GOVERNMENT COLLEGE OF ENGINEERING KANNUR

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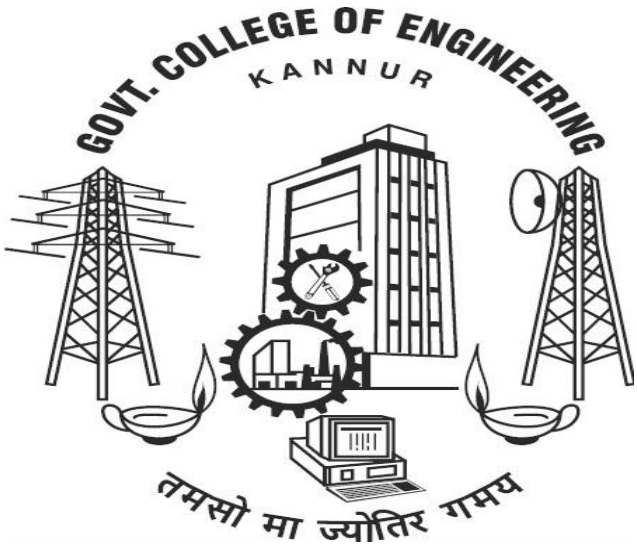

ENVIRONMENTAL HEALTH AND SAFETY MANUAL

Compiled by

Mr. Bijesh R
Assistant Professor
Department of Mechanical Engineering
Govt. College of Engineering Kannur

GOVERNMENT COLLEGE OF ENGINEERING KANNUR

VISION

A globally renowned institution of excellence in engineering education, research and consultancy.

MISSION

To contribute to the society by providing quality education and training leading to innovation, entrepreneurship and sustainable growth.

PREFACE

This Employee Health and Safety(EHS) Handbook is intended for Government College of Engineering Kannur (GCEK) employees and students of all catogary. Institution is firmly committed to conduct all educational, research, service and campus activities in a safe manner and protects the health of students, faculty, staff and the public while preserving its environments. The widely accepted standards and guidelines that should be followed to keep accidents to a minimum are described within this manual.

This EHS manual of GCEK consists of 10 chapters. The chapter 1 presents the policy of GCEK with regard to Environmental Health and Safety. The procedure to handle emergency situations is described in Chapter 2 and Chapter 3. Chapter 5 discusses Fire safety and Chapter 7 deals with Electrical safety. Hence these two chapters are possibly relevant to all workers occupied at GCEK. The chapter 4, 6 and 9 are specifically prepared for those who are dealing with chemicals. The chapter 8 deals with Mechanical Safety and would be relevant to workers in several departments within the GCEK. Chapter 10 deals with safety training practices. All the safety procedures prescribed here are in line with Indian Standard IS 14435/1997 (refer appendix I). A full layout of the college is given in the last page of this manual.

Please take few minutes to read the contents of this manual and decide which part you need to read and understand for your safety and the safety of others with whom you are working.

EHS COMMITTEE AND RESPOSIBILITIES

EHS Committee Members:

EHS Committee EHSC of Govt. College of Engineering Kannur consists of eight members representing various departments of the institute, as listed below:

1) Faculty in Charge
2) One faculty (Mechanical Engg. Dept.)
3) One faculty (Electrical Engg. Dept.)
4) One faculty (Chemical Engg. Dept.)
5) Workshop Superintendent (Mechanical Engg. Dept.)
6) Hostel Warden/representative
7) Sergeant, GCEK
8) AA/AO, GCEK

The names of present EHS Committee Members are given in last page of appendix (page no.179)

Responsibilities of EHS Committee:

EHS committee is assumed to deliver the following responsibilities for the well wish of GCEK:

Table 1. Responsibilities of EHS committee

Responsibility	Detailed Tasks
Environment & Safety	Attend to and assist in general, occupational, and chemical Safety issues throughout GCEK Conduct bimonthly general safety rounds Ensure availability of Emergency medicines at all laboratories
Sanitarian & Bio-safety	Attend to Sanitation and Bio-safety issues throughout GCEK Conduct Waste Management Plan training sessions Prepare yearly reports on Waste Management, Bio-safety and Sanitation Attend to issues of Life Safety and Hygiene
Risk Management	Report on all non-patient related incidents Develop and review risk related policies & procedures Develop and implement wellness activities to the community Report all potential & actual claims to the insurance
Fire Protection	Attend to Life Safety and Fire issues throughout GCEK Conduct annual fire safety round Initiate steps to maintain the fire extinguishers in time
General	Revise Safety Manual by incorporating the updated safety rules and procedures Prepare annual report of all activities of EHS Committee

CONTENTS

Chapter 1

POLICY

1 POLICY

1.1 Introduction

The Govt. College of Engineering Kannur (GCEK) is committed to the provide and maintain safe and healthy environment for its faculty, staff, students, visitors, and the general public. For this reason, the Environmental Health and Safety (EHS) manual is prepared. All GCEK employees and students are responsible and accountable for EHS performance and its protection as outlined in this manual. The mission of EHS is to protect resources in support of the institute's teaching, research, healthcare, community outreach, and service learning goals and objectives.

1.2 Responsibilities

The heads of departments, laboratory in-charges, principal investigators, workshop superintendent, 1st grade instructors, etc., are responsible for the environmental health and safety of faculty, staff, students, and visitors engaged in activities under their direction or supervision. They must ensure that faculty, staff, students, and subordinates comply with all relevant regulations and standards and that work activities are performed in a safe and considerate manner.

Each faculty, staff, and student member is responsible for complying with the applicable provisions of environmental health and safety standards and regulations promulgated by regulatory agencies whose codes and standards will be utilized in conducting institute operations and is also responsible and accountable for EHS performance and its protection as outlined in this manual.

Faculty, staff and students are responsible for the following:

- Performing their jobs in the safest prescribed manner
- Eliminating and/or reporting workplace hazards
- Reporting accidents, incidents, and unsafe practices or conditions to the Head of Department
- Ensuring proper disposal of or transfer of alt hazardous materials before leaving the institute

The instructor is the key to maintain a positive safety attitude in the laboratory. The best practice is to encourage laboratory safety without creating a fearful climate. The following points will support an instructor for a safe and successful delivery of laboratory exercises:

- ✓ Know the safety procedures, potential hazards and precautions for each experiment before teaching or conducting a laboratory exercise
- ✓ Know the location and operation of emergency equipment, what emergency procedures are appropriate and how to summon assistance if needed
- ✓ Understand the chemical hazards and precautions specified in the pertinent Material Safety Data Sheets (MSDS)
- ✓ Explain each experiment and alert others to possible hazards before they begin the laboratory exercise
- ✓ Foster a serious attitude toward lab content and safety. Supervise students closely while encouraging respect for safety.

1.3 Enforcement

GCEK expects all faculty, staff, and students to report any suspected hazardous conditions, to be vigilant in complying with all environmental health and safety requirements, and to acquire the information they need to properly conduct their activities at the institute.

Compliance with laws, regulations, and institute policies are viewed as conditions of employment, academic eligibility, and institute privileges. Violation of such requirements shall be considered grounds for disciplinary action.

Chapter 2

EMERGENCY SITUATION

2 EMERGENCY SITUATION

2.1 Emergency Numbers

Table 2.1 Emergency Numbers

Campus Security	9656514190
Ambulance	102
GCEK Primary Health Centre	0497 2780226
District Hospital Casualty	0497 2700243
Medical College Casualty, Pariyaram	0497 2808080
Govt Hospital for Mother and Child	0497 2780280
Police Station	100
Water Emergency	101
Electrical Emergency	9496011150
Anti-Ragging Helpline	9744430507
Women Helpline	9388700999
Counselling Cell Helpline	9446556231
Lourde Hospital	0460 2200160
NSS	9446406169
Hostel Warden	9895041241

2.2 Reporting Accidents

All accidents, injuries, or near-misses should be reported to your Head of the Department/laboratory superintendent and then to the EHS Committee (EHSC) without any delay. If the incident occurred in the lab, superintendent is required to submit a Report of Accident, Injury, or Occupational illness and send it to the Head of the Department and EHSC. Students and lab superintendent should understand that the purpose of reporting and documenting accidents is not to affix

blame, but instead to determine the cause of the accident so that similar incidents may be prevented in the future.

Minor injuries many times are not reported because they are perceived to be embarrassing or that "careless actions" lead to the accident. However, minor injuries can sometimes lead to more serious complications that only become evident at a later time. Taking corrective action as a result of a minor accident may keep a major incident from happening. Without knowledge of all minor accidents, the desirable investigation and resulting corrective actions are circumvented.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 3

EMERGENCY PROCEDURES

3 EMERGENCY PROCEDURES

3.1 Introduction

During the course of normal operations there is always a chance for an emergency situation to arise. These emergencies can be the result of a fire, chemical exposure, chemical spill, or the need for medical assistance. In the event of an emergency, an emergency response plan should be implemented. This plan would include evacuation of the facility if deemed appropriate.

Internal communication is very important during any emergency situation. It is essential that all employees and students know how to act and react during the emergency. To accomplish this, it is necessary that a written Emergency Response Plan be developed and that all employees are trained on how to act accordingly. All accidents, regardless of severity, should be reported and investigated.

3.2 Fires

3.2.1 Building fires

The following steps are recommended if a fire occurs in a building:

- Initiate a building evacuation using the emergency alarm.
- **Dial 101** to notify Public Safety and request fire department assistance.
- If the fire is small and you have been trained in the use of portable fire extinguishers, you may attempt to extinguish the fire. Fight the fire from a position where you can escape.
- If your clothing catches fire, drop to the floor and roll to smother the fire. If a co-worker‟s clothing catches fire, lower the person to the floor and roll him or her to smother the flames. Use a safety shower immediately thereafter.
- Use the nearest safe exit route to exit the building. Close all doors on the way out to prevent the spread of smoke and fire.
- After exiting, immediately proceed to a safe location at least 30 meters away from the building.
- Do not re-enter the building until the all clear is given by the fire department.

3.2.2 Laboratory fires

Fires are a common emergency in any laboratory and specifically in a laboratory with flammable materials. In the event of a fire, do the following things:

- Assist any person in immediate danger to safety, if it can be accomplished without risk to you.
- Immediately activate the building fire alarm system.
- If the fire is small and you have been trained in the use of portable fire extinguishers, you may attempt to extinguish the fire. Fight the fire from a position where you can escape.
- DON‟T fight the fire if either of these conditions exists: The fire is too large or out of control. The atmosphere is toxic.
- If first attempts to put out the fire do not succeed, evacuate the building immediately.
- Doors, and if possible, windows, should be closed as the last person leaves a room or area of a laboratory.
- When they hear the fire alarm sound, all personnel in the affected areas shall evacuate the building immediately.
- Upon evacuating the building, personnel shall proceed to a designated area at least 50 meters away from the affected building.
- No personnel will be allowed to re-enter the building without permission.
- You must report all fires to your supervisor.

3.2.3 Fire safety reminders

- Never use an elevator if the building fire alarm is activated.
- Use stairwells to evacuate the building. Be aware of your egress routes.
- Never block open corridor/hallway doors in a building.
- Check all appliances in your office before leaving. Turn them off.
- Use electrical extension cords properly. Examine the cords periodically for safe service.

3.3 Chemical Exposures

The following procedures should be followed in the event of a chemical exposure. In all cases the incident should be reported to your laboratory chief, technician or principal investigator, regardless of severity.

3.3.1 Chemicals on skin or clothing

1. Immediately flush with water for no less than 15 minutes (except for hydrofluoric acid).
2. While rinsing, quickly remove all contaminated clothing or jewelry.
3. Use caution when removing pullover shirts or sweaters to prevent contamination of the eyes.
4. Check the MSDS (Material Safety Data Sheet) to determine if any delayed effects should be expected.
5. Discard contaminated clothing or launder them separately from other clothing. Leather garments or accessories cannot be decontaminated and should be discarded.

Do not use solvents to wash skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent may facilitate absorption of a toxic chemical.

For flammable solids on skin, first brush off as much of the solid as possible, then proceed as described above.

For hydrofluoric acid, rinse with water for 5 minutes and apply calcium gluconate gel, then get immediate medical attention. If no gel is available, rinse for 15 minutes and consult a doctor immediately.

3.3.2 Chemicals in eyes

1. Immediately flush eye(s) with water for at least fifteen minutes. The eyes must be forcibly held open to wash, and the eyeballs must be rotated so all surface area is rinsed.
2. Remove contact lenses while rinsing. **Do not lose time removing contact lenses before rinsing**. Do not attempt to reinsert contact lenses.
3. Seek medical attention regardless of the severity or apparent lack of severity. Contact for an ambulance or transportation to a health center if it is needed. Explain carefully what chemicals were involved.

3.3.3 Chemical Inhalation

1. Close containers, open windows or otherwise increase ventilation, and circulate fresh air.
2. If symptoms, such as headaches, nose or throat irritation, dizziness, or drowsiness persist, seek medical attention by calling emergency or going to a health center. Explain carefully what chemicals were involved.
3. Review the MSDS to determine what health effects are expected, including delayed effects.

3.3.4 Accidental ingestion of chemicals

1. Immediately go to a health center or contact Ambulance at 108 for instructions.
2. Do not induce vomiting unless directed to do so by a health care provider.

3.3.5 Accidental injection of chemicals

Wash the area with soap and water and seek medical attention, if necessary immediately go to a health center or contact Ambulance at 108. Explain carefully what chemicals were involved.

3.4 Chemical Spills

All chemical spills, regardless of size, shall be reported in writing to your supervisor. The report shall include the date, time, location, chemical(s) and their volume, and names of all persons involved, including any visitors who were exposed and personnel involved in the cleanup.

3.4.1 Emergency spills

Chemical spill is classified as an Emergency Spill whenever it:

- Causes personal injury or chemical exposure that requires medical attention
- Causes a fire hazard or uncontrollable volatility
- Requires a need for breathing apparatus of the supplied air or self-contained type to handle the material involved
- Involves or contaminates a public area
- Causes airborne contamination that requires local or building evacuatio

- Causes a spill that cannot be controlled or isolated by laboratory personnel
- Causes damage to college property that will require repairs
- Involves any quantity of metallic mercury
- Cannot be properly handled due to lack of local trained personnel and/or equipment to perform a safe, effective cleanup
- Requires prolonged or overnight cleanup
- Involves an unknown substance.

The following tactics are prioritized in terms of usual preferred action sequences. However, each spill incident is unique and involves persons with varying levels of spill expertise and experience. Thus, for any individual incident, isolation of the spill and/or securing the area might best occur prior to or simultaneously with contacting Police/Fire by dialling 100 /101. The following general procedures should be used for all emergency spills:

1. Contact the Campus Security for Assistance. Notify the police dispatcher of location of the spill and, if known, the chemical spilled.
2. If the spill presents an immediate danger, leave the spill site and warn others, control entry to the spill site.
3. Remove contaminated clothing. Flush skin/eyes with water at least 15 to 30 minutes; use soap for intermediate and final cleaning of skin areas.
4. Protect yourself, and then remove injured person(s) to fresh air, if safe to do so.
5. Notify nearby persons and evacuate as necessary. Prevent entry, as necessary, by posting a guard in a safe area and/or shutting doors.
6. If flammable vapors are involved, do not operate electrical switches unless to turn off motorized equipment. Try to turn off or remove heat sources, where safe to do so.
7. If the substance involved is an unknown, then emergency spill response procedures are limited to self-protection, notification of Campus Security for response, isolation of the chemical, evacuating and securing the area involved.
8. Do not touch the spill without protective clothing.
9. Where the spill does not present immediate personal danger, try to control the spread or volume of the spill. This could mean shutting a door, moving nearby equipment to prevent further contamination, repositioning an overturned container or one that has a hole in the bottom or side, creating a dike by

putting an absorbent around a spill or opening the sashes on the fume hoods to facilitate removal of vapors.

