EGE UNIVERSITY

DEPARTMENT OF CHEMICAL ENGINEERING

CHEMICAL HYGIENE PLAN

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INTRODUCTION

This document describes the Chemical Hygiene Plan of Ege University, Faculty of Engineering, Department of Chemical Engineering. In the laboratories of the Department for the purpose of research and education a variety of chemicals are used which can represent a risk to the health of the students and as well as the staff. The Department of Chemical Engineering has established the Chemical Hygiene Plan to ensure that employees and students are protected from health hazards associated with hazardous materials in the laboratory and to ensure that exposures are kept below the permissible exposure limits. The chemical waste will be reduced and the produced waste will be separately collected and their secure elimination will be provided. This Chemical Hygiene Plan imparts methods and requirements for all laboratory personnel to follow while working in the laboratories.

SAFETY VERSUS RISK

Hazards present in laboratories include toxic chemicals, electrical equipment, radioisotopes, compressed gasses, and biohazards. By identifying sources of hazards and by assessing the risks of accidents, however, even activities of high potential risk can be engaged in safely. Most hazards that are faced in the laboratory are already known and their associated risks have been defined. Techniques to avoid unnecessary exposure to these hazards have been developed and are incorporated into the safety standards and procedures which you will be expected to follow.

The best way to learn about the hazards in the workplace and how to avoid them is to work with an experienced and knowledgeable person and to actively seek relevant information and training.

TERMINOLOGY

The following terms are often encountered when reading about the properties of chemicals and the toxicity of chemicals. Simple definitions are included here to help you understand the properties of common chemicals.

CHEMICAL PROPERTIES TERMS

Pyrophoric chemicals spontaneously ignite in air. No source of ignition (spark) is needed. They react spontaneously when exposed to oxygen. Silane is an example of a pyrophoric gas.

Flash point is the minimum temperature of a liquid at which it gives off sufficient vapor to form an ignitable mixture with air. Liquids with a flash point near room temperature can be ignited very easily during use.

Exothermic reaction is a reaction which produces heat (releases energy).

TYPES OF EXPOSURE

Acute exposure as used in toxicology refers to a short term exposure. It has nothing to do with either the severity of the exposure or the severity of the effect. The type of exposure occurring during an accidental chemical spill is properly described as an acute exposure.

Chronic exposure as used in toxicology refers to a long term exposure. Again it has nothing to do with the severity of the exposure, the severity of the consequences, or the duration of the consequences. Chronic exposures can be the result of chemicals in the workplace, the home, or the environment. Chronic exposures are usually the result of carelessness, ignorance, or neglect, and not the result of an accident.

Local exposure refers to exposure limited to a small area of skin or mucous membrane.

Systemic exposure means exposure of the whole body or system, through absorption, ingestion, or inhalation.

TYPES OF EFFECTS

Acute effects refer to the duration of the symptoms. Acute means symptoms lasting a few hours or days. Again, it has nothing to do with the severity of the effects.

Chronic effects are long term effects, manifested by prolonged duration and continuing injury.

Local effects occur in a small area, at the place of contact.

Systemic effects occur throughout the body, or at least away from the point of contact.

Allergies and ***hypersensitivity*** are reactions by particular individuals to particular chemicals, caused by heredity or prior overexposure. Hypersensitive individuals should avoid exposure to the offending agents.

EXPOSURE LEVELS

TLV-Threshold Limit Value

This is actually TLV-TWA (time weighted average) but is commonly called just TLV. It is the (averaged) level to which you can be exposed 8 hours a day, 5 days a week forever, without adverse health effects. This level is most relevant to chronic (long term) background exposure to chemicals in the work place. Short term exposures in excess of TLV are thus not necessarily hazardous. This value is not particularly relevant to our laboratory situation. It is sometimes used as a guideline, since short term exposure to < TLV should be very safe.

IDLH - Immediately Dangerous to Life and Health

This level represents the maximum value for which a 30 minute exposure will result in no irreversible or escape impairing effects, i.e. the maximum level which will not cause you to pass out or sustain irreversible organ damage. It is the value most appropriate to sudden, one time accidental exposures. For your information, a short table of values for relevant chemicals is listed below.

Arsine	6 ppm
Ammonia	500 ppm
Carbon Monoxide	1500 ppm
Chlorine	25 ppm
Hydrogen Fluoride	20 ppm
Diborane	40 ppm
Phosphine	200 ppm

STEL- Short Term Exposure Limit

Actually TLV-STEL. Maximum concentration to which you can be exposed for 15 minutes, up to 4 times a day without adverse effects.

PEL- Permissible Exposure Limit

The statutory equivalent of TLV.

LD50

The dose at which 50% of those exposed will die. Separate levels apply to various modes of exposure, (inhalation, dermal, etc.). Usually expressed in terms of mg per kg of body weight; often measured for mice and rats, for obvious reasons.

All these levels are approximate, with considerable inconsistency between various sources. It is obvious that one can not do well controlled experiments on human subjects. It is thus wise to be conservative in estimates using these numbers.

TOXIC EFFECTS

Carcinogen
A substance producing or inciting cancerous growth.

Mutagen
Capable of inducing mutations.

Teratogen
A substance causing damage or death to the fetus.

Asphyxiant
A substance causing suffocation by replacing oxygen in the air or displacing oxygen from hemoglobin in the blood.

Anaesthetic
A substance having a depressant effect upon the central nervous system.

Hepatotoxic
Causing damage to the liver.

Nephrotoxic
Causing damage to the kidneys.

Neurotoxic
Causing damage to the nervous system.

Hematopoietic system
The blood system with the different blood cells.

Pulmonary
Regarding the lungs.

Dermatitis
Inflammatory condition of the skin (dermis).

GOOD LABORATORY PRACTICE

Preplanning and Clean-up

Preplanning experiments and a properly organized work area can eliminate a lot of potential problems. Clean-up and decontamination must be a routine part of experimental design for all lab personnel.

The careful routing and identification of contaminated and waste materials as they are generated can make clean-up safer for lab personnel as well for the other people who must deal with the glassware, discards, and wastes once they have left the lab. Be knowledgeable about what happens to any biohazardous, radioactive, or other dangerous material that leaves the lab. Make sure that it is placed in an appropriate container, that it is appropriately labeled, and that it is placed in the appropriate location for pick-up.

Don't depend on a sophisticated equipment set up to protect you. Thousands of rands worth of biosafety cabinets, fume hoods, disinfectants, and the barrier protection offered by gloves, shielding, and lab coats can be easily defeated by sloppy work habits and a reluctance to recognize or deal with a problem. Safe and acceptable working habits and personal hygiene are the most important protection against an accident or a laboratory acquired infection. Recognize and understand the risks that exist in the work place and be able to logically assess which risks are acceptable and which are not. If the appropriate equipment that is required to do an experiment safely is not available, redesign the experiment or do not perform it until it can be done safely.

