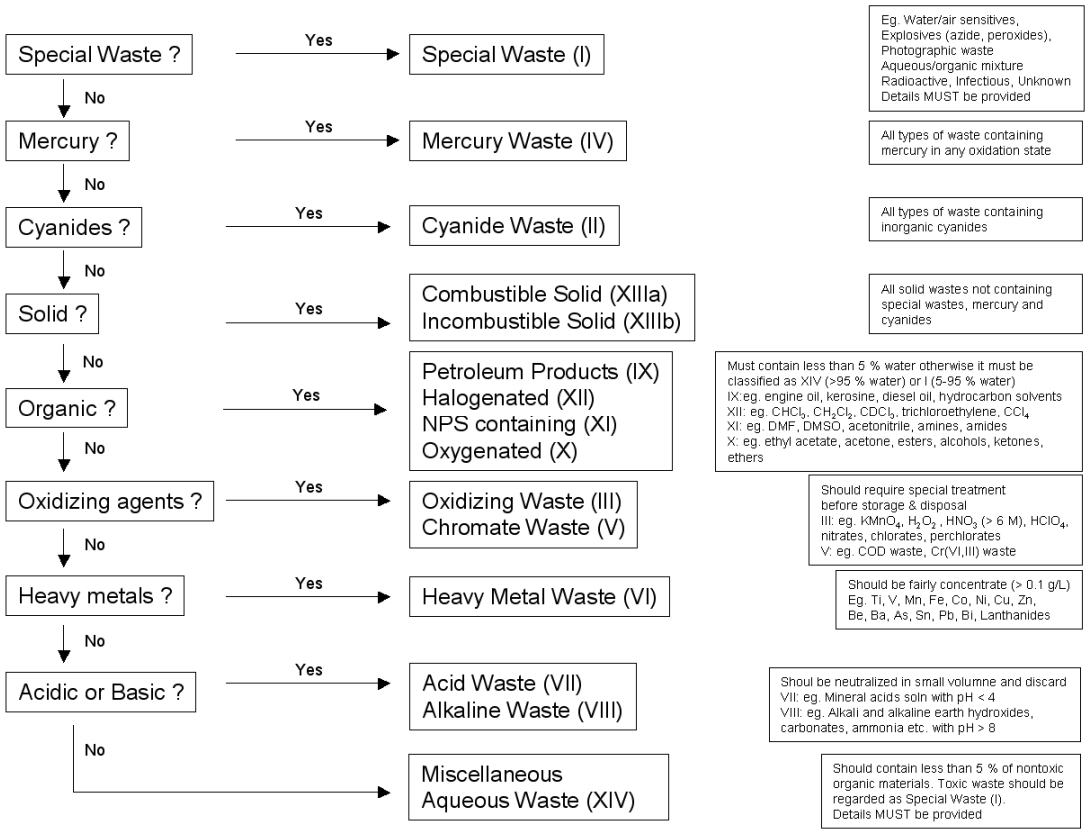
5. Container: Select proper containers for the waste and fill up both type and size of such containers. The standard containers are plastic gallon of 20 L (GL20), glass bottle of 1.0 L (GB1), 2.5 L (GB2.5), 4.0 L (GB4), tin can of 18 L (MC18) or thick plastic bags (BG1-BG5). (For plastic bags, the weight will be calculated in kilograms. Any fraction of one kilogram should be counted as one. Each bag should not exceed the maximum of 5 kilograms. Waste supplied in containers that are not properly listed will not be processed.

6. Capacity of the waste container is measured by container's size. The containers should not be overfilled or removed to the disposal area before they become full.

7. Transaction ID is automatically given by WasteTrack during registration

8. Signature: The form must be signed by sender, lab personnel, and lab advisor with telephone numbers.

Flowchart of Toxic Waste Classification



Accident Report Form

1. General Information

   1.1. Date of the accident ..... Time .....

   1.2. Location Room ..... Floor ..... Mahamakut Bldg

   1.3. Rough sketch of the incident scene

2. Nature of incident

3. Remedial action taken

4. Currently available safety measures

5. Additional measures recommended to prevent a repetition

Signature .....

(.....)

Accident Reporter

Risk Assessment Form

Lab ..... Floor ..... Mahamakut Building

Date and Time of the Experiment ..... Experiment operator .....

Information on the experiment

Class (1-10) .....

Risk Level ( ) A ( ) B

(See definition in the Safety Manual No. 7.4)

Experimental Summary

Chemicals to be used (specify name, quantity and hazard)

.....

.....

.....

.....

.....

.....

.....

Risk assessment and emergency plan

.....

.....

.....

.....

.....

.....

.....

Signature ..... Signature .....

(.....) (.....)

Experiment operator Advisor

The Safety Committee – Department of Chemistry

(departmental appointment no. 27/2555, duration: 1st November 2012 – 30th September 2016)

Department Head (Assoc. Prof. Dr. Vudichai Parasuk)	Consultant
Prof. Dr. Tirayut Vilaivan	Chairman
Dr. Puttaruksa Varanusupakul	Secretary
Assist. Prof. Dr. Saowarux Fuangswasdi	Member
Assist. Prof. Dr. Boosayarat Tomapatanaget	Member
Assist. Prof. Dr. Sumrit Wacharasindhu	Member
Dr. Panuwat Padungros	Member
Dr. Thanit Praneenararat	Member

The Safety Committee takes responsibility on managing all chemical and toxic waste according with the University's strategy. The integrated process and cooperation in division, department and university levels are introduced to accomplish the objectives and effectively react in case of emergency.

Responsibility of the Safety Committee – Department of Chemistry

1. Set up a policy on safety use of chemicals and waste disposal of the Department.
2. Prepare and revise the Safety Manual for laboratory use in the Department.
3. Regularly inspect all laboratories in the Department to ensure that all are in safe and suitable condition every semester.
4. Arrange training on safety use of chemicals and waste disposal to students at the beginning of every academic year.
5. Arrange a quiz on chemical laboratory safety practice for students and researchers in the Department.
6. Take care of the course 2302704 Chem Safe Res Lab—a required course for master program of the Department of Chemistry. (The Chairman of the Committee has all the rights to solve any problems incurred during the time when the course has not been assigned to any particular person).
7. Complete other safety-related tasks as assigned.

Name List and Telephone Numbers of Floor-based Emergency Contacts in the Department of Chemistry

Floor	Name	Room	Number
Department Supervisor	Assist. Prof. Dr. Soamwadee Chaianansutcharit	1302	089-123-1544 0-2218-7619
Assistant to the Department supervisor	Assist. Prof. Dr. Boosayarat Tomapatanaget	1536	081-557-5370
7	Lect. Ponwason Eamchan	905/6	085-361-6609
8	Assoc. Prof. Dr. Surachai Pornpakakul	1519	081-562-0555
9	Dr. Passapol Ngamukot	905/4	081-692-4049
10	Dr. Sakulsuk Unarunothai	1009	089-111-4158
11	Assoc. Prof. Dr. Pornthep Sompornpisut	1115	089-500-5795
12	Assist. Prof. Dr. Apichat Imyim	1203	085-358-6675
13	Dr. Aticha Chaisuwan	1303	084-003-2185
14	Assist. Prof. Dr. Sumrit Wacharasindhu	1405/6	084-375-8009
15	Assist. Prof. Dr. Boosayarat Tomapatanaget	1536	081-557-5370
Chairman of the Safety Committee	Prof. Dr. Tirayut Vilaivan	1340	0-2218-7627 083-986-8772
Secretary of the Safety Committee	Dr. Puttaruksa Varanusupakul	1228/6	0-2218-7612 089-188-7043