10. Never assume gases or vapors do not exist or are harmless because of lack of smell.
11. Increase ventilation by opening closed fume hood sashes to the 12 inch or full open position. Exterior doors may be opened to ventilate non-toxic vapors.
12. Use absorbents to collect substances. Reduce vapor concentrations by covering the surface of a liquid spill with absorbent. Control enlargement of the spill area by confining with absorbent.

3.4.2 Minor spills

Minor spills are those spills that do not fit the requirements for Emergency Spills. The following general procedures should be used for all minor spills:

1. Attend to any persons who may have been contaminated. If these persons require medical attention this is an Emergency Spill (see above).
2. Notify persons in the immediate area about the spill.
3. Evacuate all nonessential personnel from the spill area.
4. If the spilled material is flammable, turn off ignition and heat sources.
5. Avoid breathing vapors of the spilled material. If respiratory protection is necessary this is an Emergency Spill (see above).
6. Leave on or establish exhaust ventilation if it is safe to do so.
7. Secure supplies to effect cleanup.
8. Put on appropriate personnel protective equipment.
9. Spilled Liquids:
    - Confine or contain the spill to a small area. Do not let it spread.
    - For small quantities of inorganic acids or bases, use a neutralizing agent or an absorbent mixture (e.g., soda ash or liatomaceous earth). For small quantities of other materials absorb the spill with a noncreative material (such as vermiculite, clay, dry sand, or towels).
    - For larger amounts of inorganic acids and bases, flush with large amounts of water (providing the water will not cause additional damage). Flooding is not recommended in store rooms where violent spattering may cause additional hazards or in areas where water-reactive chemicals may be present.
    - Carefully pick up and clean any cartons or bottles that have been splashed or immersed.

- If the spilled material is extremely volatile, let it evaporate and be exhausted by the laboratory hood (provided that the hood is authorized for use with the spilled chemical).

10. Spilled Solids:

- Generally, sweep spilled solids into a dustpan and places them into a container suitable for that chemical.
- Dispose of residues according to safe disposal procedures. Remembering that personal protective equipment, brooms, dustpans, and other items may require special disposal procedures.
- Report the chemical spill in writing as required above.

3.4.3 Mercury handling and spill clean up

1. Storage and handling

- Always store mercury in unbreakable containers and stored in a well-ventilated area.
- When breakage of instruments or apparatus containing mercury is a possibility, the equipment should be placed in an enameled or plastic tray or pan that can be cleaned easily and is large enough to contain the mercury.
- Transfers of mercury from one container to another should be carried out in a hood, over a tray or pan to confine any spills.
- If at all possible, the use of mercury thermometers should be avoided. If a mercury thermometer is required, many are now available with a Teflon coating that will prevent shattering.
- Always wash hands after handling mercury.

2. Protective Clothing

For small spills, a laboratory coat, safety glasses, and gloves should be used. Gloves made of the following have been rated as excellent for protection against elemental mercury:

- Chlorinated polyethylene (CPE)
- Polyvinyl Chloride (PVC)
- Polyurethane
- Nitrile Rubber (also known by several brand names)

- Butyl Rubber
- Neoprene

If mercury has been spilled on the floor, the workers involved in cleanup and decontamination should wear plastic shoe covers. Laboratory Superintendent or Tradesman should be called immediately if a spill is extensive enough to require workers to kneel or sit where mercury has been spilled since impermeable clothing will be required.

3. Spill Kits

Special spill kits are available from a variety of sources. If a spill kit is purchased, follow the manufacturer's directions. Alternatively, a kit can be assembled with the following components:

- protective gloves
- mercury suction pump or disposable pipettes to recover small droplets
- elemental zinc powder
- dilute sulphuric acid (5-10%) in spray bottle
- sponge
- plastic trash bag
- plastic container
- plastic sealed vial for recovered mercury

4. Clean Up Procedures

- Wearing protective clothing, pools and droplets of metallic mercury can be pushed together and then collected by a suction pump.
- After the gross contamination has been removed, sprinkler the entire area with zinc powder. Spray the zinc with the dilute sulphuric acid.
- Using the sponge, work the zinc powder/sulphuric acid into a paste consistency while scrubbing the contaminated surface and cracks or crevices.
- After the paste has dried, it can be swept up and placed into the plastic container for disposal.
- Rags, shoe covers, sponges, and anything used for the cleanup should be

placed in the trash bag to be disposed of as contaminated material.

3.5 Medical Emergencies

Personal injury is not uncommon in laboratories. These injuries are usually minor cuts or burns but can be as severe as acute effects of chemical exposure or incidents such as heart attacks or strokes. Prevention of injuries should be a major

emphasis of any laboratory safety program. Proper training will help prevent injuries from glassware, toxic chemicals burns and electrical shock.

In the event of any personal injury, the initial responsibility for first aid rests with the first persons at the scene, who should react quickly but in a calm and reassuring manner. The person assuming responsibility should:

- Immediately call for medical help(refer emergency numbers in chapter 2 page number 6). Call 108 for medical emergencies.
- Be explicit in reporting suspected types of injury or illness, location of victim, and type of assistance required.
- Send someone to meet the ambulance crew at likely entrances of the building.
- Not move the injured person except where necessary to prevent further injury.

The following details should be posted at each laboratory:

- The names of person(s) with telephone number in the area trained in CPR (cardio pulmonary resuscitation) and First Aid.
- Telephone number for medical emergency (refer chapter 2 page no. 6).

3.6 General First Aid

1. First aid equipment should be readily available in each laboratory. See Section, 4.6.3 of this manual for additional information.
2. Following any First Aid, a nurse or physician qualified to handle chemical emergencies should provide further examination and treatment. The location and phone number of emergency services should be clearly posted.
3. It is recommended that each Department have at least one person trained in basic First Aid and Cardio Pulmonary Resuscitation (CPR).

4. Someone knowledgeable about the accident should always accompany the injured person to the medical facility and provide a copy of any appropriate MSDS if the accident resulted from chemical exposure.
5. Minor injuries requiring first aid should always be reported to a supervisor and recorded reasons for this are as follows.
    - A minor injury may indicate a hazardous situation that should be corrected to prevent a serious future injury.
    - It is important to document a minor injury as having been "work related" if the injury later leads to serious complications, such as from an infected cut.

3.7 Personal Protection during First Aid

1. Persons responding to a medical emergency should be protected from exposure to blood and other potentially infectious materials. Protection can be achieved through adherence to work practices designed to minimize or eliminate exposure and through the use of personal protective equipment (i.e., gloves, masks, and protective clothing), which provide a barrier between the worker and the exposure source. For most situations in which first aid is given, the following guidelines should be adequate.
    - For bleeding control with minimal bleeding and for handling and cleaning instruments with microbial contamination, disposable gloves alone should be sufficient.
    - For bleeding control with excessive blood, disposable gloves, a coat, a mask, and protective eyewear are recommended.
    - For measuring temperature or measuring blood pressure, no protection is required.
2. After emergency care has been administered, hands and other skin surfaces should be washed immediately and thoroughly with warm water and soap if contaminated with blood, other body fluids to which universal precautions apply, or potentially contaminated articles. Hands should always be washed after gloves are removed, even if the gloves appear to be intact.

3.8 Leaking Compressed Gas Cylinders

Occasionally, a cylinder or one of its component parts develops a leak. Most such leaks occur at the top of the cylinder in areas such as the valve threads, safety device, valve stem, and valve outlet.

If a leak is suspected, do not use a flame for detection; rather, a flammable-gas leak detector or soapy water or other suitable "snoop" solution should be used. If the leak cannot be remedied by tightening a valve gland or a packing nut, emergency action procedures should be affected. Laboratory workers should never attempt to repair a leak at the valve threads or safety device; rather, they should consult with the supplier for instructions.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 4

SAFETY RULES

4 SAFETY RULES

4.1 General Safety Policies

- The safety and well being of its students, faculty, and staff come above all other considerations at GCE Kannur.
- No experiment that subjects personnel to unreasonable risk is acceptable, no matter how desirable the information, which might be obtained.
- It is the first duty of research directors, instructors, supervisors and all persons in authority to provide for safety in the environment and operations under their control.
- It is the GCEK policy to comply not only with legal safety standards, but to act positively, where it can, to prevent injury, ill-health, damage and loss arising from work carried out within its buildings.
- The GCEK seeks to encourage all its members to participate in and contribute to the establishment and observance of safe working practices.

4.2 Elementary Safety Rules

- Keep this manual within easy access in your laboratory and be familiar with its contents.
- The safe way is the right way to do your job.
- Plan your work.
- Follow instructions.
- If you do not know how to do the job, ask your instructor or research director. Report to the Safety Coordinator all unsafe conditions, unsafe acts and "near misses" which might cause future accidents.
- Be able to use all safety devices and protective equipment provided for your use.
- Know the location and contents of the nearest safety station. Maintain good housekeeping by keeping your work area clean and orderly.
- Storage unused equipment in the storage room.
- Wear proper clothing.
- Avoid bringing long hair, loose sleeves, cuffs, rings, bracelets, etc. in proximity to moving machinery.
- Proper shoes are required in the laboratory.
- Horseplay in any form is dangerous and prohibited.
- Do not run in laboratory areas or halls.

- Do not oil, grease, or work on unprotected machinery in motion.
- All machinery and equipment under repair and adjustment shall be properly "locked out" and tagged.
- Know the evacuation procedure for your area, the location of fire exits, the location and use of fire extinguishers, and the proper method of reporting fires.
- Compressed gas cylinders should be secured firmly.
- Never move a cylinder unless the protective cap is screwed over the valve.
- DON‟T try completely new and untried experiments involving potentially dangerous chemicals without help.
- Changes to common procedures, including: "scaling-up" a reaction; a change in heat source or reaction temperature or pressure; change in solvent; etc., turn a known procedure into a high-risk procedure.
- Be sure to discuss all changes to known procedures with class instructor or laboratory engineer.
- It is your responsibility to see that adequate information is supplied to protect safety personnel or firemen who may have to deal with an emergency situation in your laboratory.
- Never leave a reaction or experiment running unattended.
- NEVER carry out hazardous work alone, especially at night or over the weekends. Make sure someone is in visible or audible range to help you if something goes wrong.
- Regardless of the work function, there should be a check procedure established at some regular interval to determine the physical state of the person working alone.
- Keep aware of where your neighbours are.
- Report every accident or fire, no matter how trivial, at once to the Campus Security.
- Smoking is prohibited in the campus.

4.3 General Safety Rules

4.3.1 Personal safety practices

- Lab coats and safety glasses are required in laboratories employing chemicals, or biohazards. Never wear shorts, sandals, or open-toed shoes in a lab.
- Do not allow children or pets in laboratories.
- Never pipette anything by mouth.
- Be aware of dangling jewellery, loose clothing, or long hair that might get caught in equipment.
- Store food and drinks in refrigerators that are designated for that use only.
- Never work alone in a lab if it is avoidable. If you must work alone, make someone aware of your location and have them call or check on you periodically.
- Wash your hands frequently throughout the day and before leaving the lab.
- Do not wear lab coats, gloves, or other personal protective clothing out of the lab and into non-lab areas. This clothing may have become contaminated and you could spread the contamination.
- Contact lenses should not be worn in a lab because chemicals or particulates can get caught behind them and cause severe damage to the eye.

4.3.2 Record keeping

- It is the Lab Superintendent‟s responsibility to keep an updated hazardous chemical inventory poster on file and to post a current inventory summary sign on each lab storage cabinet. Lab personnel should also keep usage records of high-risk substances (Hazardous Chemical Inventory Instruction Sheet).
- Each Lab Superintendent must document and report any lab accident that results in an injury, to the head of the department and then to the EHS Committee without any delay. A student injured in a laboratory should complete a First Report of Injury or Illness (with the assistance of his or her lab Superintendent).

- Laboratory health and safety training records are maintained in the department. Any laboratory health and safety training conducted by department or college must be documented and must contain the following information: date, training outline, length of training, persons conducting the training, and employee's printed name and signature.
- Understand the chemical hazards and precautions specified in the pertinent Material Safety Data Sheets (MSDSs). Material Safety Data Sheets must be maintained for hazardous products in use. Departments are encouraged to maintain accessible copies of MSDSs for immediate reference by any concerned worker.

4.3.3 Housekeeping

The following recommendations are designed for accident prevention:

- Each laboratory Superintendent shall be responsible for maintaining the cleanliness of his/her area
- Clean your work area throughout the day and before you leave the lab
- If necessary, clean equipment after use to avoid the possibility of contaminating the next person who needs to use it
- Equipment must be maintained in safe operating condition, including electrical wires in good condition and not overloaded to any one outlet, pumps, mercury bubblers vented to fume hoods, belt guards on pumps, all equipment electrically grounded, and refrigerators properly designated and used (food or chemicals/flammables, but not both)
- Reasonably neat and clean counter tops and shelves

- Maintenance: Malfunctioning safety equipment detected by laboratory personnel during attempted use or visual surveys and used Fire Extinguishers should be reported immediately to the head of the department to coordinate prompt repair or replacement.
- Keep all aisles and walkways in the lab clear to provide a safe walking surface and an unobstructed exit.
- Do not block access to emergency equipment and utility controls.

4.3.4 Labelling and signs

Prominent signs and labels of the following types should be used:

- Location signs shall be prominently posted to indicate safety showers, eye wash stations, and other safety and first aid equipment.
- Warning signs at areas or equipment where special or unusual hazards exist.
- The manufacturer‟s label should be kept intact. Do not intentionally deface or obscure the label or the hazard warnings.
- When a chemical is transferred from the original container into a secondary container for storage, the new container should be labelled with the name of the product, the chemical constituents and the primary hazard warnings.
- A plan showing evacuation route(s) should be posted prominently in each laboratory.
- Telephone numbers to be called in case of fire, accident, hazardous chemical spill or other emergency.

4.3.5 Storage

- Major chemical hazard classes should physically segregate chemicals. Incompatibles within these classes should also be segregated. Table 4.1 lists segregation categories of chemicals usage.

Table 4.1. Segregation categories of chemicals

Acids	• Segregate acids from active metals such as sodium, potassium, magnesium, etc. • Segregate oxidizing acids from organic acids such as glacial acetic acid and from flammable and combustible materials, such as cardboard boxes. • Segregate acids from chemicalswhich could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulphide, calcium carbide, etc. • Segregate acids from bases.
Bases	• Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials.
Flammables	• Store in approved safety cans or cabinets. Segregate from oxidizing acids and oxidizers. Keep away from any source of ignition: heat, sparks, or open flames.
Oxidizers	• Store in a cool dry place. Keep away from combustible and flammable materials. Keep away from reducing agents such as zinc, alkali metals, and formic acid
Water Reactive Chemicals	• Store in a cool dry place away from any water source. • Have a Water Reactive Chemicals Class D fire extinguisher available in case of fire
Pyrophoric Substances	• Materials that will react with the air to ignite when exposed (e.g., white phosphorus) • Store the contained material in a cool dry place, making provisions for an airtight seal.

Light Sensitive Chemicals	• Store in amber bottles in a cool, dry, dark place.
Peroxidizable Chemicals	• Store in airtight containers in a dark and cool place. Most peroxidizable compounds are flammable and should be stored in a flammable liquid storage cabinet or room. • Label the containers with receiving, and opening dates. • Periodically test for the presence of peroxides. • Discard before exceeding expiration date.
Toxic Chemicals	• Store according to the nature of the chemical, using appropriate security where necessary.
Nitrated Compounds	• Nitrated compounds can be considered explosive; special care may be taken to handle them.