Laboratory Fume Hoods

Work Practices

- A key to safe handling of chemicals is a good, properly installed fume hood. Not only do they keep undesirable vapours from the laboratory atmosphere, but with the hood sash closed they provide a protective barrier between you and the chemical operations.
- Use fume hoods whenever possible when handling chemicals and especially when directed to "Avoid inhalation of vapors" or to "Use with adequate ventilation".
- Before each use check that the fume hood is operating properly.
- Keep your head out of the hood!
- Except when adjusting apparatus within the hood, keep the hood sash closed.
- Think ahead - prepare an emergency plan in the event of power failure or other unexpected occurrence such as fire or explosion in the hood.
- Report persistent problems with fume hoods to the Safety Representative.
- Conduct all operations, which generate air-born contaminants, inside a fume hood.
- Always wear appropriate eye protection and a lab coat when working around a fume hood.
- Keep apparatus at least 15 cm from the face of the hood to minimize turbulence at entrance to hood as this can cause some of the contaminants to be swirled out of the hood.
- Avoid blocking the rear ventilation slot. If necessary, material can be stored at the back of the hood on an elevated shelf so that the slot air flow is not impeded.
- Try not to store chemicals or gas cylinders inside the hood. Hazardous chemicals should be stored in an approved safety cabinet.
- Do not place electrical receptacles or other ignition sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood (current design criteria).
- Avoid cross drafts at the face of the hood. Minimize foot traffic past the hood and position windows and supply air diffusers to direct air away from the hood.
- Do not raise the sash higher than the labeled height as this will reduce the hood efficiency.
- Leave the sash lowered when the experiment is unattended.
- Keep the bypass grille clean.

Fume Hood Airflow Failure - Response Procedures

The abrupt and complete loss of air flow to a laboratory fume hood may create significant hazards or cause injury to maintenance and laboratory staff. The purpose of this procedure is to ensure that the hazards associated with hood system failure are minimized.

Good experimental design requires that fume hood users develop a plan of action to follow if the fume hood fails. Fume hood users should incorporate the following elements into their emergency planning in order to facilitate the emergency shut-down of experiments being conducted in fume hoods:

- An understanding of the hazards associated with the materials being used. Keep the amount of toxic material in use to a minimum.
- The provision for personal protective equipment such as chemical cartridge respirators which will provide protection from chemicals in use.
- A planned shut-down procedure, so that the experiment may be shut down safely. (Some experiments may be safely interrupted, but it may be safer for others to be driven to completion). Shut-down includes: closing chemical containers, closing off heat, relieving all pressures, removing hazardous substances and monitoring for radioisotopes where they are in use.
- Determine if evacuation of the lab would be required and if the Fire Team should be called.

RESPONSIBILITIES OF ALL STAFF, RESEARCHERS AND STUDENTS

A member of staff, a researcher or a student will:

- Have a high regard for personal safety and the maintenance of an accident-free, safe working environment in the chemistry building.
- Be aware of the content and regulations within the Safety Manual for handling Hazardous Chemical Substances.
- Set a good example for others in safety matters.
- Notify the Safety Representative of hazardous situations.
- Be aware of any special role they are to play in the evacuation of the building.
- Be prepared to assume responsibility during an emergency.
- Ensure that unattended reactions are carried out safely.
- Be aware of the general nature of the work being performed, in particular after-hours work.
- Be aware of the safety implications of the work.
- Be aware of the general layout of equipment in the laboratory, operation of fume hoods and of the linkages of fume hoods throughout the building.
- Be aware of and correct hazardous situations in their area.

A member of staff will also

- Ensure that students or other workers are aware of and are following safety procedures.
- Ensure that protective equipment is available, is in working order and is used.
- Ensure appropriate housekeeping standards are maintained.

A researcher or student will also

- Maintain good housekeeping in the laboratory at all times.

- Be aware of the likely hazards involved with the chemicals and procedures which are in use (this will require frequent consultation of the safety literature - see Bibliography).
- Request information and training when unsure how to handle a hazardous chemical or procedure.
- Notify their supervisors and neighboring workers if an experiment is potentially hazardous.

Procedures for after-hours work

- After-hours work is defined as 6pm - 8am weekdays plus all of the weekend.
- The nature of experimental work to be carried out after-hours by students should be discussed with the supervisor, or an appropriate more senior worker (e.g. postdoctoral fellow) and only approved work may be done.
- In the event of an evacuation alarm, the after-hours procedure is for occupants of the building to follow the normal procedures of shutting down services and then leaving the building by the assigned escape route for the area in which they are working. All persons are to assemble at the assigned assembling point where a check is to be made that everyone has left the building. No-one is to leave the area before being checked in this way. One person is to be nominated to act as liaison person with the Fire Brigade and any other services involved.
- No unauthorised persons may be admitted to the building after working hours. Strangers should be challenged. If unsure, call 0232-311 55 55, 0232-311 15 77 or (5555 or 1577 intern telefon numbers) (E.U. Campus Security) for assistance from Security.
- Pin numbers must be used for entry and exit.

Procedures for visitors

- Visitors may not be familiar with the ever-present hazards within a chemical laboratory and as such are not permitted to wander within the building.
- No visitors are to enter laboratories unaccompanied.
- Children are under no circumstances allowed in the building without strict supervision.
- Children are to be kept out of laboratories at all times.

SAFETY RULES IN THE CHEMISTRY LABORATORY

Table of Contents

- First Assignment for Students
- Dressing for Laboratory Work
- Safety Equipment in the Chemistry Labs
- What to Do In Case of an Accident, Injury or Illness

First Assignment for Students

The following is the first assignment in this course!

1. Complete the laboratory **safety quiz** and give it to your lab instructor. (Copy the quiz from your lab manual or print out the quiz on the Internet.) You cannot work in the lab until your instructor has received a successfully completed safety quiz from you. If you fail the safety quiz, or if you do not turn in the safety quiz, you will not be allowed to work in the laboratory at all. Any work missed due to the lack of a correctly completed lab safety quiz will earn a grade of "0."

Safety Rules

Please note: your laboratory instructor will reduce your grade or ask you to leave the lab if the safety rules are not followed!

1. NO food or drink in the lab, to avoid possible contamination.
2. Keep your hands away from your face, while working.
3. Wash your hands as often as possible, especially before leaving the lab.
4. Keep your workstation neat and clean.
5. Be well prepared before you come to the lab.
6. Know what to do in case of emergency.

Appropriate Dressing in Laboratory Work

WEARING LAB-APRONS IN THE LABORARY IS MANDATORY AND CONSIDER THE FOLLOWING POINTS

If you come to the lab dressed inappropriately you will be asked to leave and you will receive a grade of "0" for the day's work.

1. **Wear safety glasses at all times.**

The use of safety eyewear by anyone working in a chemical laboratory is required. These are available for sale in laboratory equipment suppliers.

2. **Tie back long hair.**

Long hair can accidentally fall into chemicals or tighten to any parts of rotary equipments. Long hair can also block your vision, which can lead to accidents.

3. **Do not wear clothing which is loose enough to knock over containers on the work bench or dip into chemicals.**

4. **Wear clothing (shirt, blouse, or dress) which covers and protects your chest, belly, sides, back, shoulders and upper arms.**

5. **Wear clothing (pants, very long skirt or very long dress) which covers and protects your body from the waist all the way down to and including your ankles.**

6. **Wear shoes which cover and protect your feet completely.**

No sandals, open-toed shoes, or shoes with open sides or heels. And no slippers - the top of your foot must be covered!

Dress Recommendations

1. **Wear comfortable shoes.**

Two or more (for Chemical Eng. Laboratory) hours of walking and standing on a floor can leave your feet very tired and sore if you wear uncomfortable shoes.

2. **Wear socks.**

They offer added padding for your feet, and extra protection to your ankles.

3. **Wear clothing which you don't care too much about.**

Tiny splatters or droplets of chemical are very likely to get on your clothing. You might not even know that the droplets are there. But the chemical can stain your clothes or weaken the fibers of the clothing so that the next time you do the laundry your clothes will come out of the dryer with little, fuzzy holes in them.