General considerations:

The following are the general storing rules for storing materials and equipment in cabinets and on shelves:

- Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed with non-sparking components to avoid an explosion.
- Storing materials and equipment on top of cabinets should be avoided.
- Make sure that the weight of the chemicals does not exceed the load capacity of the shelf or cabinet.
- Heavy-duty brackets and standards should be used for wall-mounted shelving must have.
- Cabinets for chemical storage must be of solid, sturdy construction, preferably hardwood or metal.
- Do not store materials on top of high cabinets where they will be hard to see or reach.
- Do not store corrosive liquids above eye level.
- Return the chemicals to their proper locations after each use.
- Store chemicals do not require a ventilated cabinet inside a closable

cabinet.

- Do not expose chemicals to heat or direct sunlight.
- Do not storage of incompatible chemicals in one cabinet.

- If the primary container breaks or leaks collect and store the material in corrosion resistant storage trays or secondary containers.

4.3.6 Storage of flammable liquid

- A maximum of 10 gallons of flammable liquids, in approved containers, maybe stored outside of a flammable liquid cabinet. See the table 4.2 for container types and limits.

Table 4.2 Approved Flammable Liquid Storage Containers
Container**

Container Type	**Flammable Liquids**			**Combustible Liquids**	
	Class l-A	Class l-B	Class l-C	Class II	Class III
	Flash Point Flash <73 °F Boiling Point < 100 °F (Ethyl ether)	Point <73 °F Boiling Point *100 °F (Hexane)	Flash Point >73 °F and S100 °F (Diesel fuel)	Flash Point > 100 °F and <140 °F (Mineral spirits	Flash Poin *140 °F (Kerosene
Glass	1 pint *	1 quart *	1 gallon	1 gallon	5 gallons
Metal	1 gallon	5 gallons	5 gallons	5 gallons	5 gallons
Approved Plastic	0	0	0	05	Gallons
Safety Can	2 gallons	5 gallons	5 gallons	5 gallons	5 gallons

* Containers may be up to 1 gallon for reagents of Analytical Purity Grade or High Grade. ** Source UW safety manual.

4.3.7 Chemical Incompatibility Chart

Mixing these chemicals purposely or as a result of a spill can result in heat, fire, explosion, and/or toxic gases. Details are given in Table 4.3.

Table 4.3. A partial list of incompatible chemicals

Chemical	**Keep out of contact with**
Acetic Acid	Chromic Acid, nitric acid, hydroxyl-containing compounds, ethylene glycol, perchloric acid, peroxides, and permanganates
Acetone	Bromine, chlorine, nitric acid, sulphuric acid, and hydrogen peroxide
Acetylene	Bromine, chlorine, copper, mercury, fluorine, iodine, and silver
Alkaline and Alkaline Earth Metals such as calcium, lithium, magnesium, sodium, potassium, powdered aluminium	Carbon dioxide, carbon tetrachloride and other chlorinated hydrocarbons, water, Bromine, chlorine, fluorine, and iodine. Do not use C02, water or dry chemical extinguishers. Use Class D fire extinguisher (e.g., Met-L-X) or dry sand
Aluminium and its Alloys (especially powders)	Acid or alkaline solutions, ammonium persulphate and water, chlorates, chlorinated compounds, nitrates, and organic compounds in nitrate/nitrate salt baths
Ammonia (anhydrous)	Bromine, chlorine, calcium hypochlorite, hydrofluoric acid, iodine, mercury, and silver
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulphur and finely divided organics or other combustibles
Aniline	Hydrogen peroxide or nitric acid
Bromine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, and turpentine

Calcium Oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Caustic (soda)	Acids (organic and inorganic)
Chlorates or Perchlorates	Acids, aluminium, ammonium salts, cyanides, phosphorous, metal powders, oxidizable organics or other combustibles, sugar, sulphides and sulphur
Chlorine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, and turpentine.

Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulphide
Chromic Acid	Acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine and other flammable liquids
Copper	Acetylene, hydrogen peroxide
Cumene Hydroperoxide	Acids
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, bromine, chlorine, fluorine, iodine
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, and other oxiding agents
Hydrocarbons	Bromine, chlorine, chromic acid, fluorine, hydrogen peroxide, and sodium peroxide
Hydrofluoric Acid	Ammonia, aqueous or anhydrous.
Hydrogen Peroxide (anhydrous)	Chromium, copper, iron, most metals or their salts, aniline, any flammable liquids, combustible materials, nitromethane, and all other organic material
Hydrogen Sulphide	Fuming nitric acid, oxidizing gases.
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen.

Mercury	Acetylene, alkali metals, ammonia, fulminic acid, nitric acid with ethanol, hydrogen, oxalic acid.
nitrates	Combustible materials, esters, phosphorous, sodium acetate, stannous chloride, water, zinc powder
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, flammable gases and liquids, hydrocyanic acid, hydrogen sulphide and nitratable substances
nitrates	Potassium or sodium cyanide.
nitroparaffins	Inorganic bases, amines.
Oxalic acid	Silver, mercury, and their salts

Oxygen (liquid or enriched air)	Flammable gases, liquids, or solids such as acetone, acetylene, grease, hydrogen, oils, phosphorous
perchloric Acid	Acetic anhydride, alcohols, bismuth and its alloys, paper, wood, Acid grease, oils or any organic materials and reducing agents
peroxides (organic)	Acid (inorganic or organic). Also avoid friction and store cold.
phosphorus pentoxide	Alcohols, strong bases, water
potassium	Air (moisture and/or oxygen) or water, carbon tetrachloride, carbon dioxide
potassium Chlorate	Sulphuric and other acids.
potassium Perchlorate	Acids
potassium Permanganate	Benzaldehyde, ethylene glycol, glycerol, sulphuric acid.
silver and silver salts	Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds
Sodium	See Alkali Metals
Sodium Chlorate	Acids, ammonium salts, oxidizable materials and sulphur
Sodium Nitrite	Ammonia compounds, ammonium nitrate, or other

	ammonium salts
Sodium Peroxide	Any oxidizable substances, such as ethanol, methanol, glacialacetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural, etc.
Sulphides	Acids.
Sulphur	Any oxidizing materials
Sulphuric Acid	Chlorates, perchlorates, permanganates, compounds with light metals such as sodium, lithium, and potassium
water	Acetyl chloride, alkaline and alkaline earth metals, their hydrides and oxides, barium peroxide, carbides, chromic acid, phosphorous oxychloride, phosphorous pentachloride, phosphorous pentoxide, sulphuric acid, sulphur trioxide

4.3.8 Compressed gas cylinder storage

Cylinders containing the compressed gases listed below must be stored in a ventilated enclosure (cage) outside the labs. Cylinders must be positioned and secured at all times so that they will not fall down.

Acetylene

Ammonia

Arsenic Pentafluoride

Arsine

Boron Trifluoride

1,3 – Butadiene

Carbon Monoxide

Carbon Oxysulphide

Chlorine

Chlorine Monoxide

Cholrine Trifluoride

Chloroethane

Fluorine

Formaldehyde

Germane

Hydrogen Chloride, anhydrous

Hydrogen Cyanide

Hydrogen Fluoride

Hydrogen Selenide

Hydrogen Sulphide

Methylamine

Methyl Bromide

Methyl Chloride

Methyl Mercaptan

Cyanogen
Diborane
Dichloroborane
Dichlorosilane
Dimethylamine
Ethane
Ethylamine
Ethylene
Ethylene Oxide
Nitrogen Oxides
Phosgene
Phosphine
Silane
Silicon Tetrafluoride
Stibine
Trimethylamine

4.3.9 Unattended operation

- Unattended operations or experiments should be avoided whenever possible.
- It is the responsibility of the worker to design all experiments so as to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas.
- If an operation needs to run longer than working hours, the door to the room must be labelled with the name and phone number where the person responsible for the reaction can be reached.
- Clear directions for an untrained person to shut down the operation during an emergency should be posted.
- Arrangements should be made for other workers to periodically inspect the operation.
- Laboratory lights should be left on, and signs should be posted identifying the nature of the experiment and the hazardous substances in use.

4.3.10 Working alone

Working alone in the labs is not allowed under any conditions if hazards exist. An individual is advised to work only under conditions in which appropriate emergency aid is available when needed.

4.3.11 Handling and transporting chemicals

To avoid spills and chemical exposure due to incorrect transportation of chemicals consider the following:

- Keep chemicals in their original packing when transporting, if possible.
- When transporting compressed gas cylinders do not carry or roll cylinders from one area to another. The cylinder should always be strapped in a cylinder cart and the valve protected with a cover cap.
- Use a bottle carrier, cart or other secondary container when transporting chemicals in breakable containers (especially 250 ml or more) through hallways or between buildings. Secondary containers are made of rubber, metal or plastic, with carrying handle(s).

4.3.12 Handling glassware

- Only glass in good condition should be used and discard or send for repair all broken, chipped, starred or badly scratched glassware.
- Do not store glassware near the edge of shelves. Store large or heavier glassware on lower shelves.
- Avoid catching the glassware if it is dropped or knocked over.
- A proper size of the glassware should be used; allow at least 20% free space.

4.4 Safety Guidelines for Non-Regular Classes

- Students should be assigned to work in laboratories in which graduate students and/or postgraduates also are working.
- Students should receive instruction and close supervision directly from their faculty mentor, although a senior graduate/postgraduate student working with the faculty member may also be involved.
- Students should not work alone, particularly at night or on weekends, on operations involving chemicals or other hazards of the type covered in

the Safety Manual. If work at night or on weekends is required, it should only be done with the express permission of the faculty mentor and with specific arrangements to avoid working alone.

- An outline of the independent study project, including the goal(s) and as far as practical, the kinds of experiments to be carried out, methods to be used and data to be collected, as well as a proposed schedule of accomplishments, should be completed (by the student and faculty member together) before the beginning of the first semester or as soon as possible thereafter. This will serve as a guide so that it is clear to student and mentor what each expects at each stage of the project and for the Overall project. It would be appropriate for each to sign and keep a copy. This document should also state where the lab space for the project is and who else is to be involved in the supervision (if anyone).
- Supervising faculty and, if appropriate, associate supervisors, should discuss with the student the potential hazards of all experiments to be carried out, and closely supervise preparations for all new potentially hazardous operations.
- Students should agree with their supervising professors on a weekly work schedule and should make every effort to maintain this schedule.
- Students must read the concerned part(s) in the safety manual as specified by the instructor and sign a statement that they have done so, before they are allowed to begin laboratory work.
- In order to comply with first four guidelines above, that faculty without graduate students or postdoctoral associates or without lab space should enter into collaborations with other faculty who have students and facilities, or at least make arrangements to "borrow" appropriate lab space. If at all possible, these arrangements should be made (at least tentatively) before students are accepted for supervision. If necessary, the Coordinator of Independent Study can be called on to facilitate arrangements.

4.5 Personal Protection

The laboratory should be kept clean and free from clutter, by regular maintenance. At the completion of each experiment, equipment should be

cleaned and properly stored. Do not let unused equipment or chemicals accumulate in the lab. Do not use the aisles of the lab or the space in front of the emergency escape panels for storage. Dispose of all hazardous wastes in accord with the procedures indicated in this manual. Reagent bottles must be properly labelled - when pouring hold the bottle with its label to your palm to protect the label. Notify your Head of the Department of bottles whose contents are in doubt.

4.5.1 Hygiene

- Wash hands often-always before eating and before leaving the laboratory. Washing should be an instinctive reaction to spillage of any chemical on the skin.
- Never eat or drink in the lab - never use lab equipment as a food or drink container.
- No food items should ever be stored or even cooled in a laboratory refrigerator. Food and beverages can become contaminated within a very short period of time to a life-threatening level by absorption of chemical vapors. Any food/beverage found in inappropriate areas will be removed without notice.

4.5.2 Eye protection

In all laboratories where chemicals are used there is the hazard of splashes or dust particles entering into the eyes. Pressurized or vacuum vessels may explode or implode sending shrapnel through the lab. While working with electrical wiring there are hazards from molten solder and debris. Therefore, it requires the use of various types of eye protection listed in order of increasing effectiveness include:

1. Ordinary spectacles
2. Safety glasses with side shields
3. Protective goggles, which can be worn over spectacles, if necessary
4. Face shields
5. Head shields, which protect all of the head and throat

Most lab operations simply require the use of safety glasses. However, when any chemicals are being used at least chemical goggles should be used or in some cases a face shield is required.

4.5.3 Ear protection

The healthy ear can detect sounds ranging from 15 to 20,000 Hertz. Temporary exposure to high noise levels will produce a temporary hearing loss. Long-term exposure to high noise levels produces permanent hearing loss. There appears to be no hearing hazard (although possible psychological effects) to noise exposure below 80 dB. Exposure above 130 dB is hazardous and should be avoided. Earmuffs offer the highest noise attenuation, and are preferred for levels above 95 dB. Earplugs are more comfortable and are preferred in the 80-95 dB range. If you suspect a hearing hazard exists then notify the instructor or Superintendent to check the sound level.

4.5.4 Foot protection

All persons in labs must wear shoes (bare feet are not allowed) and adequate clothing to protect the skin from spilled chemicals, if any.

4.5.5 Skin protection

1. A lab coat or apron should be worn when working with hazardous materials.
2. Never wear shorts in the lab.
3. Always wear clothing that minimizes the amount of skin that can be exposed to potentially harmful chemicals.

4.5.6 Hand protection.

Use gloves made of a material suitable for the operation for any laboratory procedure. Gloves are made of a variety of materials and have specific uses, if used improperly they may not provide the necessary protection.

4.5.7 Respirators

Respirator use should be avoided if at all possible (and is usually not required if adequate precautions are taken). Fume hoods provide constant respiratory protection in all laboratories in the building. Such protection is adequate for most controlled experiments in using the hoods in the building.

4.5.8 Hoods

The most important laboratory equipment is the chemical fume hood, because it is considered the first line of defence against exposure to hazardous chemicals. A Superintendent should check fume hoods at least once annually. However, lab personnel may request more frequent performance checks, particularly when the fan/motor is serviced. Where present, face velocity monitors are recalibrated at the same time. When a fume hood is suspected of breaking down, inform the Superintendent.

4.6 Safety Equipment

The following safety equipment should be in available in each lab:

- Fire extinguishers
- A first aid kit.
- A flashlight for use in case of a power failure

4.6.1 Fume hoods

The following guidelines should be followed whenever a chemical fume hood is being used:

Vertical sash hoods

Use the chemical fume hood with the vertical sash lowered to 18" or the indicated operating height. The operating height should be clearly marked by arrows on yellow tags located on either side of the sash track. Do not work in the hood with the hood sash fully open. To be effective, the fume hood must be operated with the sash at the designated operating height. This will allow the sash to serve as a physical barrier between your face and the contents of the fume hood in case of explosion or fire.

Horizontal sash hoods

Use the chemical fume hood with the horizontal sash(es) in place to serve as a physical barrier between your face and the hood contents.

Proper hood operation

- Keep the sash(es) clean. Never obstruct your view with paper, notices, decals, or other items on the sash(es).
- Do not place equipment or chemicals close to slot openings in the baffles at the rear of the hood or close to the front edge of the hood.
- Avoid sudden movements while working in the hood.
- Perchloric acid can leave explosive residues in a fume hood, duct system, or on a hood fan. Perchloric acid can also form explosive mixtures with organic compounds. for this reason, the use of Perchloric acid in fume hoods must be carefully evaluated prior to use

4.6.2 Fire extinguishers

Minimum of two sets of fire protection equipment must be available in each lab at two different locations. The extinguishers should be tested and maintained in accordance with the applicable standards.

4.6.3 First aid kits

1 First aid kits are to be used for the immediate response to minor injuries, such as cuts or minor burns and should be located in accessible places (with location clearly marked) in the laboratory.

2 A lab superintendent should be responsible for monitoring and maintaining the first aid kit(s).

3 First aid kit contents should include items such as Band-aids, sterile gauze pads, bandages, scissors, antiseptic wipes or ointments. All kits should also contain examination gloves for response to emergencies in which blood is present.

4 An emergency electrical response board should be available in Laboratories where high-voltage equipment is in use. This will contain an instruction card and a non-conductive stick to turn off the equipment and remove the shock victim from contact with the source.

4.6.4 Safety shields

Equipment that might cause high explosions, implosions or splash hazards should be protected using safety shields. Laboratory equipment should be shielded on all sides so that there is no line-of-sight exposure of personnel. Portable shields can be used to protect against hazards of limited severity, e.g., small splashes, heat, and fires.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 5

FIRE SAFETY

5 FIRE SAFETY

The Four Elements of Fire

- Fuel (such as wood, paper, cloth, propane, gasoline, kerosene)
- Oxygen (16% of the air)
- Heat (for instance, a match or spark)
- The chemical reaction that results from fuel, oxygen and heat mixing in the right quantity, at the right time

Table 5.1 Classification of Fire as per OISD116 & IS: 2190/1992

Class of Fire	Type of fire
A	**Wood, Paper and clothing which produce glowing embers or char.**
B	**Flammable Gases, Liquids and Greases Including Gasoline And Most Hydrocarbon Liquids Which Must Be Vaporized For Combustion To Occur**
C	**Electrical Equipment Or In Materials Near Electrically Powered Equipment**
D	**Combustible metals, such as magnesium, zirconium, potassium, and sodium**

5.1 Different Types of Fire Extinguishers

- Water
- Carbon dioxide
- Dry chemical powder
- Mechanical Foam Type
- Specialized fire extinguishers for metal fires

Fire Extinguisher Chart

Extinguisher		Type of Fire				
Colour	Type	Solids (wood, paper, cloth, etc)	Flammable Liquids	Flammable Gasses	Electrical Equipment	Cooking Oils & Fats
	Water	✓ Yes	✗ No	✗ No	✗ No	✗ No
	Foam	✓ Yes	✓ Yes	✗ No	✗ No	✓ Yes
	Dry Powder	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✗ No
	Carbon Dioxide (CO_2)	✗ No	✓ Yes	✗ No	✓ Yes	✓ Yes

Fig 5.1 Fire extinguisher Chart

5.1.1 Water (CO_2 cartridge) type fire extinguisher

Fig 5.2. Water (CO_2 cartridge) type fire extinguish

- Its inner container is filled with water & cap-assemble is fixed with the CO_2 cartridge. It is used for class-A fires only.
- Cools burning material. Very effective against fires in furniture, fabrics, etc. (including deep seated fires), and can be safely used only in the absence of electricity.
- Air-pressurized water (APW) type extinguisher cools the burning material by absorbing heat from the same. Effective on class-A fires, it has the advantage of being inexpensive, harmless, and relatively easy to clean up.

5.1.2 Mechanical Foam Extinguishers

Fig 5.3 Mechanical Foam Extinguishers

Foam Extinguisher contains a foam solution and CO_2 cartridge connected to cap. The discharge hose fixed nozzle with aeration provision.

When foam extinguisher is used the foam should not be allowed to strike the surface of burning liquid, but should be directed against a side wall or any vertical surface of the container so that the foam runs down and forms a blanket which will spread over the liquid. Where the liquid is not confined the foam should be allowed to fall gently on it such a way as to build up a blanket which will flow over the burning surface

5.1.3 Dry chemical powder (DCP) extinguisher

It is mainly filled with any of the following chemical powder and pressurizes with CO_2 cartridge or air:

1. Sodium bicarbonate ($NaHCO_3$)
2. Potassium bicarbonate ($KHCO_3$)
3. Urea based potassium bicarbonate
4. Mono Ammonium phosphate $(NH_4)\ H_2PO_4$

For CLASS A fires the discharge should be continued intermittently to coat the surface area of CLASS A materials

Dry chemical extinguishers are intended for use on CLASS A, CLASS B, and CLASS C fires.

- The discharge should be directed at the base of the flames.
  - Attack the near edge of the fire and progressing forward, moving the nozzle rapidly with a side-to-side sweeping motion for best results.
  - Do not blast flaming liquid around the area.
  - To prevent possible re-flash continue discharge after flames are extinguished.

5.1.4 CO_2 Fire Extinguisher

Fig 5.5 CO_2 Fire extinguisher

Carbon Dioxide extinguishers are designed for Class B and C (flammable liquid and electrical) fires only. They are filled with non-flammable carbon dioxide gas under extreme pressure. You can recognize a CO_2 extinguisher by its hard horn and lack of pressure gauge. The pressure in the cylinder is so great that when you use one of these extinguishers, bits of dry ice may shoot out of the horn.

These extinguishers are intended primarily for use on CLASS B and CLASS C fires.

- Initial application must start reasonably close to the fire.
- On all fires the discharge should be directed at the base of the flames.
- CO_2 discharge should be applied to the burned surface even after the flames are extinguished, to prevent possible re-flash.

In case of flammable liquid fires, apply the discharge from the fire extinguisher first at the near edge of the fire and gradually progressing forward in order to get the best results.

Role of Discharge Horn

Its main duty to stop the entrainment of air with CO_2 and reduce the velocity of CO_2.Without the horn, the jet of CO_2 acts like a blow torch and may by velocity increase the intensity of fire.

Figure 5.6 Role of Discharge Horn

Carbon Dioxide is a non-flammable gas that extinguishes fire by displacing oxygen, or taking away the oxygen element of the fire triangle. The carbon dioxide is also very cold as it comes out of the extinguisher, so it cools the fuel as well. CO_2s may be ineffective at extinguishing Class A fires because they may not be able to displace enough oxygen to successfully put the fire out. Class A materials may also smoulder and re-ignite.

5.1.5 Specialized fire extinguishers for metal fires (class D)

Specialist fire extinguishers are required to tackle Class D flammable metal fires. As you might expect when dealing with such volatile and specialist materials, you need the correct agent for the metal being extinguished.

Specialist fire extinguishers for metal fires work by smothering the fire with a non-reactive agent, which forms a crust and excludes air from contact with the metals.

- Sodium Chloride fire extinguishers are designed for use on Class D fires involving magnesium, sodium, and potassium. When a sodium chloride fire extinguisher is applied to a fire, the heat of the fire makes the sodium chloride cake together and forms an air-excluding crust
- Copper powder metal fire extinguishers are designed for use on Class D fires involving lithium. Graphite powder metal fire extinguishers can also be used on lithium fires.
- Lithium fires must be tackled with a specialist lithium extinguisher only, commonly sold as a L2 extinguisher
- Graphite powder can also be applied to burning metal powders, where even the gentle blast from a fire extinguisher could lift up the powder and cause a dust cloud explosion. Graphite powder has the added advantage of drawing heat away from the fire as well as smothering it.
- Sodium bicarbonate and sodium carbonate fire extinguishers can both be used on Class D fires. Sodium bicarbonate extinguishers can be used on most metal alkyls, plus liquids that ignite on contact with air. Sodium carbonate fire extinguishers can be used to extinguish fires involving sodium, potassium, or their alloys.

5.2 Rules for Fighting Fires

- Fires can be very dangerous and you should always be certain that you will not endanger yourself or others when attempting to put out a fire
- Assist any person in immediate danger to safety, if it can be accomplished without risk to you.
- Only after having done these things, if the fire is small, you may attempt to use an extinguisher to put it out.

However, before deciding to fight the fire, keep these rules in mind:

- Do Not Fight the Fire If you don't have adequate or appropriate equipment
- You might inhale toxic smoke
- The final rule is to always position yourself with an exit or means of escape at your back before you attempt to use an extinguisher to put out a fire.

5.3 Location and Marking of Extinguishers

Extinguishers should be properly located clearly visible and easily accessible for immediate use in the case of fire. Directional arrows will be provided to indicate the location of extinguishers, in locations where visual obstruction cannot be completely avoided. All extinguishers should be labelled indicating clearly the type of fire used for.

5.3.1 Distribution and Mounting of Extinguishers

Extinguishers must be distributed in such a way that the amount of time needed to travel to their location and back to the fire does not allow the fire to get out of control Extinguishers will be installed on hangers, brackets, in cabinets, or on shelves. Extinguishers having a gross weight not exceeding 40 pounds will be so installed that the top of the extinguisher is not more than 3-1/2 feet above the floor.

Extinguishers mounted in cabinets or wall recesses or set on shelves will be placed so that the extinguisher operating instructions face outward.

5.3.2 Maintaining Portable Fire Extinguishers

- Must maintain in a fully charged and operable condition.
- Must keep in their designated places at all times except during use.
- Must conduct an annual maintenance check.
- Must record the annual maintenance date and retain this record for one year after the last entry or the life of the shell, whichever is less.

- The extinguisher should be mounted on the wall.
- The area in front of the extinguisher shall be clear with no obstructions.
- The pressure gauge should be in the green zone.
- The inspection tag should show that the extinguisher has been inspected within the last year.

5.4 Proper Use of Fire Extinguishers

- All extinguishers have simple instructions on them, and they are usually some variation of these simple steps:
- Pull the pin.
- Aim the extinguisher hose or nozzle at the base of the fire.
- Squeeze the handle.
- Sweep it slowly back and forth in order to cover the entire fire with the extinguishing substance.

Operational sequence of a fire extinguisher is depicted at the end of appendix page number 178.

5.5 Fire Alarm

- In the event of a fire emergency, an emergency alarm will sound for the building.
- Upon hearing three consecutive alarms, all persons shall evacuate the building and assemble in the designated assembly point.
- All persons shall evacuate, unless a testing of the alarm system is announced.
- The person setting off the alarm should call the fire department 101 and campus security (9446867466), and verify the emergency.
- Emergency alarms shall be tested once per month.

5.6 Fire Drills

Fire drills should be performed at least once per year. All personnel and Users shall participate, with NO exceptions. All personal involved in the fire drill should be informed ahead of time. All personnel shall evacuate, as in a real fire, to the designated assembly area.

5.7 Fire Emergency Procedures

The safety procedures discussed here are in line with the Indian Standard IS14435/1997(refer Appendix I)

If you discover a fire:

- Activate the nearest fire alarm.
- Notify the fire department by dialling 101. Give your location, the nature of the fire, and your name.
- Notify Head of the Department and other occupants.

Fight the fire ONLY if:

- The fire department has been notified of the fire
- The fire is small and confined to its area of origin
- You have a way out and can fight the fire with your back to the exit
- You have the proper extinguisher, in good working order and know how to use it. If you are not sure of your ability or the fire extinguisher capacity to contain the fire, leave the area.

If you hear a fire alarm:

- Evacuate the area. Close windows, turn off gas jets, and close doors as you leave.
- Leave the building and move away from exits and out of the way of emergency operations.
- Assemble in a designated area.
- Report to the campus security so he can determine that all personnel have evacuated your area.
- Remain outside until competent authority states that it is safe to re-enter.
- Evacuation Routes
- Learn at least two escape routes, and emergency exits from your area.

- Learn to activate an emergency alarm.
- Learn to recognize alarm sounds.
- Take an active part in fire evacuation drills.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 6

CHEMICAL HAZARD

6 CHEMICAL HAZARD

6.1 Introduction

The specific rules and procedures for working with hazardous chemicals, outlined in this chapter, give an insight into the proper methods for handling materials, which pose significant hazards due primarily to their chronic toxicity. However, these specific rules and procedures, along with the general rules for working with chemicals, do not address some of the basic physical hazards, which may stem from acute exposure to different types of laboratory chemicals. This chapter offers some specific guidelines for working with common laboratory chemicals that, for varying reasons, are acutely toxic in the sense that they may cause considerable harm to human life and health pending short term exposures. The Chapter addresses five fundamental classes of laboratory chemicals: flammables, corrosives, oxidizers, reactives and compressed gases. These classes of chemicals may include chemicals that are also covered in the previous section regarding their property of toxicity.

The National Fire Protection Association (NFPA) has developed a colour-coded numerical system for indicating the **health (blue)**, **flammability (red)** and **reactivity (yellow**) hazards of chemicals. NFPA labels are required on all chemicals in the some purchased chemicals already have these markings (or their equivalents) on the container. Other ones don‟t have such markings and should have a NFPA label put on them **immediately**. Labelling is shown in fig 6.1

The degree of hazard associated with a particular substance ranges between 0 to 4 with 4 being extremely dangerous and 0 indicates no harm. The degree and type of hazard are summarized in Fig. 6.2. Toxic chemicals are listed in Appendix III. The properties of various chemicals used in laboratories of the institute are given in Appendix IV.

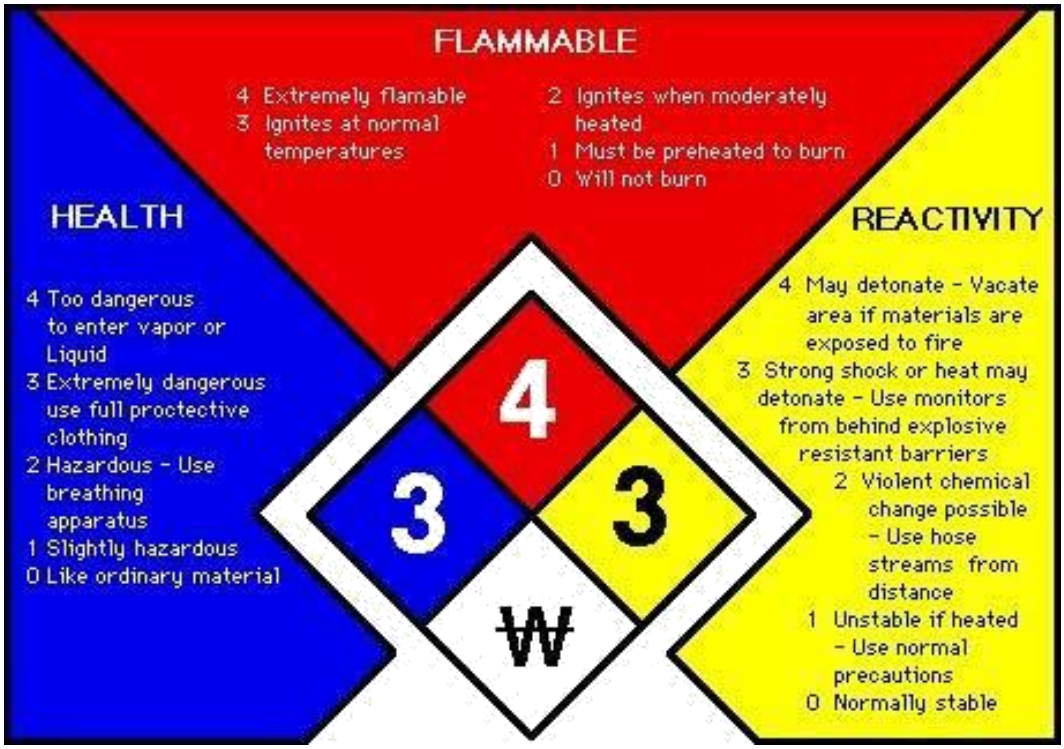

Fig 6.1 NPFA Health Hazard of chemicals

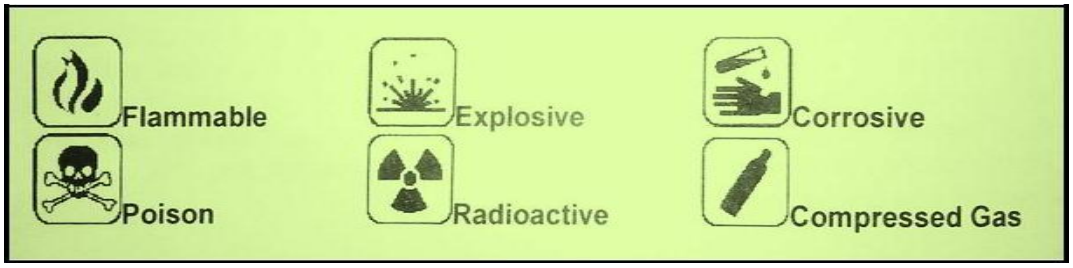

Fig. 6.2.The degree and type of hazard

Health Hazard

0. Material offers no health hazard.

1. Material only slightly hazardous to health. Exposure could cause irritation if not treated.

2. Exposure could cause injury. Exposure requires prompt treatment. Appropriate protective equipment should be worn.

3. Exposure could cause serious injury. Appropriate protective equipment should be worn.

4. Could cause serious injury or death. Only special protective equipment designed specifically to protect against the specific hazard should be worn.