4. **Do not wear valuable jewelry while working in the lab.**

Chemicals which are harmless to your body may be capable of damaging jewelry. Take your jewelry off and store it in your purse or book bag before beginning any experiment.

Safety Equipment and How to Use It

1. **First Aid Kit**

One first aid kit is located in each laboratory. It contains gauze squares, small, adhesive bandages. If any injury occurs which cannot be handled with these supplies, then the student can be escorted to the Health Services office (MEDİKO) to receive treatment, or can wait in the lab for an Emergency Medical Service (EMS) team from Ege University Hospital or MEDİKO if the injury is severe.

2. **Broom and Dustpan**

In the Chemistry Lab we use a lot of glassware. Glassware usually winds up getting broken some time during the semester. When that happens, it is unsafe to pick up the broken glass with your hands.

Instead, you should use a broom and dustpan to collect the broken glass. The broken glass should then be disposed of in the specially marked container provided.

3. **Fume Hoods**

The fume hoods are large cabinets which have sliding glass doors in front. Fume hoods are used to protect you from harmful fumes, gases and odors. The fume hood has an air duct in its ceiling which is attached to a powerful fan. When the fan is turned on, the air in the fume hood is pulled up through the duct, carrying away any harmful fumes or smoke. Any time your experiment will produce harmful or bad-smelling gases or smoke, you will perform the experiment in the fume hood. Our fume hoods are on at all times, and they can only be turned off by authorized personnel.

4. **Sink**

While the sink is used for cleaning glassware and many other tasks, it is also a part of our safety equipment. If you happen to get chemicals onto your hands or forearms, you must move quickly to the sink to rinse the chemicals off. The treatment for any chemicals which get on the body is to rinse the affected body area for 15 minutes under cold running water (or as long as you can stand it).

When you are in the lab, if you notice that you have a mysterious itch on your arm which just won't go away, assume that it is a chemical on your skin and wash with soap and plenty of water.

If chemicals are splashed into your face they should not reach your eyes because you will be wearing safety glass. If this sort of accident happens, you should wash your face until you are reasonably sure most of the chemical is gone from your face.

If chemicals get into your eyes, you should call out for help. If you cannot see, someone will guide you where you should wash out your eyes thoroughly. You should blink continuously and rapidly while washing your eyes to aid the flushing action of the water.

If chemicals get onto your body, you should quickly remove any contaminated clothing and rinse yourself.

5. **Fire extinguishers**

There are fire extinguishers in each laboratory. While you are in the laboratory, please look carefully at the fire extinguishers. Notice how they are attached to the wall, and what you would have to do to get them off of the wall. Read the instructions on the side of the fire extinguisher so you will be familiar with their use. If you ever need to use a fire extinguisher, remember the following (A) pull the pin, (B) aim to the side at first, (C) depress the handle, (D) sweep the spray from side to side across the BASE of the fire (where the fire meets the fuel), not just at the flames! When the fire is out, clean up the area!

Note: Never spray a person with a fire extinguisher. The chemicals in the fire extinguisher can be harmful.

6. **Fire alarm: If a fire alarm sounds you must evacuate the building!**

There are alarm switches at each floor. It is unlikely that you will need to use them, but you should locate them and look at them so you know how they work.

Note: We will prosecute for intentional false alarms!

7. **Telephone**

If someone asks you to call for help, find a lab instructor, professor or staff member and ask them to call an Emergency Medical Service (EMS) team from MEDİKO or hospital. Be sure to stay with that

person until you have given all the necessary information (building, room number, what happened, etc.).

What to Do in Case of an Accident

Always tell your instructor about all accidents immediately!!!

1. **Broken glass.**

Do not pick up broken glass with your fingers! Get a broom and dustpan. Sweep the broken glass into the dustpan and dump it into the specially marked containers provided in each lab.

2. **Small chemical spill.**

Wipe up liquid spills with paper towels and dispose of them as your instructor suggests. Solids should be dissolved in water, if possible, and wiped up. Otherwise, sweep them up with a broom and a dust-pan and dispose of them as your instructor suggests. In all cases, after the chemical spill has been wiped up, rinse the area with water to make sure that all residual chemicals have been removed.

3. **Large chemical spill.**

Move away from the area of the spill. Warn the people around you LOUDLY. Call your instructor! Let the expert handle the clean-up!

4. **Chemical splash in your face, safety glass.**

Rinse your face quickly.

5. **Chemical splash or broken glass in your face.**

If this sort of accident happens, you may not be able to see well enough to go to rinse your face. YELL LOUDLY FOR HELP and cooperate with anyone who comes to your aid.

6. **Large splash of dangerous chemical on your clothing and/or body.**

Quickly follow this procedure while continuously YELLING FOR HELP:

A. **Move away from the area where the spill occurred (you don't want to get more chemical on you).**
B. **CALL LOUDLY FOR HELP and to warn others to stay away from the spill!**
C. **Remove any contaminated clothing.**
D. **The treatment for chemical exposure is 15 minutes under cold running water, or as long as you can stand it.)**

7. **Small, confined fire.**

If you have a small fire in a container, (for instance, a small beaker full of alcohol has caught fire) find something you can use as a lid for the container. When the container is covered, the fire will quickly burn itself out. Call the instructor for help.

8. **Small, open fire**

If you have a small fire which is not in a container, move away from the fire and SHOUT FOR HELP! You can use a fire extinguisher to put the fire out. If you ever need to use a fire extinguisher, remember the following (A) pull the pin, (B) aim to the side at first, (C) depress the handle, (D) sweep the spray from side to side across the BASE of the fire (where the fire meets the fuel), not just at the flames! When the fire is out, clean up the area!

9. **Large fire**

SHOUT FOR HELP and leave the area immediately! The fire alarm will probably sound. When it does, evacuate the building and TELL EVERYONE YOU CAN, where the fire is.

10. **Your clothing on fire**

Don't run! It will only fan the flames and make the fire worse! Instead, you should **STOP** moving, **DROP** to the ground (lie down!), and **ROLL** on the ground to squash out the flames! **YELL** continuously**!**

Note: If you want to help a person who is in this sort of trouble, don't use a fire extinguisher! You must never use a fire extinguisher on a human being. The chemicals in the extinguisher can be harmful!

11. **Fire Alarm**

If a fire alarm sounds you must evacuate the building immediately!

To evacuate properly, you should quickly and calmly do the following:

A. **Turn off all flames and unplug any hot plates or other electric equipment you are using.**

B. **Get your stuff.**

Take your book bag, purse, car keys, etc. with you. We never know whether the evacuation will last for 5 minutes or 5 hours. You don't want to become stranded on campus!

C. **Walk calmly out the door, down the hall, down the *stairs* (elevators should not be used during an emergency unless you are handicapped), out the door and away from the building.**

Your instructor should escort the class out of the building. Try to stay together as a class, and stay near to your instructor. If your class is allowed back into the building, you should finish your experiment, or at least clean up what you have left on the work bench. If the evacuation lasts beyond the end of the class period, then you are free to go.

What to Do in Case of an Injury or Illness

1. **Small cut**

Tell your instructor, and let your instructor look at the injury. Wash the injury thoroughly with water. If the injury is minor, you may use the first aid kit in the laboratory. (The first aid kit contains triple antibiotic ointment and adhesive bandages.) If your injury still hurts so badly that you can't finish the experiment, then you may be escorted to the Medical Health Services office (MEDİKO) or University Hospital so the cut can be treated.