Flammability Hazard

0. Will not burn.

1. Ignites after considerable heating.

2. Ignites if moderately heated.

3. Can be ignited at all normal temperatures.

4. Highly flammable gases or highly volatile flammable liquids.

Reactivity (Stability) Hazard

0. Normally stable. Not reactive with water.

1. Normally stable. Unstable at high temperature and pressure. Reacts with water.

2. Normally unstable but will not detonate. Materials can undergo chemical change with rapid release of energy.

3. Can detonate or explode, but requires strong initiating force or heating under containment.

4. Readily detonates or explodes.

6.2 Flammable solvents

Flammable liquids are the most common chemicals found in a laboratory. The primary hazard associated with flammable liquids is, of course, their ability to readily ignite and burn. One should note that it is the vapor of a flammable liquid, not the liquid itself that ignites and causes a fire. Examples of flammable liquids are acetone, ethyl ether, toluene, methyl formate, etc. In general, the vapors of many flammables are irritating to mucous membranes of the respiratory system and eyes, and in high concentrations are narcotic.

1. The rate at which a liquid vaporizes is a function of its *vapor pressure*. In general, liquids with high vapor pressures evaporate at a higher rate compared to liquids of lower vapor pressure. It should be noted that the

   vapor pressure increases rapidly as the temperature is raised, as does the

evaporation rate. A reduced-pressure environment also accelerates the rate of evaporation.

2. The *flash point* of a liquid is the lowest temperature at which a liquid gives off vapor at such a rate as to form an air: vapor mixture that will ignite, but will not sustain ignition. Many commonly used flammable solvents hav

flashpoints significantly lower than room temperature. The table 6.1 shows the flash point of few commonly used solvents.

Table 6.1. Flash point of few commonly used solvents

Compound	**Flash Point (°C)**
Diethyl ether	-45.0
Acetone	-17.8
Isopropyl alcohol	11.7

3. The *limits of flammability* or *explosivity* define the range of fuel air mixtures that will sustain combustion. The lower limit of this range is called the *Lower Explosive Limit* or LEL, and the higher limit of this range is called the *Upper Explosive Limit* or UEL. Materials with very broad flammability ranges (e.g., acetylene, LEL = 3%, UEL = 65%) are particularly treacherous due to the fact that virtually any fuel air combination may form an explosive atmosphere.
4. The *vapor density* of a flammable material is the density (mass to volume ratio) of the corresponding vapor relative to air under specific temperature and pressure conditions. Flammable vapors with densities greater than unity (and thus "heavier" than air) are potentially lethal because they will accumulate at floor level and flow, with remarkable ease, in much the same manner that a liquid would. The obvious threat is that these mobile vapors may eventually reach an ignition source, such as an electrical outlet or a Bunsen burner at another student's bench

6.2.1 Use and storage

1. Flammable liquids that are not in active use must be stored in safe containers inside fire resistant storage cabinets designed for flammables, or inside storage rooms.

2. Minimize the amount of flammable liquids stored in the lab.
3. Use flammables only in areas free of ignition sources.
4. The transfer of material to or from a metal container is generally accompanied by an accumulation of static charge on the container. This fact must be kept in mind when transferring flammable liquids, since the discharge of this static charge could generate a spark, thereby igniting the liquid. To make these transfers safer, flammable liquid dispensing and receiving containers must be bonded together before pouring. Large containers such as drums must also be grounded when used as dispensing or

   receiving vessels. All grounding and bonding connections neighbours must be metal to metal. (The aforementioned bonding and grounding wires may be found in most lab safety catalogs).
5. Never heat flammables with an open flame. Instead, use steam baths, water baths, oil baths, hot air baths, sand baths or heating mantles.
6. Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed with non-sparking components to avoid an explosion.

6.2.2 First aid

The first aids to be given to a person in case of exposure to flame/ flammable solvents are presented in table 6.2.

Table 6.2.The first aids to a person in case of exposure to flame/flammable solvents

Inhalation Exposures	• Remove person from the contaminated area if it is safe to do so. • Get medical attention and do not leave person unattended.
Ingestion Exposures	• Remove the person, if possible, from the source of contamination. • Get medical attention
Dermal Exposures	•Remove person from source of contamination. • Remove clothing, jewellery, and shoes from the affected areas. • Obtain medical attention.
	• Remove person from the source of contamination.

Eye Contact	• Flush the eyes with water for at least 15 minutes. • Obtain medical attention.

6.2.3 Personal protective equipment

Always use a fume hood while working with flammable liquids. Nitrile and neoprene gloves are effective against most flammables. Wear a non-flammable lab coat to provide a barrier to your skin and goggles if splashing is likely to occur.

6.3 Oxidizers

Oxidizers or oxidizing agents pose fire and explosion hazards on contact with combustible materials. Depending on the class, an oxidizing material may increase the burning rate of combustibles with which it comes in contact; It cause the spontaneous ignition of combustibles with which it comes in contact; or undergo an explosive reaction when exposed to heat, shock, or friction. Oxidizers are generally corrosive and many are highly toxic. Some examples of common oxidizers include peroxides, nitrites, nitrates, perchlorates, chlorates, chlorites, hypochlorites, dichromates, among others.

6.3.1 Use and storage

1. In general, store oxidizers away from flammables, organic compounds, and combustible materials.
2. Strong oxidizing agents like chromic acid should be stored in glass or some other inert container, preferably unbreakable. Corks and rubber stoppers should not be used.
3. Reaction vessels containing appreciable amounts of oxidizing material should never be heated in oil baths, but rather on a heating mantle or sand bath.

6.3.2 Use and storage of perchloric acid

Perchloric acid is an oxidizing agent of particular concern. The oxidizing power of perchloric acid increases with an increase in concentration and with an increase in temperature. Cold, 70% perchloric acid is a strong, non-oxidizing corrosive. A 72% perchloric acid solution at elevated temperatures is a strong oxidizing agent. An 85% perchloric acid solution is a strong oxidizer at room temperature.

1. Do not attempt to heat perchloric acid if you do not have access to a properly functioning perchloric acid fume hood. Perchloric acid can only be heated in a hood specially equipped with a washdown system to remove any perchloric acid residue. The hood should be washed down after each use and it is preferred to dedicate the hood to perchloric acid use only.
2. Whenever possible, substitute a less hazardous chemical for perchloric acid.
3. Perchloric acid can be stored in a perchloric acid fume hood. Keep only the minimum amount necessary for your work. Another acceptable storage site for perchloric acid is on a metal shelf or in a metal cabinet away from 45 organic or flammable materials. A bottle of perchloric acid should also be stored in a glass secondary container to contain leakage.
4. Do not allow perchloric acid to come in contact with any strong dehydrating agents such as sulphuric acid. The dehydration of perchloric acid is a severe fire and explosion hazard.
5. Do not order or use anhydrous perchloric acid. It is unstable at room temperature and can decompose spontaneously with a severe explosion. Anhydrous perchloric acid will explode upon contact with wood.

6.3.3 First aid

In general, if a person has inhaled, ingested, or come into direct contact with these materials, the person must be removed from the source of contamination as quickly as possible when it is safe to do so. Medical help must be obtained. In the case of an exposure directly to the skin or eyes it is imperative that the exposed person be taken to an emergency shower or eyewash immediately. Flush the affected area for a minimum of 15 minutes, and then get medical attention.

6.3.4 Personal protective equipment

In many cases, the glove of choice will be neoprene, polyvinyl chloride (PVC), or nitrile. Be sure to consult a glove compatibility chart to ensure the glove material is appropriate for the particular chemical you are working with. Goggles must be worn if the potential for splashing exists or if exposure to vapor or gas is likely.

Always use these materials in a chemical fume hood as most pose a hazard via inhalation. Cylinders of compressed gases should be kept in ventilated cabinets.

6.4 Corrosives

6.4.1 General characteristics

1. Corrosives are most commonly acids and alkalis, but many other materials can be severely damaging to living tissue.
2. Corrosives can cause visible destruction or irreversible alterations at the site of contact. Inhalation of the vapor or mist can cause severe bronchial irritation. Corrosives are particularly damaging to the skin and eyes.

3. Certain substances considered non-corrosive in their natural dry state are corrosive when wet such as when in contact with moist skin or mucus membranes. An example of these materials is lithium chloride, halogen fluorides, and allyl iodide.
4. Sulphuric acid is a very strong dehydrating agent and nitric acid is a strong oxidizing agent. Dehydrating agents can cause severe burns to the eyes due to their affinity for water.

Examples of corrosives include sulphuric acid, chromic acid, ammonium bifluoride, bromine, ammonium hydroxide, among others.

All corrosives possess the property of being severely damaging to living tissues and also attack other materials such as metal. Skin contact with alkali metal hydroxides, e.g. sodium hydroxide and potassium hydroxide, is more dangerous than with strong acids. Contact with alkali metal hydroxides normally causes deeper tissue damage because there is less pain than with an acid exposure. The exposed person may not wash it off thoroughly enough or seek prompt medical attention.

All hydrogen halides are acids that are serious respiratory irritants and also cause severe burns. Hydrofluoric acid is particularly dangerous. At low concentrations, hydrofluoric acid does not immediately show any signs or symptoms upon contact with skin. It may take several hours for the hydrofluoric acid to penetrate the skin before you would notice a burning sensation. However, by this time permanent damage, such as second and third degree burns with scarring, can result.

6.4.2 Use and storage

1. Always store acids separately from bases. Also, store acids in acid storage cabinets away from flammables since many acids are also strong oxidizers.

2. Do not work with corrosives unless an emergency shower and continuous flow

eyewash are available.

3. Add acid to water, but never add water to acid. This is to prevent splashing from the acid due to the generation of excessive heat as the two substances mix.
4. Never store corrosives above eye level. Store on a low shelf or cabinet.
5. It is a good practice to store corrosives in a tray or bucket to contain any leakage.

6. When possible, purchase corrosives in containers that are coated with a protective plastic film that will minimize the danger to personnel if the container is dropped.
7. Store corrosives in a wooden cabinet or one that has a corrosion-resistant lining. Corrosives stored in an ordinary metal cabinet will quickly damage it. If the cabinet supports that hold up the shelves become corroded, the result could be serious. Acids should be stored in acid storage cabinets specially designed to hold them and Nitric acid should be stored in a separate cabinet or compartment.

6.4.3 Use and storage of hydrofluoric acid

1. Hydrofluoric acid is extremely hazardous and deserves special mention. Hydrofluoric acid can cause severe burns and inhalation of anhydrous hydrogen fluoride can be fatal. Initial skin contact with hydrofluoric acid may not produce any symptoms.

2. Only persons fully trained in the hazards of hydrofluoric acid should use it.
3. Always use hydrofluoric acid in a properly functioning fume hood. Be sure to wear personal protective clothing!
4. If you suspect that you have come in direct contact with hydrofluoric acid: wash the area with water for at least 15 minutes, remove clothing, then promptly seek medical attention. If hydrogen fluoride vapors are inhaled, move the person immediately to an uncontaminated atmosphere (if safe to do so), keep the person warm, and seek prompt medical attention.
5. Never store hydrofluoric acid in a glass container because it is incompatible with glass.
6. Store hydrofluoric acid separately in an acid storage cabinet and keep only that amount necessary in the lab.

Creams for treatment of hydrofluoric acid exposure are commercially available.

6.4.4 First Aid

The first aids to be provided to a person in case of exposure to hydrochloric acid are presented in table 6.3.

Table 6.3.The first aids to a person in case of exposure to hydrochloric acid

Inhalation	• Remove person from source of contamination if safe to do so. • Get medical attention. • Keep person warm and quiet and do not leave unattended. Inhalation
Ingestion	• Remove person from source of contamination. • Get medical attention and inform emergency responders of the name of the chemical swallowed.
Skin Contact	• Remove person from source of contamination and take immediately to an emergency shower or source of water. • Remove clothing, shoes, socks, and jewelry from affected areas as quickly as possible, cutting them off if necessary. • Be careful not to get any chemical on your skin or to inhale the vapors. • Flush the affected area with water for a minimum of 15 minutes. Get medical attention.
Eye Contact:	• Remove person from source of contamination and take immediately to an eyewash or source of water. • Rinse the eyes for a minimum of 15 minutes. Have the person look up and down and from side to side. • Get medical attention. Do not let the person rub their eyes or keep them tightly shut.

6.4.5 Personal protective equipment

Always wear the proper gloves when working with acids. Neoprene and nitrile gloves are effective against most acids and bases. Polyvinyl chloride (PVC) is also effective for most acids. A rubber coated apron and goggles should also be worn. If splashing is likely to occur, wear a face shield over the goggles. Always use corrosives in a chemical fume hood.

6.5 Reactives

6.5.1 General characteristics

Reactive chemicals are grouped as a category primarily because of the safety hazards associated with their use and storage and not because of similar acute or chronic health effects. For health hazard information on specific reactive materials consult the MSDS, or the manufacturer. However, there are some

hazards common to the use of reactive materials. Injuries can occur due to heat or flames, inhalation of fumes, vapors, and reaction products, and flying debris.

Polymerization reactions:

Polymerization is a chemical reaction in which two or more molecules of a substance combine to form repeating structural units of the original molecule. This can result in an extremely high or uncontrolled release of eat. An example of a chemical which can undergo a polymerization reaction is styrene.

Water reactive materials:

1. When water reactive materials come in contact with water, one or more of the following can occur: liberation of heat which may cause ignition of the chemical itself if it is flammable, or ignition of flammables that are stored nearby; release of a flammable, toxic, or strong oxidizing gas; release of metal oxide fumes; and formation of corrosive acids.

2. Water reactive chemicals can be particularly hazardous to firefighting personnel responding to a fire in a lab, because water is the most commonly used fire extinguishing medium. Examples of water reactive materials include lithium, sodium, potassium, magnesium, zinc, alkyl-aluminums, among others.

Peroxide-forming materials:

Peroxides are very unstable and some chemicals that can form them are commonly used in laboratories. This makes peroxide-forming materials some of the most hazardous substances found in a lab. Peroxide-forming materials are chemicals that react with air, moisture, or impurities to form peroxides. The tendency to form peroxides by most of these materials is greatly increased by evaporation or distillation. Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. Many peroxides formed from materials used in laboratories are more shock sensitive than TNT. Just the friction from unscrewing the cap of a container of ether that has peroxides in it can provide enough energy to cause a severe explosion. Examples of peroxide-forming materials (the first group listed is the most hazardous): diisopropyl ether divinylacetylene, sodium amide, potassium amide, dioxane diethyl ether, tetrahydrofuran vinyl ethers, acrylonitrile styrene, among others.

Other shock-sensitive materials:

These materials are explosive and sensitive to heat and shock. Examples of shock sensitive materials: chemicals containing nitro groups, fulminates, hydrogen peroxide (30%+), ammonium perchlorate, benzoyl peroxide (when dry), compounds containing the functional groups: acetylide, azide, diazo, halamine, nitroso, and ozonide.

6.5.2 Use and storage

1. A good way to reduce the potential risks is to minimize the amount of material used in the experiment. Use only the amount of material necessary to achieve the desired results.

2. Always substitute a less hazardous chemical for a highly reactive chemical whenever possible. If it is necessary to use a highly reactive chemical, order only the amount that is necessary for the work.

3. Store water-reactive chemicals in an isolated part of the lab. A cabinet far removed from any water sources, such as sinks, emergency showers, and chillers, is an appropriate location. Clearly label the cabinet "Water-Reactive Chemicals - No Water".

4. Store pyrophoric in an isolated part of the lab and in a clearly marked cabinet. Be sure to routinely check the integrity of the container and have the material disposed of through EH&S if the container is corroded or otherwise damaged.

5. Do not open the chemical container if peroxide formation is suspected. The act of opening the container could be sufficient to cause a severe explosion. Visually inspect liquid peroxide-forming materials for crystals or unusual viscosity before opening. Pay special attention to the area around the cap. Peroxides usually form upon evaporation, so they will most likely be formed on the threads under the cap.

6. Date all peroxide forming materials with the date received, and the expected shelf life. Chemicals such as diisopropyl ether, divinyl acetylene, sodium amide and vinylidene chloride should be discarded after three months. Chemicals such as dioxane, diethyl ether, and tetrahydrofuran should be submitted to EHSC for disposal after one year

7. Store all peroxide-forming materials away from heat, sunlight, and sources of ignition. Sunlight accelerates the formation of peroxides.

8. Secure the lids and caps on containers of peroxide-forming materials to discourage the evaporation and concentration of these chemicals.

9. Never store peroxide-forming materials in glass containers with screw cap lids or glass stoppers. Friction and grinding must be avoided. Also, never store these chemicals in a clear glass bottle where they would be exposed to light.

10. If you notice crystal formation in the container or around the cap, do not attempt to open or move the container. Proper disposal should be carried out.

11. Never distill ether unless it is known to be free of peroxides.

12. Store other shock sensitive materials separately from other chemicals and in a clearly labelled cabinet.

13. Never allow picric acid to dry out, as it is extremely explosive. Always store picric acid in a wetted state.

6.5.3 First aid

1. If someone is seriously injured the most important step to take is to contact emergency responders as quickly as possible. This is best accomplished by directly calling them at 108. Explain the situation and describe the location clearly and accurately.

2. If someone is severely bleeding, apply a sterile dressing, clean cloth, or handkerchief to the wound. Then put protective gloves on and place the palm of your hand directly over the wound and apply pressure and keep the person calm. Continue to apply pressure until help arrives.

3. If a person's clothes are on fire, he or she should drop immediately to the floor and roll. If a fire blanket is available, put it over the individual. An emergency shower, if one is immediately available, can also be used to douse flames.

4. If a person goes into shock, have the individual lie down on their back if safe to do so and raise the feet about one foot above the floor.

6.5.4 Personal protective equipment

1. Wear appropriate personal protective clothing while working with highly reactive materials. This might include: impact resistant safety glasses or goggles, a face shield, gloves, a lab coat (to minimize injuries from flying glass or an explosive flash), and a shield.

2. Conduct work within a chemical fume hood as much as possible and pull down the sash as far as is practical. While the experiment does not require you to reach into the fume hood, keep the sash closed.

3. Barriers can offer protection of personnel against explosions and should be used. Many safety catalogs offer commercial shields which are commonly polycarbonate and are weighted at the bottom for stability. It may be necessary to secure the shields firmly to the work surface.

LABORATORIES

i. Chemical Technology lab
ii. Material testing and Engineering lab
iii. Environmental Engineering lab

iv. Fluid and particle mechanics lab
v. Particle technology lab
vi. Heat transfer operation lab
vii. Process control and reaction Engineering lab
viii. Mass transfer operation lab
ix. Research lab
x. Process simulation lab

Laboratory safety

All students must read and understand the information in this document with regard to laboratory safety and emergency procedures prior to the first laboratory session. Students must adhere to written and verbal safety instructions throughout the academic term. Since additional instructions may be given at the beginning of laboratory sessions, it is important that all students arrive at each session on time.

Personal and General laboratory safety

1. Never eat, drink, or smoke while working in the laboratory.
2. Read labels carefully.
3. Do not use any equipment unless you are trained and approved as a user by your supervisor.
4. Wear safety glasses or face shields when working with hazardous materials and/or equipment.
5. Wear gloves when using any hazardous or toxic agent.
6. Clothing: When handling dangerous substances, wear gloves, laboratory coats, and safety shield or glasses. Shorts and sandals should not be worn in the lab at any time. Shoes are required when working in the machine shops.
7. If you have long hair or loose clothes, make sure it is tied back or confined
8. Keep the work area clear of all materials except those needed for your work. Coats should be hung in the hall or placed in a locker. Extra books, purses, etc. should be kept away from equipment, which requires air flow

or ventilation to prevent overheating.

9. Disposal- Students are responsible for the proper disposal of used material if any in appropriate containers.
10. Equipment Failure- If a piece of equipment fails while being used, report it immediately to your lab assistant or tutor. Never try to fix the problem yourself because you could harm yourself and others.
11. If leaving a lab unattended, turn off all ignition sources and lock the doors.
12. Never pipette anything by mouth.
13. Clean up your work area before leaving.
14. Wash hands before leaving the lab and before eating.

Electrical safety

1. Obtain permission before operating any high voltage equipment.
2. Maintain an unobstructed access to all electrical panels.
3. Wiring or other electrical modifications must be referred to the Electronics Shop or the Building Coordinator.

Mechanical safety

1. When using compressed air, use only approved nozzles and never direct the air towards any person.
2. Guards on machinery must be in place during operation.
3. Exercise care when working with or near hydraulically or pneumatically driven equipment. Sudden or unexpected motion can inflict serious injury.

Chemical safety

1. Treat every chemical as if it were hazardous.
2. Make sure all chemicals are clearly and currently labeled with the substance name, concentration, date, and name of the individual responsible.
3. Never return chemicals to reagent bottles. (Try for the correct amount and

share any excess.)

4. Comply with fire regulations concerning storage quantities, types of approved containers and cabinets, proper labeling, etc. If uncertain about regulations, contact the building coordinator.
5. Use volatile and flammable compounds only in a fume hood. Procedures that produce aerosols should be performed in a hood to prevent inhalation of hazardous material.
6. Never allow a solvent to come in contact with your skin. Always use gloves.
7. Never "smell" a solvent!! Read the label on the solvent bottle to identify its contents.
8. Dispose of waste and broken glassware in proper containers.
9. Clean up spills immediately.
10. Do not store food in laboratories.

6.6 Compressed Gas Cylinders

Cylinders of compressed gases can pose a chemical as well as a physical hazard. If the valve were to break off a cylinder, the amount of force present could propel the cylinder trough a brick wall.

Use and storage

1. Whenever possible, use flammable and reactive gases in a fume hood or other ventilated enclosure. Certain categories of toxic gases must always be stored and used in ventilated enclosures.

2. Always use the appropriate regulator on a cylinder. If a regulator will not fit a cylinder's valve, replace the cylinder, not the regulator. Do not attempt to adapt or modify a regulator to fit a cylinder it was not designed for. Regulators are designed to fit only specific cylinder valves to avoid improper use.

3. Inspect regulators, pressure relief devices, valves, cylinder connections, and hose lines frequently for damage.

4. Never use a cylinder that cannot be positively identified. Color-coding is not a reliable way of identifying a cylinder because the colors can vary from supplier to supplier.

5. Do not use oil or grease on any cylinder component of an oxidizing gas because a fire or explosion can result.

6. Never transfer gases from one cylinder to another. The gas may be incompatible with the residual gas remaining in the cylinder or may be incompatible with the cylinder material.

7. Never completely empty cylinders during lab operations; rather, leave approximately 25 psi of pressure. This will prevent any residual gas in the cylinder from becoming contaminated.

8. Place all cylinders so that the main valve is always accessible.

9. Close the main cylinder valve whenever the cylinder is not in use.

10. Remove regulators from unused cylinders and always put the safety cap in place to protect the valve.

11. Always secure cylinders, whether empty or full, to prevent them from falling over and damaging the valve (or falling on your foot). Secure cylinders by chaining or strapping them to a wall, lab bench, or other fixed support.

12. Oxygen should be stored in an area that is at least 6 m away from any flammable or combustible materials or separated from them by a non-

    combustible barrier at least 2 m high and having a fire-resistance rating of at least 1/2 hour.

13. To transport a cylinder, put on the safety cap and strap the cylinder to a hand truck in an upright position. Never roll a cylinder.

14. Always clearly mark empty cylinders and store them separately.

15. Be careful while handling compressed gas cylinders and never drop or strike a cylinder against anything.

16. Use only wrenches or other tools supplied by the cylinder supplier to open a

valve. Open cylinder valves slowly.

17. Only compatible gases should be stored together in a gas cylinder cabinet.

18. Flammable gases must be stored in properly labelled, secured areas away from possible ignition sources and kept separate from oxidizing gases.

19. Do not store compressed gas cylinders in areas where the temperature can exceed 50°C.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 7

ELECTRICAL SAFETY

7 ELECTRICAL SAFETY

In many laboratories, electrically powered equipments can pose a significant hazard to laboratory workers, particularly when mishandled or not well-maintained. Many laboratory electrical devices have high voltage or high power requirements, carrying even more risk. Electrical shock and fire are the major hazards associated with electricity.

7.1 Electrical Hazards

The severity and effects of an electrical shock depend on a number of factors, such as:

- The pathway through the body
- The amount of current
- The length of time of the exposure
- Whether the skin is wet or dry.

The table 7.1 shows the general relationship between the degree of injury and amount of current for a 50-60 cycle hand-to-foot path of one second's duration of shock. While reading this chart, keep in mind that most electrical circuits can provide, under normal conditions, up to 20,000 milliamperes of current flow. Keeping in mind that the electrical shock hazards and sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors or combustible materials.

Table 7.1. General relationship between the degree of injury and amount of current

Current	Reaction
1 Milliampere	Perception level
5 Milliamperes	Slight shock felt; not painful but disturbing
6-30 Milliamperes	Painful shock; "let-go" range
50-150 Milliamperes	Extreme pain, respiratory arrest, severe muscular contraction

1000-4,300 Milliamperes	Ventricular fibrillation
10,000+ Milliamperes	Cardiac arrest, severe burns and probable death

Source, *University of Princeton*

7.1.1 Power loss

The following hazardous situations can be created due to the Loss of electrical power:

- If magnetic or mechanical stirrers fail to operate, safe mixing of reagents may be compromised.
- Fume hoods may cease to operate, allowing vapors to be released into the laboratory
- Flammable or toxic vapors may be released as a chemical warms when a refrigerator or freezer fails.

Fig. 7.1 Two prong plug

7.2 Preventing Electrical Hazards

There are various ways of protecting people from the hazards caused by electricity, guarding insulation, guarding, grounding, and electrical protective devices.

7.2.1 Insulation

All electrical cords should have sufficient insulation to prevent direct contact with wires. In a laboratory, it is particularly important to check all cords before each use, since corrosive chemicals or solvents may erode the insulation. Damaged cords should be repaired or taken out of service immediately.

7.2.2 Guarding

Live parts of electric equipment operating at 50 volts or more must be guarded

against accidental contact. Proper shields may be used to protect against exposed live parts.

7.2.3 Grounding

Only equipment with three-prong plugs (Fig 7.2) should be used in the laboratory instead of a two prong plug (Fig 7.1). The third prong provides a path to ground for internal electrical short circuits, thereby protecting the user from a potential electrical shock.

Fig.7.2 Three prong plug

7.2.4 Circuit protection devices

Circuit protection devices, such as fuses, circuit breakers, ground-fault circuit interrupter, are designed to automatically shut off the flow of electricity in the event of a ground-fault, overload or short circuit in the wiring system.

Fig. 7.3 MCB

- Fuses and circuit breakers like the one shown in fig 7.3 prevent over-heating of wires and components that might otherwise create fire hazards. They disconnect the circuit when it becomes overloaded. This overload protection is very useful for equipment that is left on for extended periods of time, such as stirrers, vacuum pumps, drying ovens, and other electrical equipment.
- The ground-fault circuit interrupter, or GFCI, is designed to shutoff electric power if a ground fault is detected, protecting the user from a potential electrical shock. The GFCI is particularly useful near sinks and wet location.

7.2.5 Motors

All newly purchased equipment should have spark free induction motors. Any

switches located on the device should be removed and insert a switch on the cord near the plug end.

Laboratory workers can significantly reduce electrical hazards by following some basic precautions:

- Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately.
- Use safe work practices every time electrical equipment is used.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Limit the use of extension cords. Use only for temporary operations and then only for short periods of time. In all other cases, request installation of a new electrical outlet.
- Multi-plug adapters must have circuit breakers or fuses.
- Place exposed electrical conductors (such as those sometimes used with electrophoresis devices) behind shields.
- Minimize the potential for water or chemical spills on or near electrical equipment.

7.3 Safe Work Practices

The following are a list of rules for working with electrical equipment:

- Turn off the power to equipment before inspecting it.
- Check circuits for proper grounding with respect to the power source.
- Never change wiring with circuit plugged into power source.
- Never plug leads into power source unless they are connected to an established circuit.
- Keep access to electrical panels and disconnect switches clear and unobstructed.
- Tools and equipment with non-conducting handles should be used when working with electrical devices.
- All current transmitting parts of any electrical devices must be enclosed.
- When checking an operating circuit, keep one hand either in a pocket or behind your back to avoid making a closed circuit through the body.

- Avoid contacting circuits with wet hands or wet materials.
- Wet cells should be placed on a piece of non-conducting material.
- Do not insert another fuse of larger capacity if an instrument keeps blowing fuses -this is a symptom requiring expert repairs.
- Extension cords must be connected to a power strip equipped with a fuse.
- Maintain a workspace clear of extraneous material such as books, papers, and clothes.

- Do not use or store highly flammable solvents near electrical equipment.
- Multi-strip outlets (cube taps) should not be used in place of permanently installed receptacles. If additional outlets are required have them installed by an electrician.

7.4 Static Electricity and Spark Hazards

Proper grounding of equipment and containers is necessary to avoid sparks. Sparks may result in explosions in areas where flammable liquids are being used. Some common potential sources of sparks are:

- The making and braking of an electrical circuit when the circuit is energized.
- Metal tanks and containers.
- Plastic lab aprons.
- Metal clamps, nipples, or wire used with no conducting hoses.
- High-pressure gas cylinders upon discharge.

7.5 High Voltage or Current

Only trained electricians should repair of high voltage or high current equipment. For further resources:

"Electrical Safety: Safety and Health for Electrical Trades Student Manual"

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 6 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 8

MECHANICAL SAFETY

8 MECHANICAL SAFETY

Within all laboratories as well as the Mechanical Workshop at the Government Engineering College, Trichur, there are various hazards from rotating machinery, grind wheels, hand-held drilling machines, saws and cutting tools, guillotine, bending and punching tools etc.

The prime rule of safety within a mechanical workshop as well as with other labs is that of good housekeeping and general tidiness. In addition students are not permitted entrance to the mechanical workshop and labs unless approval has been obtained from the lab superintendent or technician.

The tools and equipment are for student use in conducting class experiments or building approved projects. Safe operation is important to ensure successful project or experiment completion, but most importantly to ensure the personal safety of the operator and those observing. The following procedure will help to ensure the safe operation and avoid injury.