2. **Large cut**

Tell your instructor, and let your instructor look at the injury. To stop or slow down bleeding, apply pressure to the wound. If the wound is very large or there is glass or other foreign matter in the wound, then apply pressure around the arm or leg (between the body's torso and the injury) to slow the bleeding. In all cases, a large cut must be attended to by medical professionals! If you can walk, you may be escorted to the Medical Health Services office (MEDİKO). Or you may wait while an Emergency Medical Service team from University Hospital is called.

3. **Small burn**

Tell your instructor, and let your instructor look at the injury. Chemical burns and heat burns should both be treated with lots of cold running water. *Never put anything but cold water on a burn!* Doctors often have to remove ointments because they retard healing! After this treatment, if the burn still hurts badly enough that you cannot complete the experiment then you will be escorted to the Medical Health Services (MEDİKO) so the burn can be treated.

4. **Large burn**

In all cases, a large burn must be attended to by medical professionals! Tell your instructor, and let your instructor look at the injury. Then you may be escorted to the Medical Health Services (MEDİKO), or you may wait while an Emergency Medical Service from the University Hospital is called.

5. **Fainting**

In all cases, an Emergency Medical Services team will be called from MEDİKO or University Hospital. If you feel like you might faint, please ask for an escort to the Medical Health Services office (MEDİKO) before it is too late. You can usually lie down there, and you may avoid the expense of calling for emergency help.

6. **Breathing difficulties**

In all cases, the student will be escorted to the Medical Health Services office (MEDİKO) *if the student so chooses*. Otherwise an Emergency Medical Service from University Hospital *will* be called!

Summary on Guidelines for Laboratory Safety

1. Be familiar with your lab assignment **before** you come to lab. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ask the teacher before proceeding.

2. Never work alone. No student may work in the laboratory without an instructor present.

3. When first entering a laboratory room, do not touch any equipment, chemicals, or other materials in the laboratory area until you are instructed to do so.

4. Do not eat food, drink beverages, or chew gum in the laboratory. Do not use laboratory glassware as containers for food or beverages.

5. Perform only those experiments authorized by the instructor. Never do anything in the laboratory that is not called for in the laboratory procedures or by your instructor. Carefully follow all instructions, both written and oral. Unauthorized experiments are prohibited.

6. Safety glass and aprons must be worn whenever you work in lab. Wear older clothes that cover the maximum amount of skin.

8. Observe good housekeeping practices. Work areas should be kept clean and tidy at all times. Bring only your laboratory instructions, worksheets, and/or reports to the work area. Other materials (books, purses, backpacks, etc.) should be stored in the classroom area.

9. Know the locations and operating procedures of all safety equipment including the first aid kit, spill kit, fire extinguisher, and fire blanket. Know where the fire alarm and the exits are located.

10. Be alert and proceed with caution at all times in the laboratory. Notify the instructor immediately of any unsafe conditions you observe.

11. Dispose of all chemical waste properly. Never mix chemicals in sink drains. Sinks are to be used only for water and those solutions designated by the instructor. Solid chemicals, metals, matches, filter

paper, and all other insoluble materials are to be disposed of in the proper waste containers, not in the sink. Check the label of all waste containers twice before adding your chemical waste to the container. Cracked or broken glass should be placed in the special container for "Broken Glass."

12. Labels and equipment instructions must be read carefully before use. Set up and use the prescribed apparatus as directed in the laboratory instructions provided by your teacher.

13. Keep hands away from your face, eyes, mouth, and body while using chemicals. Wash your hands with soap and water after performing all experiments. Clean (with detergent powder), rinse, and dry all work surfaces and equipment at the end of the experiment.

14. Experiments must be personally monitored at all times. You will be assigned a laboratory station at which to work. Do not wander around the room, distract other students, or interfere with the laboratory experiments of others.

15. Know what to do if there is a fire drill during a laboratory period; containers must be closed, gas valves turned off, fume hoods turned off, and any electrical equipment turned off.

16. If you spill acid or any other corrosive chemical on your skin or clothes, immediately wash area with large amounts of water (remember that small amounts of water may be worse that no water at all). After this get the teacher's attention. The spill kit will be used for spills on floor or counter-top.

17. At the end of the laboratory session see that: a) the water is turned off b) desk top, floor area, and sink are clean c) all equipment is cool, clean, and arranged.

Clothing

18. Any time chemicals, heat, or glassware are used, students will wear laboratory glass. Contact lenses should not be worn in the laboratory unless you have permission from your instructor.

19. Dress properly during a laboratory activity. Long hair, dangling jewelry, and loose or baggy clothing are a hazard in the laboratory. Long hair must be tied back and dangling jewelry and loose or baggy clothing must be secured. Shoes must completely cover the foot. No sandals are allowed.

Accidents and Injuries

20. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the instructor immediately, no matter how trivial it may appear.

21. If you or your lab partner is hurt, immediately yell out to get the instructor's attention.

22. If a chemical should splash in your eye(s), immediately flush with running water for at least 15 minutes. Notify the instructor immediately.

Handling Chemicals

23. All chemicals in the laboratory are to be considered dangerous. Do not touch, taste, or smell any chemical unless specifically instructed to do so. The proper technique for smelling chemical fumes (when instructed to do so by the teacher) is to gently fan the air above the chemical towards your face. Breathe normally.

24. Check the label on chemical bottles twice before removing any of the contents. Take only as much chemical as you need. Smaller amounts often work better than larger amounts. Label all containers and massing papers holding dry chemicals.

25. **Never return unused chemicals to their original containers**.

26. Never use mouth suction to fill a pipet. Use pipet bulb or pipet filler.

27. Acids must be handled with extreme care. **ALWAYS ADD ACID SLOWLY TO WATER,** with slow stirring and swirling, being careful of the heat produced, particularly with sulfuric acid.

28. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.

29. Never take chemicals or other materials from the laboratory area.

30. Take great care when transferring acids and other chemicals from one part of the laboratory to another. Hold them securely and in the method demonstrated by the teacher as you walk.

Handling Glassware and Equipment

31. Inserting and removing glass tubing from rubber stoppers can be dangerous. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) before attempting to insert it in a stopper. Always protect your hands with towels when inserting glass tubing into, or removing it from, a rubber stopper. If a piece of glassware becomes "frozen" in a stopper, take it to your instructor for removal.

32. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be completely dry before touching an electrical switch, plug, or outlet.

33. Examine glassware before each use. Never use chipped or cracked glassware. Never use dirty glassware. **Do not immerse hot glassware in cold water; it may shatter.**

34. Report damaged electrical equipment immediately. Look for things such as frayed cords, exposed wires, and loose connections. Do not use damaged electrical equipment.

35. If you do not understand how to use a piece of equipment, ask the instructor for help.

Heating Substances

36. Always turn the hot plate off when not in use.

37. You will be instructed in the proper method of heating and boiling liquids in test tubes. Do not point the open end of a test tube being heated at yourself or anyone else.

38. Heated metals, glass, and ceramics remain very hot for a long time. **They should be set aside to cool on a trivet** and then picked up with caution. Use tongs or heat-protective gloves if necessary. Determine if an object is hot by bringing the back of your hand close to it prior to grasping it.

SAFETY QUIZ

FOR CHEMISTRY LABORATORY

This safety quiz is in the laboratory manual.

Print this quiz out to answer all the questions.

Read the Safety Rules in the Laboratory Manual before completing this quiz. Passing score is 100% on the Safety Quiz.