8.1 General safe working procedure

- Only use tools and machines for their intended purpose.
- Report all damaged equipment and do not use it until a qualified person has repaired it.
- Do not operate a machine if you are wearing loose clothing.
- Where machine guards are provide they must be kept in place.
- Long hair needs to be properly restrained.
- Always use clamps to hold a work piece in the drilling machine table. Do not attempt to hold the work piece by hand. Brass is particularly liable to seize on the drill bit unless the correct type of bit is used and the bit kept sharp. Get advice from trained technical staff if you are at any time unsure. Do not take risks. Return all drill bits to their proper holder.
- Do not use hand tools of the wrong size and ensure that the hand tool (whether spanner or screwdriver etc.) fits the work correctly.

- Never use hand files unless they have a proper handle fitted. The pointed tang of a file can slip and pierce the palm of the hand.

- Ensure that hand-cutting tools are sharp - a blunt hand tool will slip easily and can cause injury. When using a hand tool remember to apply the force for cutting or filing in a direction away from the body.

- Keep machine tools, workbenches and surrounding areas clean of loose metal sward and chippings.

- If the machining operation requires you to do so, (e.g. drilling, grinding a tool) always use safety glasses as well as the machine guard.

- Abrasive grind wheels can cause serious eye injuries due to grit being thrown from the grind wheel - wear appropriate eye protection. Grinding wheels are subject to additional legislation and must only be mounted and adjusted by a trained workshop technician.

- Never use compressed air for cleaning clothing and machinery.

- Only one person will operate a machine at any one time.

- Ensure the safety of yourself and others by being aware of your surroundings. If you see someone committing an unsafe act, report it to the supervisor immediately. As the machine operator you are responsible for the safety of the people in your immediate area. It is your responsibility to look around and be sure that everyone within your range is wearing safety glasses. Likewise a welder must be sure not to start welding if people without welding helmets are watching him.

- Use hoisting and lifting equipment when moving heavy weights around. Make sure that slings are correctly placed. If you are not sure, ask and do not take risks.

- Always ensure that when you leave a machine or piece of equipment that it is in a safe condition for the next person to approach and use.

- You may not wear gloves while operating machinery. Holding objects with a

rag near moving machinery is also not permitted. Gloves, rags, etc. can be easily caught in machines that are in motion, pulling the operator into the equipment.

- Machinery may not be left running unattended. You must be at the controls of the machine you are using whenever it is in motion.

- Observers must not distract the operator of a machine as this may cause serious injury to the operator or the observers.

- Observe the limitations of all machines.

NOTE 1: If you are in doubt about the operating procedures of any piece of technical equipment, find out before you switch it on, or attempt to use it, otherwise damage may be caused to the equipment or injury to yourself or some other person who may happen to be in the vicinity at that time.

NOTE 2: It is the responsibility of the officer in charge of the workshop to ensure that staffs who use the workshop only occasionally adopt the same safety precautions and procedures as full-time workshop personnel.

8.2 Hand Tools

Hand tools are non-powered. They include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance.

- Hammers or mallets with broken handles or loose heads should not be used.

- Mushroom heads on chisels and punches should be "dressed" properly or the tool should be discarded.

- While chipping, use prescribed type of goggles and chip in a direction where flying chips can do no harm. Use a screen if necessary.

- When cutting with pliers, be sure cuttings do not fly.

- A wood saw or hacksaw should be started by drawing the saw blade backward if fingers are used to guide it at the cutting edge.

- All files should be equipped with handles.
- Use wrenches properly sized for the job. Be sure wrench jaws are not sprung, chipped, or have worn teeth. Never use a wrench as a hammer.
- Clean grease and oil from hands before using tools to prevent slipping. To prevent injury or damage to your project use only tools that are in good condition.
- Use tools only for the job that they were designed for. Screwdrivers are for turning screws; hammers are for striking objects; parallel bars are for holding material in place until clamped; etc.
- A chisel or punch head that becomes mushroomed should be given to the supervisor for repair. Mushroomed heads can chip off and cause injuries.
- Cut away from your hands and body when using a knife or sharp object.
- Use a wrench on nuts and bolts, not pliers.
- Use open-end or adjustable wrenches that fit the nut snugly to prevent slipping and injuring fingers or damaging parts.
- Use the correct size tool for the job. That includes screwdrivers.
- All power tools must be turned off and have come to a complete stop before the operator can set them down. NO EXCEPTIONS.

8.3 Machine Tools

- Stand to one side-never directly in line-with work being fed through machines such as circular saws, jointers, or wood shapers.
- Revolving shafts, although apparently smooth, will catch loose or ragged clothing, gloves, jewellery, hair, or wiping rags. Proper clothes and caution are always necessary when working around any revolving machinery. Shirtsleeves should be rolled up. Neckties should not be worn.

- Goggles must be worn whenever flying chips, particles of material, liquids, chemicals, or sparks may cause eye injury.
- Whenever possible, ground all power tools.
- Machinery should be inspected regularly to insure cleanliness and proper operation.
- Machinery should be placed and anchored securely to prevent tipping or other movement.
- There should be a power shut-off switch within reach of the operator at each machine.
- Machinery should be equipped with an emergency stop button which is colored red.
- Manually operated valves and switches controlling the operation of machines should be identified and readily accessible.
- Machines must be shut down before cleaning, repairing, or oiling. Disconnect or use Lock Out techniques.
- Keys or adjusting tools must never be left so that they may creep, be thrown, or fall when a machine is started.
- When drilling or tapping material sees that it is securely fastened by blocks or clamps so that it cannot spin or climb the drill. In no case should the operator rely on his hands to secure the material from turning.
- Use a brush, special tool, or hook to remove chips, shavings, or other material from work.
- Transparent guards should be kept clean.
- Keep fingers clear of a machine's point-of-operation by using special tools or devices, such as push sticks, hooks, or pliers.

8.3.1 Drill press

- Check the drill press head and table for security and condition before starting.
- A center punch will help locate the hole to be drilled in the correct place.
- Clamp material to be drilled securely to the drill-table before starting the machine.
- Tighten the chuck of the drill press and remove the release key before starting the machine or your arm may be twisted around the spindle. Never leave the key in the chuck.
- Use drills properly sharpened to cut the right size.
- Run drills only at the correct speed and do not force or feed too fast. Broken drills can cause serious injury.
- If your work should slip from the clamp, never attempt to stop it with your hands. Stop machine to make any adjustment or repair.
- Drill presses should never be forced by exerting excess pressure on the feed lever.
- Drive belts should be covered.
- Hands are to be kept clear of the revolving spindle, chuck, drill and chips. When drilling large holes drill a pilot hole with a small appropriate drill and then step up in size to prevent drill chatter.
- Be sure the drill press is stopped before removing the work piece, chips or cuttings.

8.3.2 Electric drill (hand held)

- Center punch the hole to be drilled.
- Tighten the drill using the chuck key and remove the chuck key immediately.
- Hold the drill motor firmly, and keep hands away from the revolving spindle and drill.

- Use a larger drill if a larger hole is needed. Using side pressure on the drill to "wobble" out the hole to increase the diameter will only damage the drill and cause it to break.

- Apply straight and steady pressure on the drill, and ease up on the pressure as the drill begins to break through the material.

- With the motor still running back out the drill as soon as the hole is drilled.

- Turn off the drill and hold firmly until it comes to a complete stop before laying it on the workbench.

8.3.3 Bench Grinder

- Adjust the work rest to within 1/16 inch of the wheel face.

- Stand to the side of the grinder, not in line with the wheels, turning on a grinder and while the wheels are accelerating, this is the most common time for a damaged wheel to fly apart.

- Do not allow hands to come in contact with the grinding wheel while it is in motion.

- Dress the grinding wheel when it is worn uneven or out or round.

- Hold the work firmly, and make grinding contact without bumping or impacting the grinder.

- Use only enough pressure to assure grinding, but not heavy pressure, as this will only cause overheating and grinder damage. If the work piece begins to get warm, quench it in water.

- Grind only on the face of the wheel. Grinding on the side can cause the grinder wheel to explode due to heat stress build-up.

- Keep the work piece in motion across the face of the wheel.

- Stone type grinding wheels are not for grinding aluminium, brass, or copper because the soft metal gets embedded in the stone which may get overheated and can explode.

8.3.4 Disc grinder – Portable

- You must wear a face shield as well as safety glasses when using the disc grinder.
- Always be aware of the direction you are throwing the stream of sparks. It is your responsibility to be sure you are not throwing them on other people, in the vicinity of those without eye protection, or on potentially flammable items.
- Like all other hand tools the disc grinder must be stopped (not moving) before it can be set down.

8.3.5 Engine lathe

- Make sure that all gear and belt guards are in place.
- Never leave a chuck wrench in a chuck.
- Keep your hands off the chuck rims when a lathe is in operation.
- Do not attempt to screw the chuck onto the lathe spindle with the power on, as it may get cross-threaded and cause injury. Stop the machine, place a board under the chuck, and then screw on by hand.
- Steady rests should be properly adjusted to conform to the material being worked on.
- See that tailstock, tool holder, and work are properly clamped before turning on power.
- Never attempt to adjust a tool while the lathe is running.
- Never apply a wrench to revolving work or parts.
- Always use a brush to remove chips-never your hands.
- Roll up loose sleeves, and do not wear loose clothes such as sweaters or neckties while operating the lathe.
- Be certain the work piece is set up securely and tightly when using chucks and collets.

- Keep hands away from chips as they are very sharp and possibly hot.
- Complete cuts that are close to the chuck or against a shoulder by hand feeding to prevent machinery or work piece damage.
- Never move the speed selector controls while the spindle is rotating.
- Never push the reverse switch while a chuck is moving forward as this could cause the chuck to unscrew itself and fall off and cause serious injury.
- Regulate the depth of cut according to the size and type of material.
- Use tools that are properly ground for the particular job.
- You may never check measurements or surface finishes of the work piece while it is spinning.
- After you have chucked up your work piece and completed your tool setup you must spin the chuck by hand to ensure that the jaws of the chuck and the work piece will not hit the carriage of the lathe or the tool rest between the turning centers.
- Use only a Live Center Chuck and Faceplate Turning.
- Counterbalance work piece on the faceplate if it is irregular in shape.
- Stand to one side of the revolving faceplate to avoid being hit by flying objects.

8.3.6 Milling machine

- Secure the work piece firmly in the vice or with appropriate clamps.
- Check the work piece, milling machine table, and holding device for clearance of the quill during the cutting.
- Set the machine for the proper depth of cut.
- Select the correct spindle speed for the type of material and the cutter being used.
- Select the proper direction of rotation for the cutter.

- Feed the work piece against or opposite the direction of rotation of the cutter.
- Keep hands on the controls while the machine is running.
- Never try to feel the finished surface while the cut is being taken.
- The milling machine is a precision piece of equipment so it is important to not damage the table. The table is not a workbench or a place to put tools.
- Be sure you know how to stop the milling machine quickly before operating the machine.
- Be sure the power feed controls are in their "Neutral" position before turning on the machine.
- Handle cutters carefully. They are sharp. If they can cut metal, they can cut you.
- Use a soft hammer or mallet to seat the work piece against the parallel bars or bottom of the vice.

8.4 Oxygen-Acetylene Welding

- Signs reading "DANGER-NO SMOKING OR OPEN FLAMES" or the equivalent should be posted.
- Grounding of the machine frame and safety ground connections of portable machines should be checked periodically.

- Electrical power to the welder should be shut off when no one is present.
- Welding is to be done only by those employees who are qualified as welders.
- Always stand to one side and away from the gauge faces and front of the regulator when opening the cylinder valve. In case of an explosion, flying glass will not cut you.
- Oxygen is not a substitute for compressed air. Never use oxygen equipment around oily gloves, clothes or oily surfaces. Oil or grease in presence of oxygen, under pressure, will ignite violently.
- Suitable fire extinguishing equipment should be available for instant use.
- Firewatchers should be assigned when welding or cutting is performed in locations where a serious fire might develop.
- Cylinders have exploded from what seemed to be slight jars. Be sure your cylinders are chained or strapped securely.
- Never use acetylene from a cylinder in a horizontal position. In this position, the acetone is drawn out of the cylinder with the acetylene.
- Use the cylinder valve-not the regulator-to turn the gas off. The regulator is not designed to be used as a shut-off valve.
- Do not watch the electric arc without welding glass. Ultraviolet and infrared rays are thrown off in concentrated form and can burn unprotected eyes.
- Local exhaust ventilation is recommended for most welding, cutting, and brazing. It is required when the following base metals, fluxes, coatings, plating or filler metals are used:
  - ✓ Beryllium
  - ✓ Cadmium
  - ✓ Chromium Fluorides
  - ✓ Lead
  - ✓ Mercury Zinc Inert gas welding
  - ✓ Oxygen cutting of stainless steel
- Cylinders must always be fastened with a chain or other suitable device as a

protection against falling or rolling.

- Keep the welding equipment free of oil and grease and away from oily rags. When oil comes in contact with oxygen it will explode.
- If leaks are detected in the equipment, they are to be reported immediately to lab superintendent or technician.
- Adequate ventilation is needed in the welding area before beginning.
- Keep all flammable material away from the work area.
- Never open an acetylene cylinder valve more than one-half (1/2) turns. Always keep the key on the acetylene cylinder valve. In case of a flashback or fire from a leaky cylinder connection, a gloved hand can withstand the heat long enough to close the valve.
- Eye protection helmets, hand shields, and goggles meeting the appropriate standards are required. Release the regulator pressure screw and open the cylinders slowly. The normal pressure setting for acetylene is 5 psi with a maximum of 15 psi.
- The oxygen cylinder valve should be opened all the way as it is a double seating valve. The normal pressure setting for oxygen is 10 psi with higher settings used for torch cutting.
- Point the torch away from yourself and observers before lighting the torch.
- Use a friction torch lighter (flint striker) to ignite the torch.
- A lighted torch should not be turned on concrete. Concrete always contains some moisture, which may cause the concrete to explode.
- Close the acetylene valve first if the torch backfires.
- Keep sparks and flames away from the gas cylinders and hoses.
- Close both cylinder valves and then release the pressure from the lines when you have finished the job.
- Hot metals are to be quenched rather than left lying on the table hot, or mark with chalk the word “HOT” if air cooling is desired.

- Clean your work area when completed and put scrap metals in the appropriate container.

8.5 Electric Welding

- A proper welding helmet, long sleeves or leather apron, long pants and leather gloves (or cotton gloves if TIG welding) are required to protect the welder and observers from eye and skin damage due to the intense ultraviolet (UV) radiation that emanates from the arc.

- Do all welding in the welding area if at all possible. Shields and fire hazard precautions will need special attention if welding in other areas.

- Check for adequate ventilation before welding.

- Welding on zinc-plated metals is hazardous to your health, and can be fatal. Do not weld on zinc-plated metal (galvanized metal). For assistance in setting up the welding equipment ask the supervisor.

- After your weld is complete, quench the work piece in water.

- Before you begin welding, you must set up the welding shields to protect others from the effects of the UV radiation on their eyes and skin.

8.6 Compressed Air

- Wear safety glasses, goggles, or face shield when using the blowgun.

- Blowing compressed air at your skin or that of others can inject air bubbles into the blood stream and cause death.

- You are responsible for insuring that your use of the air hose does not injure others, (i.e. do not blow chips at someone without eye protection), LOOK FIRST.

8.7 Sheet Metal Shear

- Follow the manufacturer's specifications as to gauge of sheet metal that can be safely cut.

- Keep fingers and measuring scales out of the way of the blade.
- Do not cut round stock or anything except sheet metal in the shear.
- Place the sheet against the guide and then clamp it in position with the clamp on the machine.
- The treadle is operated with one foot, and the other foot must be kept clear as the treadle comes down.
- Return the treadle to the up position slowly with foot pressure. Do not let it make a rapid return.
- Pick up the scrap pieces when you have completed cutting.
- Before using any wood tools you must inspect your material for foreign metal objects; such as nails, screws, staples, etc.

8.8 Wood Tools

Before using any wood tools you must inspect your material for foreign metal objects; such as nails, screws, staples, etc.