Date: ……/……/……..
Name:……..Surname:……
Signature:……

1. According to the dress code, what should you wear in the laboratory?

2. What type of safety glass should you wear and when should you wear them?

3. In what cases might you be asked to leave the laboratory?

4. Can you eat in the laboratory? Explain your answer.

5. What should you do if:
   A) you broke a beaker and cut your finger.

   B) chemicals have splashed on your face.

   C) the fire alarm sounds.

   D) your lab manual has caught on fire.

   E) your shirt has caught on fire.

F) chemicals have spilled on your pants.

G) Did you carefully read and understand “the summary on guidelines for laboratory safety”

WASTE DISPOSAL

Introduction and Overview

1. Introduction to chemical waste management

Proper waste management procedures must be followed at all times to ensure safe and effective disposal. The purpose of part is to provide laboratory personnel and other hazardous waste generators with the general information and guidelines necessary to properly manage and dispose of hazardous materials at LABS.

Hazardous waste materials generated include **chemical waste**. This part will cover the disposal of hazardous chemical waste in detail.

2. Waste minimization

The laboratory workers at LABS have a direct effect on the total volume of waste generated. With a little planning in advance, waste output can be significantly reduced. Waste minimization will result in a safer workplace, lower purchase and disposal costs, and less waste placed into the environment. To help minimize the volume of hazardous waste generated, laboratory workers are asked to implement the following methods whenever possible:

- **Substitution**

  Often a non-hazardous, less hazardous or less regulated chemical can be used in place of regulated hazardous chemicals in a given process. For example, a procedure which calls for benzene as the solvent may work equally well with toluene, which is less toxic. Flammable scintillation cocktails are readily replaced with less hazardous cocktails. There are also many non-hazardous cleaning solutions which can be substituted for toxic chromic acid cleaning solutions. Similarly, perhaps a different procedure may be utilized which does not require the use of hazardous chemicals or radioactive isotopes.

- **Scale reduction**

  Micro-scale experimental techniques are becoming increasingly popular in research laboratories. Reducing the scale of experiments and procedures reduces the quantity of hazardous waste produced. These then become investigator initiated savings and result in more experimental mileage for each research Rand expended. Safety may also be enhanced.

- **Over-purchase of chemicals**

  Many chemicals deteriorate over time, so if more chemical is purchased than is required; the unused portion becomes outdated and ends up as waste. There are two separate costs related to the stockpiling of chemicals; the cost of the unused chemical and the disposal cost. Careful planning of the actual quantities of chemicals required can reduce the purchase costs to the laboratory and reduce the disposal costs. Many chemical suppliers are now selling chemicals in smaller containers to help laboratories reduce the quantity of chemicals which must be stored.

- **Chemical exchange**

Chemical purchases can also be reduced by borrowing and sharing chemicals between laboratories. We encourage departments to keep records of infrequently used chemicals and where they are located and make arrangements to share rather than buy chemicals which are infrequently needed.

3. General waste streams

- There are five major categories of waste generated at LABS. These waste types are classified as radioactive, chemical, infectious, domestic and recyclable waste materials. Each one of these types of waste is governed by different regulations and disposed of in a different manner. Therefore, care must be taken to insure different wastes are not mixed together. For example, if domestic waste is contaminated with infectious waste, all of the waste will have to be treated as infectious waste. Everyone who generates and discards waste at LABS must play an active role in disposing of waste materials properly. Waste materials are segregated into one of the four waste types:

- **Chemical Waste**
  All forms of chemical waste such as acids, bases, solvents, and laboratory chemicals must be disposed of through the waste store. Empty containers which held hazardous chemicals must also be disposed of through the waste store.

- **Domestic Waste**
  Domestic (household) waste (plastic, cardboard, paper) is disposed of in standard waste-baskets. This waste must not contain any radioactive, chemical, or infectious waste. No liquids of any kind (sterile water, saline, etc.), nor grease or motor oil may be placed into the domestic waste. Domestic waste is picked up by Cleaning Services personnel. Empty chemical containers which held non-hazardous chemicals may be placed in this type of waste.

4. Chemical waste disposal procedures

1. Identification of hazardous chemical waste

One of the major problems each of us has in managing chemical waste is deciding what waste is hazardous and what is non-hazardous. Since the identification of hazardous chemical waste is a difficult problem, laboratory workers at LABS are simply asked to dispose of all chemical waste (after proper labelling) through the Waste Chemicals Store.

Characteristics of hazardous waste

If a waste meets one or more of the following four "characteristics" it is considered a hazardous waste for purposes of disposal.

- **Ignitability**
  - Any liquid having a flashpoint of less than 60^{o}C is an "ignitable" material. This includes almost all organic solvents.

Some common examples are:

Aromatics	**Alcohols**	**Alkanes**	**Miscellaneous**
benzene	methanol	hexane	acetonitrile
toluene	ethanol	heptane	acetone
xylene	propanol	petroleum ether	ethyl ether
pseudocumene	butanol	lacquer thinner	ethyl acetate

- It is an ignitable compressed gas (propane, methane, etc.).
- Oxidizers (e.g., potassium nitrate, sodium nitrite)
- It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.

- **Corrosivity**
  - Any aqueous material having a pH less than or equal to 2.0 or greater than or equal to 12.5 is a corrosive material.
  - Any liquid or solid which corrodes steel (SAE 1020) at a rate greater than ¼" per year at 55 ^{o}C is a corrosive.
  - All common organic and mineral acids are considered corrosives. Common bases such as solid sodium hydroxide and potassium hydroxide are also corrosive.

The following are examples of corrosives:

Mineral Acids	**Organic Acids**	**Bases**
nitric acid	formic acid	ammonium hydroxide
perchloric acid	acetic acid	potassium hydroxide
sulfuric acid	trichloroacetic acid	sodium hydroxide
hydrochloric acid	propionic acid	
phosphoric acid		

- **Reactivity**

A waste material is considered "reactive" if it meets any one of the following definitions:
  - It is normally unstable and readily undergoes violent change without detonating.
  - It reacts violently with water or forms potentially explosive mixtures with water or, when mixed with water forms toxic vapor or fumes.
  - It can form hydrogen cyanide or hydrogen sulfide gas when exposed to pH conditions between 2 and 12.5.
  - It is readily capable of detonation or explosive decomposition if it is subjected to a strong initiating source or is heated under confinement.

Some common examples of reactives are:

Alkali Metals	**Cyanides**	**Sulfides**	**Water Reactives**
lithium	potassium cyanide	sodium sulfide	calcium hydride
sodium	sodium cyanide	potassium sulfide	sodium methoxide
potassium	silver cyanide	ammonium sulfide	sodium ethoxide
rubidium	ferric cyanides		aluminum chloride
cesium			

- **Toxicity**
  (Toxicity Characteristic Leaching Procedure (TCLP) Wastes).

- The following chemicals are found under the Toxicity characteristic and are regulated in parts per million concentration:

Metals	**Organics**
arsenic	benzene
barium	carbon tetrachloride
cadmium	chlorobenzene
chromium	chloroform
lead	cresol
mercury	dichloroethane
selenium	methyl ethyl ketone
silver	nitrobenzene
	pyridine

Most metals are toxic to humans and aquatic life in part per million concentrations. Metals are a persistent problem because they cannot be broken down to less toxic materials.

The following are examples of toxic metal-containing compounds:

barium hydroxide	nickel chloride
cacodylic acid	osmium tetroxide
cadmium chloride	potassium dichromate
chromic acid	selenous acid
copper sulfate	silver (used photography fixer)
lead subacetate	sodium arsenate
mercuric nitrate	sodium cacodylate

2. Segregation of chemical waste

Segregation of chemical waste is necessary so that waste can be safely collected and disposed. Chemical waste must be segregated in such a manner that only chemically compatible wastes are allowed to be mixed together. The following categories can be used as a guide for segregating chemical waste into chemically compatible waste streams:

Waste Category	**Examples of Compatibility**
Flammable Solvents	acetone, methanol, ethanol, toluene, xylene, acetonitrile
Halogenated Solvents	halothane, methylene chloride, chloroform, carbon tetrachloride, trichloroethane, trichloroethylene
Heavy Metal Solutions	aqueous solutions containing arsenic, barium, cadmium, chromium, copper, lead, mercury, osmium, selenium, silver, etc. (do not mix)
Mineral Acids	hydrochloric acid, nitric acid, sulfuric acid, perchloric acid (do not mix)
Organic Acids	formic acid, acetic acid, propionic acid
Bases	sodium hydroxide, potassium hydroxide, ammonia (do not mix)
Oxidizers	potassium nitrate, hydrogen peroxide, potassium permanganate, bleach (do not mix)
Reactive Waste	phosphorus pentoxide, sodium hydride, sodium methoxide, dry picric acid (do

	not mix)
Compressed Gases	carbon monoxide, hydrogen chloride, sulfur dioxide (NOTE: unused gases are extremely expensive to dispose)

The following guidelines must be followed when collecting solid chemical waste:

- Segregate and collect solid chemical waste according to the waste categories listed above. Ask your instructor (Hazardous Substances Controller) if you are unsure of which category your chemical(s) fall.
- Do not mix solid waste with liquid waste. Collect these wastes separately.
- Collect solid waste in plastic buckets with secure lids or line a cardboard box with a plastic bag. The plastic bag must be taped shut and the box securely sealed.
- Label the plastic bucket or box with the chemical(s) IUPAC name and concentration. Blank labels are available from your Hazardous Chemicals Controller.
- Needles, syringes, and sharps must be collected separately in a plastic needle discard bucket.

Incompatible Chemical Mixtures

Caution and common sense must be used when collecting chemical waste in the laboratory so that incompatible materials are not mixed together. Empty waste containers should be properly rinsed if they held a material which is incompatible with the waste to be collected. All chemicals should be handled with respect and every effort made to understand their chemical, physical and toxic properties prior to working with them.

The following dangerous chemical mixtures must be avoided:

- Acid mixed with most cyanide salts or solutions generate highly toxic hydrogen cyanide gas.
- Acid mixed with most sulfide salts or solutions generate highly toxic hydrogen sulfide gas.
- Acid mixed with bleach generates highly toxic chlorine gas.
- Oxidizing acids (e.g., nitric, perchloric) react violently with combustible materials (paper, common solvents) and may cause a fire.
- Solid oxidizers (e.g., nitrates, iodates, permanganates) react with combustible materials (paper, common solvents) and may cause a fire.
- Hydrides (e.g., sodium hydride) react with water to form flammable hydrogen gas.
- Phosphides (e.g., sodium phosphide) react with water to form highly toxic phosphine gas.
- When silver salts are mixed with ammonia in the presence of a strong base, an explosively unstable solid is generated.
- Alkali metals (e.g., sodium, potassium, calcium, etc.) react with water to form flammable hydrogen gas.
- Oxidizers (e.g., nitric acid) react with reducers (e.g., hydrazine) to yield fires or explosions.
- Unsaturated compounds (carbonyls, double bonds, etc.) may polymerize violently in the presence of acids or bases.
- Hydrogen peroxide/acetone mixtures may explode when heated in the presence of acid.
- Hydrogen peroxide/acetic acid solutions may explode when heated.
- Hydrogen peroxide/sulfuric acid mixtures are susceptible to spontaneous and unpredictable chemical detonation.

3. Materials prohibited in the chemical waste stream

Some waste products are not allowed in the chemical waste stream because of regulatory compliance issues. Please segregate the following materials from the chemical waste streams so that it will be possible to dispose of the waste:

- Radioactive Materials
- Uranium Compounds (uranyl acetate, uranyl nitrate)
- PCB's (polychlorinated biphenyls, arochlor, chlorextol, chlorodiphenyl)
- Infectious Waste or Etiological Agents (human blood, serum, body fluids, etc.)
- Dioxin Waste (TCDD, pentachlorophenol, tri- and tetrachlorophenol)
- Explosives or Shock Sensitive Compounds
- Asbestos

4. Chemical waste collection, containers, and labeling

The following guidelines must be followed when collecting chemical waste:

- Waste must be collected in a chemically compatible container.
- Containers must be clearly labeled with IUPAC chemical name (no abbreviations please) and concentration. Unused chemical reagents in original containers with intact labels need no further labeling. Blank labels are available from the Hazardous Substances Controller. When using a container to collect waste which differs from the original chemical always obliterate the original label or place the Waste Label over the original.
- Chemical waste containers must be sealed airtight with a proper lid. Rubber stoppers, corks, and parafilm are not allowed.
- Do not fill liquid containers full. An air gap of 5-10% must be left in the container to allow for expansion of the liquid.
- Before collecting waste in a used container, rinse the container if it held a chemical that is incompatible with the waste to be collected.
- Solid chemical waste can be collected in plastic bags, fiber boxes, or plastic containers. Solid waste containers must be sealed airtight. Needles, syringes, and contaminated broken glass must be placed in plastic needle discard buckets. Glass pipets must be placed into plastic buckets or cardboard boxes. Do not mix solid and liquid chemical waste. Pasteur pipets, except those generated in chemistry laboratories, must be disposed of as infectious waste, regardless of infection potential (collect in plastic containers).

Chemical waste must be collected in a chemically compatible container to prevent the chemical from dissolving the container. For example, if waste acetic acid is collected in a steel container, the acid will soon corrode the container's wall and an unwanted leak will occur.

The original container that a chemical was shipped in is a good container to collect the waste. Unused chemicals in their original containers are acceptable for disposal since no further packaging is necessary. **If you need advice on a proper chemical waste container, or need a proper container, please contact your Hazardous Substances Controller.**

5. Empty chemical container disposal procedure

Empty chemical containers which held a material which was flammable, corrosive, reactive, or toxic must be picked up by your Hazardous Substances Controller for final disposal.

Nonhazardous containers may be discarded in the domestic trash as long as they are not made of glass. Empty nonhazardous containers may be discarded into the regular trash (agar, broth, sodium chloride, pop cans, etc.).

6. Disposal procedure for laboratory glassware

(not contaminated with extremely hazardous chemicals or carcinogens)

Glass pipets, test tubes, and other easily breakable glass products must not be discarded into the household trash because the Cleaning Services personnel who pick up this waste could be seriously cut by this waste. Such fragile glass waste must be placed into a sturdy cardboard box which has a secure lid. Once the box is filled with glass, tape the box securely closed and mark the box "broken glass". If you have broken glass or other sharp glass objects that will pierce the cardboard box, this waste should be placed into a puncture resistant plastic container.

7. Sewer disposal of chemical waste

1. Sewer disposal guidelines

The following guidelines must be followed whenever chemicals are disposed of into the sewer:

- The sanitary sewer shall be used only for the disposal of small quantities of non-toxic buffer solutions and non-hazardous chemicals. In many cases, toxic chemicals cannot be present in greater than 1 ppm concentration. Please note: a 1% solution is 10,000 ppm in concentration.
- Waste must be water soluble.
- Flammable liquids (flashpoint less than 86°C) are not allowed into the sanitary sewer. This includes most organic solvents.
- Do not dispose of corrosive waste (acidic or basic) into the sewer. If you neutralize your waste products, the pH must be between 6 and 9 before sink disposal occurs.
- Toxic, heavy metals are stringently regulated. Do not dispose of these substances in sinks or drains.

The following metals are toxic:

Antimony	lead	selenium
Arsenic	manganese	silver
Barium	mercury	thallium
Cadmium	molybdenum	uranium
Chromium	nickel	zinc
Copper	osmium	

- Waste cannot contain a large amount of highly concentrated colored dyes. Do not discard expired dyes or concentrated stock solutions into the sewer.
- Do not dispose of infectious materials (human blood, serum, etc.) in sinks or drains without prior disinfection with an appropriate disinfectant.
- Radioactive wastes must never be disposed of in the sink or drains. See the Radiation Safety Manual for additional information or call your instructor.

Although most chemical waste cannot be disposed of into the sewer and must be disposed of through the Hazardous Substances Controller, the following is a list of chemical waste that is acceptable for sewer disposal in quantities of 25 liters or less:

Organic Chemicals Sink Approved

- Acetates: Na, K, Ca, and NH_4
- Alcohols: water soluble, diluted to 10% or less (collect all alcohol wastes above 20 percent concentration as flammable waste)
- Amino acids and their salts
- Citric acid and salts of Na, K, Mg, Ca, and NH_4
- Ethylene glycol: diluted to 10% or less
- Lactic acid and salts of Na, K, Mg, Ca, and NH_4
- Sugars: dextrose, fructose, glucose, sucrose

Inorganic Chemicals Sink Approved

- Common acids and bases: neutralized, pH (6-9), no metals present
- Bicarbonates: Na, K
- Bleach
- Bromides: Na, K
- Carbonates: Na, K, Mg, Ca
- Chlorides: Na, K, Mg, Ca, Ce
- Iodides: Na, K
- Phosphates: Na, K, Mg, Ca, NH_4
- Sulfates: Na, K, Mg, Ca, NH_4

Formaldehyde / Formalin Disposal
Tissue is usually preserved in formalin (10% aqueous formaldehyde). The formalin must be poured off from the tissue and the tissue must be disposed of as infectious waste.

Dilute aqueous solutions containing less than 10% formaldehyde may be sink dumped in a cup sink located inside a well functioning fume hood with plenty of running water. Concentrated formalin solutions (37%) must be collected for disposal as Hazardous Chemicals. Formaldehyde is a possible carcinogen so personnel exposure must be minimized. Formalin solutions should never be dumped outside a fume hood because laboratory personnel may be exposed to the toxic vapors.

Sodium Azide Disposal
Sodium azide is an extremely toxic material which is sometimes used as a preservative. Sodium azide should not be used as a preservative if less hazardous alternatives are available.

When sodium azide must be used as a preservative, its concentration is usually less than 0.1%. Solutions of sodium azide of less than 0.1% can be disposed of into the sanitary sewer only if proper safety precautions are taken. Sodium azide should never be heated as it is explosive. In addition, sodium azide forms explosively unstable salts on contact with metals.

Metal plumbing (especially lead and copper) can become contaminated with unstable azide salts if they are improperly disposed of into the drain. Plumbers have been seriously injured by explosions when they attempted to unplug metal sink traps where azide solutions had been sink dumped. Only small amounts of sodium azide should be disposed of into the sink along with copious amounts of water. All azide solutions must be disposed with extreme care. (Solutions of sodium azide whose concentration is greater than 0.1% must be saved for disposal as Hazardous Chemicals.)

2. Chemicals prohibited in sewer

Most chemical waste cannot be disposed of into the sanitary sewer. The following list is representative of only a few of the many chemicals that cannot be disposed of into sinks and drains:

Flammable Solvents	**Halogenated Solvents**
acetone	Chloroform
acetonitrile	carbon tetrachloride
benzene	dichloroethane
ethyl ether	Freon
pseudocumene	methylene chloride
toluene	trichloroethane
xylene	

Acids(not neutralized)	**Bases(not neutralized)**
perchloric acid	ammonium hydroxide
hydrochloric acid	sodium hydroxide
sulfuric acid	
nitric acid	
trichloroacetic acid	

	Heavy Metals	
antimony	lead	selenium
Arsenic	manganese	silver
Barium	mercury	thallium
Cadmium	molybdenum	uranium
Chromium	nickel	zinc
Copper	osmium	

Toxic Chemicals	**Miscellaneous**
phenol	*infectious substances
hydrazine	*human blood
cyanides	*human serum
sulfides	oil
acrylamide	grease
formamide	radioactive isotopes

*sink disposal is appropriate if properly disinfected

The following are reagents which contain toxic mercury and cannot be sink dumped:

Dobbin's Reagent	Tyrosine Reagents
Millon's Reagent	Jacquemart's Reagent
Hayem's Solution	Sachsse's Solution
Morell's Solution	Knapp's Solution
Hopkins-Cole Reagent	Spiegler's Reagent
Nessler's Reagent	Mercresin
Hubb's Reagent	Tanret's Reagent
Rohrbach's Solution	Meyer's Solution

Other Toxic Reagents which may not be sink dumped
Flemming's Solution (osmium, chromic acid)
Folin-Dennis Solution (mercuric cyanide)
Fisher's Reagent (phenyl hydrazine)
Erlicki's Solution (chromium)
Ehrlich's Hematoxylin

Important - Do not pour any trade name chemical products into sinks or drains unless you know the actual chemical composition of the material involved. Many commercial trade products contain toxic chemicals which are unsuitable for sewer disposal.

3. Improper sewer disposal

The improper disposal of chemical waste into the laboratory sink has the following adverse effects:

- The disposal of volatile solvents and lachrymators (agents which cause tearing of the eyes) can cause annoying odor problems throughout the building as the vapors escape through dry floor and sink drains.
- Workmen from maintenance department working inside manholes may be exposed to dangerous chemical vapors and potentially flammable or explosive environments.
- Pond/dam water on the site may be adversely affected by the improper disposal of metals and toxic chemicals into the soiled water sewer. Careless disposal of chemicals down the drain can lead to concentration of non-biodegradable compounds and toxic metals in the ponds.
- Rising levels of toxic heavy metals and an increase in salinity of the dam water can detrimentally affect the wild-life on site.
- Corrosive wastes can dissolve and erode the concrete sewer lateral connections, decreasing their effective life span.

8. Specific chemical procedures

1. Acrylamide handling and waste disposal

Acrylamide consists of colorless, odorless crystals which are stable at room temperature but which may polymerize violently upon melting (84.5ºC). Acrylamide crystals are readily soluble in water, alcohol and acetone. Acrylamide is a neurotoxin and suspected carcinogen. Proper personal protective equipment should be worn to prevent absorption through the skin.

The acrylamide monomer is very toxic but, when polymerized into a gel, is no longer hazardous and may be discarded into the domestic trash as long as there is no other toxic chemical, infectious agent, radioactive isotope or heavy metal present in the gel. If a polymerized acrylamide gel has a small amount of liquid remaining on its surface wash the liquid carefully down the drain and then discard the gel into the trash. DO NOT discard acrylamide gels into the trash unless they are completely polymerized.

2. Chromerge, chromic acid and dichromate solutions

Chromerge, chromic acid, and dichromate cleaning solutions should not be used at LABS. Rather try substitute cleaning solutions. Unnecessary hazards related to the use of chromium based sulfuric acid cleaning solutions and reasons for not using it are as follows:

- The hexavalent chromium present in the above solutions is considered by regulatory agencies to be a potent human carcinogen.
- The addition of chloride or halogens to chromic acid cleaning solutions can generate the highly toxic and volatile carcinogen, chromyl chloride. The formation of volatile chromyl chloride necessitates that these cleaning solutions be used inside chemical fume hoods.
- Chromium is toxic to most living organisms. Trace amounts left on glassware can have an adverse effect on biological experiments.
- Used chromic acid cleaning solutions cannot be neutralized and flushed into the sanitary sewer because the chromium metal remains.

- There are many non-toxic biodegradable cleaning solutions that can be used instead of chromic acid. See the alternative cleaning solutions.

Most laboratory glassware can be properly cleaned without the use of sulfuric acid based cleaning solutions. Many of the commercial phosphate-based cleaners will do an adequate job of cleaning. For extremely dirty glassware, commercial cleaning solutions containing an organic oxidizer should be used in place of chromium in sulfuric acid solutions. For moderately dirty glassware use a standard laboratory detergent.

3. Drying agents water reactive

In research laboratories it is common practice to add drying agents to organic solvents to remove trace quantities of water. Caution must be used when choosing a suitable drying agent because many chemicals which are commonly used as drying agents are extremely water reactive.

These reactive materials generate highly flammable gases on contact with water and careless handling could cause a serious fire or explosion. The following chemicals are not recommended as general purpose drying agents because they form flammable gases on contact with water:

sodium metal	sodium hydride	potassium metal	potassium hydride
calcium metal	calcium hydride	calcium carbide	lithium aluminum hydride

Another reason to avoid using water reactive drying agents is the hazard the agent presents when the material is disposed. Flammable solvent waste is sometimes blended together into steel drums for incineration. If a water reactive material is accidentally poured into one of these drums, someone could be severely burned or killed by the resulting explosion. If a bottle of solvent contains a water reactive drying agent, please clearly mark the bottle with this information.

Phosphorous pentoxide is used as a drying agent and should be handled with care because it generates highly corrosive phosphoric acid and heat on contact with water.

Dehydrite is a drying agent which contains magnesium perchlorate. Magnesium perchlorate is a strong oxidizer which may cause fires or explosions on contact with organic materials.

The safest and most common drying agents are calcium chloride, silica gel, molecular sieves, and calcium sulfate (Drierite). The Safety Committee highly recommends these materials because of their low toxicity and high stability.

4. Explosives

Some commonly used laboratory compounds can become explosive if they dry out, are heated or deteriorate. Explosive compounds should not be disturbed when discovered. The Hazardous Substances Controller should be contacted immediately so that the material can be safely discarded.

The following compounds can be explosive under the proper, and sometimes innocuous conditions:

- **Peroxide Forming Compounds (Ethers)**
  Peroxide formation in solvents and reagents has caused many accidents. Every worker must learn to recognize and safely handle peroxidizable compounds. Peroxides form by the reaction of a peroxidizable compound with molecular oxygen. Organic peroxides are generally unstable and sometimes explode when shocked or heated. Some organic compounds (particularly ethers) form peroxides by reacting with oxygen in the air or by exposure to light. There are documented cases of researchers being killed by attempting to open an old bottle of

isopropyl and ethyl ether. Researchers have also been killed and seriously injured by distilling old ethers to dryness, which causes the residue (peroxide) to violently explode. Under no circumstances should you try to open an ether or peroxide forming compound if it is obvious that crystals have formed in the container. Anhydrous ethers tend to form peroxides at the fastest rate. All ethers and other peroxide forming chemicals should be dated when they are first brought into the laboratory and should be used or removed for disposal no later than twelve months from the date of acquisition.

The following are common examples of peroxide forming compounds:

ethyl ether	rubidium metal
isopropyl ether	potassium metal
dioxane	furan
tetrahydrofuran	vinyl ethers
bis(2-ethoxyethyl) ether	cumene
Decalin	potassium t-butoxide
cyclohexene	methyl magnesium iodide
cesium metal	styrene
sodium amide	butadiene
Glyme	vinyl pyridine
butyllithium	

Procedures for Handling Peroxide Forming Compounds

- Order only small volumes in containers of one liter or less so that storage time is decreased.
- Date all new containers when opened. Have it labelled and removed for disposal after twelve months.
- The exposure of peroxide forming compounds to light, heat and air increases the peroxide formation rate. Store these materials in full, opaque containers away from heat sources.
- Do not attempt to open old bottles of ethers. Notify your Safety Representative for advice when these containers are discovered.
- Do not store ethers in ordinary refrigerators or freezers. The flash point of most ethers is well below the operating temperature of most refrigerators. Ether vapors are heavier than air and if a container leaks, a spark from the compressor or the light switch on the door could cause a dangerous explosion. Store ethers with other flammable solvents in an approved steel flammable storage cabinet or a special explosion proof refrigerator.
- Do not distill old ethers or peroxide forming solvents unless you are certain through testing that no peroxides are present. **Distillation of old solvents is the most common cause of peroxide explosions.**
- Chemical tests are available which give a qualitative measure of peroxide present in solution.
- Solvents which contain peroxides should be discarded or treated to remove peroxide before distillation.
- Do not evaporate old ethers down to dryness. This practice concentrates the peroxide residue to dangerous levels.

- **Picric Acid**

Dry picric acid is more explosive than trinitrotoluene (TNT). Picric acid is relatively safe to handle as long as it contains 10% or more water. Picric acid becomes a shock sensitive solid when it dries out so do not attempt to open an old bottle of this material. Picric acid also forms extremely shock sensitive metal salts (picrates). Do not touch a container of picric acid if it has a metal lid. Note: Picric acid (yellow crystals) is also very toxic and must be handled with care. If picric acid is used in a laboratory check on a monthly basis to ascertain that the acid is still wet.

- **Benzoyl Peroxide**

Benzoyl peroxide becomes a shock sensitive explosive when it dries out. Benzoyl peroxide is a strong oxidizing agent and it is usually stored in cardboard tubes or plastic containers with slip-on lids. Do not attempt to open old containers of benzoyl peroxide or a container with a screw-on lid. Benzoyl peroxide also forms unstable salts on contact with metals, so do not touch a container which has a metal lid. Dry benzoyl peroxide is very flammable, so dampen spills with water before cleaning it up. Benzoyl peroxide consists of white crystals or flakes and is moderately toxic.

- **2,4-Dinitrophenylhydrazine**

This compound becomes a high explosive when it dries out. Do not attempt to open an old container of this material. 2,4- Dinitrophenylhydrazine is safe to handle as long as it contains 20% or more water. This material consists of red crystals which are also fairly toxic so it should be handled with care.

- **Nitrocellulose**

Nitrocellulose is a nitrated form of cellulose and is commonly used in gun powders and rocket fuels. This material is not unusually shock sensitive, but it is very flammable and is highly sensitive to sparks or flames. Nitrocellulose or pyroxylin is commonly found as small solid strips, filter pads, centrifuge tubes, rolls of cloth, and sometimes is dissolved in alcohol-ether solutions. Nitrocellulose is somewhat less flammable when wet. Nitrocellulose is a dangerous fire and explosive risk and must be handled with care.

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