8.9 Abrasive Wheels

- Grinding wheels should be equipped with tool rests that hold the work firmly.
- Bench and pedestal grinders should be permanently mounted or secured.
- Face shields should always be used when grinding.
- The maximum RPM rating of each abrasive wheel must be compatible with the RPM rating of the grinder motor.
- Each electrically operated grinder should be effectively grounded.
- Each grinder should have an individual “On” and “Off” control switch.
- Abrasive wheels must not be stored where they would be exposed to high temperature or humidity, water or other liquids.
- Before new abrasive wheels are used they should be visually inspected and ring tested.

- Grinding of large parts, prolonged grinding, grinding of potentially toxic materials, and cutting of wheels all require mechanical exhaust ventilation.
- Defective abrasive wheels (cracked, broken, out of balance) should not be used.
- Abrasive wheels which have been discarded should not be re-used.
- Flanges should be of such design as to satisfactorily transmit the driving torque from the spindle to the grinding wheel.
- Flanges may be made of steel, cast iron, or other material of equal or greater strength and rigidity.
- Flanges shall be designed with respect to rigidity so that when tightened, the radial width of bearing surface of contact on the wheel is maintained.
- Abrasive wheels must have cover guards.

8.10 Metal-Cutting Guillotines

The following requirements apply to the safe use of metal-cutting guillotines:

- Guards must be provided to prevent the operator's fingers from contacting the knife or clamp from either the front or rear of the machine. Only one person should be allowed to operate the machine at one time and where long material is being cut and cannot be adequately supported by the worktable, additional supports should be provided.

- A hand-operated guillotine should be made inoperative when not in use either by removal of the handle or by the use of a locking or similar device.

- The shear edges of the blades should be maintained in good condition and blade clearance must be adjusted in accordance with the manufacturer's recommendation appropriate to the thickness of the material being cut.

- Waste scrap metal provides a hazard for the hands and protective gloves should be worn when the metal is handled. A container should be provided for waste material from the guillotine.

8.11 Power Hacksaws

An automatic knock-off switch should be used at all times and a regular check should be carried out to ensure it is in good order. The work must be secured, adequately supported and the length of any overhang should be clearly indicated to avoid it being a hazard to any other person.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 9

HAZARDOUS WASTE DISPOSAL

9 HAZARDOUS WASTE DISPOSAL

The purpose of environmentally sound disposal methods is to prevent harm to the water, land, and air.

9.1 Definitions of Waste

Any useless and valueless material that is to be discarded

Generator

Any person, by site, who produces municipal hazardous waste or industrial solid waste; any person who possesses municipal hazardous waste or industrial solid waste to be shipped to any other person; or any person whose act first causes solid waste to become subject to regulation

Solid waste

Any garbage, refuse, sludge from a waste treatment plant, water treatment plant, or air pollution control facility or other discarded material. Solid waste can be solid, liquid, semi-solid, or contained gaseous material resulting from industrial, municipal, commercial, mining and agricultural operations, and from community and institutional activities.

Hazardous waste

Waste that poses substantial or potential threats to public health or the environment. It is any solid waste material exhibiting the characteristics of ignitability, corrosivity, reactivity or toxicity. Tables containing the listing and characteristics of hazardous wastes are shown at the end of this chapter, Table 9.1.

Mixed waste

Mixed-waste contains both radioactive and (chemically) hazardous waste.

Disposal

The discharge, deposit, injection, dumping, spilling, or placing of any solid waste or hazardous waste (whether containerized or non-containerized) into or on any land or water so that such solid waste or any constituent thereof may enter the environment

or be emitted into the air or discharged into any water, including ground waters.

9.2 Types of Hazardous Waste

An item is considered waste when the owner determines that the material is no longer useful and needs to be discarded. An item is considered to be hazardous waste if it meets one or more of the following characteristics:

1. A chemical component is listed as hazardous by Material Safety Data Sheet (MSDS); for example, see the website, www.msds.com
2. Mixture contains a listed hazardous waste and a non-hazardous waste.
3. Material meets the definition of one of the following:
    - Ignitability (flashpoint <60°C or supports combustion)
    - Reactivity (e.g., water reactive, cyanides, explosives, unstable chemicals)
    - Corrosivity (ph<4 or >10)
    - Environmental Protection (EP) toxicity (e.g., pesticides, heavy metals, poisons)
4. Material is not excluded from regulations.

Individual lab superintendents are responsible for properly identifying the hazardous .waste they generate and for following proper disposal procedures. Refer to the MSDS tables for list of regulated hazardous chemicals. Explosives and hazardous waste are listed in appendix II and appendix III

9.3 Containers, Tags, and Collection

Proper containment, tagging, collection and disposal are essential to the success of the Hazardous Waste Program. The following sections discuss these areas.

9.3.1 Containers

Hazardous waste collection containers must be in good condition, must not leak, and must be compatible with their hazardous contents (e.g., do not use metal containers

for corrosive waste or plastic containers for organic solvents). All containers must have suitable screw caps or other secure means of closure.

If you are reusing a container to accumulate waste, destroy the original product label. EPA regulations require that waste containers be labelled with the

accumulation start date, the identity of the contents, and the words "Hazardous Waste". Use a new label to identify the hazardous waste: do not use the disposal tag for this purpose.

Important: Never overfill hazardous waste containers. Expansion and excess weight can lead to spills, explosion, and extensive environmental exposure.

Hazardous waste containers for liquids are generally rated by volume capacity. Allow extra room in liquid containers to allow for contents expansion.

- Do not fill jugs and bottles past the shoulder of the container.
- Fill closed head cans (5 gallons or less) to leave approximately two inches of space between the liquid level and the top of the container.
- Fill closed head drums (Larger than 5 gallons) to leave approximately four inches of space.

Generally hazardous waste containers for solids are rated by their weight capacity and volume capacity. Take care not to exceed the weight capacity of a solid container. Weight is generally not a problem for jars and open head cans (5 gallons or less), but it can be a problem for open head drums (larger than 5 gallons). Depending on weight requirement, you may fill containers for solids within two inches of the closure.

Important: Keep all waste collection containers closed except when adding or removing material.

9.4 Disposing of Empty Containers

The disposing of empty containers must meet the following requirements:

- Product labels must be defaced or removed.

- Container lids or caps must be removed.
- Containers must not contain free liquid or solid residue.
- Containers must be triple rinsed.
- It is not necessary to break empty glass containers.

- Punch holes in the bottom of metal containers and plastic jugs before disposing of them in the regular trash.

Important: Containers that do meet the requirements mentioned here must be treated as hazardous waste.

9.5 Reduction of Waste Source

Lab superintendent should adhere to the following techniques to reduce waste sources:

9.5.1 Purchasing and inventory control

- Tracking systems to manage purchasing and control inventory should be used.
- The current inventory records should be maintained to prevent overstocking and to monitor the shelf life of remaining materials.
- A campus-wide chemical exchange network should be developed to promote chemical sharing and avoid redundant purchases.
- Compressed gases should be obtained from vendors who accept return of empty or partially full cylinders.
- Waste generation should be considered as a criterion in equipment selection.
- Chemical stocks should be rotated in order to use chemicals before their shelf life expires.

9.5.2 Chemical usage

- Spills and waste should be reduced by pre-weighing chemicals for undergraduate use.
- Proper labeling is requiring of all secondary containers.
- All deteriorating labels should be replaced on all containers.
- The use of heavy metals should minimize (e.g., silver, chromium, mercury, barium, cadmium, and lead).
- Alcohol or electronic thermal monitors should be used instead of mercury thermometers.
- "No-Chromix", detergents, or enzymatic cleaners should be used to clean laboratory glassware.
- Solvent waste should be minimized by recycling or substitution.

9.6 Waste Minimization Techniques

Lab Superintendents should follow these techniques to reduce hazardous waste:

- Review waste streams and recommend waste minimization procedures.
- Do not mix different types of waste.
- Do not put non-hazardous waste, such as a mixture of water, sodium bicarbonate, and acetic acid, into a waste container of hazardous waste.
- Do not combine inorganic heavy metal waste with organic solvents waste.
- Segregate halogenated waste solvents from non-halogenated waste solvents.
- Segregate waste streams by storing them in separate waste containers.
- Store waste containers separate from reagent containers being used to avoid accidental contamination.
- De-contaminate empty containers to make them non-hazardous.
- Neutralize or dilute acids and bases to make them non-hazardous and suitable for drain disposal.

- When possible, redesign experimental protocols so that harmful byproducts are detoxified or reduced.
- Recycle chemicals via purification.

9.7 Waste Segregation

Many hazardous wastes, when mixed with other waste or materials, can produce effects which are harmful to human health and the environment, such as

(1) Heat or pressure,

(2) Fire or explosion,

(3) Violent reaction,

(4) Toxic dusts, mists, fumes, or gases, or

(5) Flammable fumes or gases.

Segregated waste is safer and easier to dispose of than non-segregated waste. Mixed waste as indicated above can result in severe consequences. Each lab superintendents who generates waste is personally responsible for the following:

- Ensuring that hazardous wastes are accumulated in safe, transportable containers.
- Ensuring that hazardous wastes are stored properly to prevent possible exposure.

9.8 Incompatible Waste

Given below are the examples of potentially incompatible wastes, waste components, and materials, along with the harmful consequences, which result from mixing materials in one group with materials in another group. This list is not intended to be exhaustive. A waste generator must, as the regulations require, adequately control his wastes so that he can avoid creating uncontrolled substances or reactions of the type listed below, whether they are listed below or not. It is possible for potentially incompatible wastes to be mixed in a way that precludes a reaction (e.g., adding acid to water rather than water to acid) or that neutralizes them (e.g., a strong acid mixed with a strong base), or that controls substances produced (e.g., by generating flammable gases in a closed tank equipped so that ignition cannot occur, and burning the gases in an incinerator). In the Table 9.1 below, the mixing of a Group-A material with a Group-B material

may have the potential consequence as noted.

Table 9.1 Incompatible waste and consequences upon mixing.

Group A	**Group B**	**Consequences**
1-A) Acetylene sludge, Alkaline caustic liquids, Alkaline cleaner, Alkaline corrosive liquids, Alkaline corrosive battery fluid, Caustic wastewater, Lime sludge and other corrosive alkalies, Lime wastewater, Lime and water Spent caustic	**1-B)** Acid sludge, Acid and water, Battery acid, Chemical cleaners, Electrolyte, acid, Etching acid liquid or solvent, Pickling liquor and other corrosive acids. Spent acid, Spent mixed acid, Spent sulphuric acid	**Potential consequences:** Heat generation; violent, reaction.

2-A) Aluminium, Beryllium, Calcium, Lithium, Magnesium, Potassium, Sodium, Zinc powder, Other reactive metals and metal hydrides	**2-B)** Any waste in Group 1-A or 1-B	**Potential consequences:** Fire or explosion; generation, of flammable hydrogen gas
3-A) Alcohols, Water	**3-B)** Any concentrated waste in Groups 1-A or 1-B, Calcium, Lithium, Potassium, S02CI2, SOCI2, PCI3, CH3SiCI3, Other water-reactive waste	**Potential consequences:** Fire, explosion, or heat generation; generation of, flammable or toxic gases.
4-A) Alcohols, Aldehydes, Halogenated hydrocarbons, Nitrated Unsaturated hydrocarbons, Other reactive organic compounds and solvents	**4-B)** Concentrated Group 1-A or 1- B wastes, Group 2-A wastes	**Potential consequences:** Fire, explosion, or violent reaction
5-A) Spent cyanide and sulphide solutions	**5-B)** Group 1-B wastes	**Potential consequences** Generation of toxic hydrogen cyanide or hydrogen sulphide gas
5-A) Chlorates, Chlorine, Chlorites, Chromic acid, Hypochlorites, Nitrates, Mric acid, fuming, Perchlorates, permanganates, Peroxides, Other strong oxidizers	**6-B)** Acetic acid and other organic acids, Concentrated mineral acids, Group 2-A wastes, Group 4-A wastes, Other flammable and combustible wastes	**Potential consequences:** Fire, explosion, or violent reaction

Source: "Law, Regulations, and Guidelines for Handling of Hazardous Waste." California Department of Health, February 1975.

9.9 Segregation Classification

In addition to the guidelines for waste minimization and substitution, follow these guidelines for waste segregation:

- Segregate waste into the following groups:
  - Halogenated solvents
  - Non-halogenated solvents
  - Acids
  - Bases
  - Heavy metals
  - Poisons
  - Reactives
- Do not mix non-hazardous waste, such as water, with hazardous waste.
- Do not combine inorganic heavy metal waste with organic solvent waste in hazardous waste containers.
- Double-bag dry materials contaminated with chemicals (paper, rags, towels, gloves, etc.) in heavy-duty plastic bags. Do not use biohazard bags. Dispose of these items in the same manner as hazardous waste.
- Encapsulate sharps (e.g., needles, razor blades, etc.) then place them in trash dumpsters.

9.10 Special Concerns

Persons who generate hazardous waste must maintain and control their hazardous waste accumulation areas. Special concerns for hazardous waste include the following:

- Unneeded chemicals that are to be discarded must be handled and managed as hazardous waste.
- Gas cylinders are extremely difficult to discard. They should be returned to the manufacturer or distributor whenever possible. Cylinders that cannot be returned should be tagged as hazardous waste as soon as possible.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any delay.

Chapter 10

SAFETY TRAINING

10 SAFETY TRAINING

10.1 Information and Training Program

The Govt. Engineering College Trichur requires that all individuals that work in laboratory are adequately informed about the physical and health hazards present in the laboratory, the known risks and what to do if an accident occurs.

Every laboratory/workshop worker must be trained to know the location and proper use of available personal protective clothing and equipment. See chapter 4 of this manual for information on the use of personal protective clothing and equipment. The laboratory superintendent and/or technician is/are responsible for providing information to his or her superior personnel and EHS Committee about any hazards present in the lab or workshop. This information must be provided at the time of a lab or workshop person's initial assignment and prior to any assignments involving new potential hazards situation. The following lists the information that should be provided by the lab superintendent and technician.

- The location and availability of this manual.

- The Occupational Safety and Health Administration (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories standard http://www.osha.gov/

- The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets (MSDS) received from the chemical supplier.

- The Permissible Exposure Limits (PEL) for Occupational Safety and Health Administration (OSHA) regulated substances or recommended exposure limits (for example, Threshold Limit Value- TLV) for other hazardous chemicals where there is no applicable OSHA standard (see OSHA Permissible Exposure Limits of some common laboratory chemicals). Other significant values may be found on the appropriate MSDS.

- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.

- Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as continuous monitoring devices, and visual appearance or odor of hazardous chemicals when being released);
- The physical and health hazards of chemicals in the work area.
- The applicable details of this manual.

Lab superintendents and technicians must be re-trained when new equipment or chemical hazards are introduced into their workplace, as well as upon reassignment to different workplaces that involve new equipment or chemical hazards. The lab superintendent or technician must conduct site-specific training. Basic safety training is required for all employees of the College, including faculty, staff, and students who have the potential for exposure to hazardous chemicals. Training is required before the employee can be assigned work in or around hazardous chemicals. The training takes approximately one hour and includes:

- Central requirements of the basic, including training, chemical labels, and Material Safety Data Sheets (MSDS);
- Spill clean-up and chemical disposal procedures;
- Chemical storage guidelines; and
- Hazards specific to different chemical groups.

10.2 Laboratory Safety Training

Laboratory safety training is required for all employees of the College, including faculty, staff, and students who may work in a laboratory that contains hazardous equipment or using hazardous chemicals or biological materials. This training must be received prior to the beginning of a laboratory assignment. The training takes approximately one hour and should include:

- Safety equipment and practices.
- Emergency procedures.
- Emergency equipment.
- Waste disposal.

10.3 Fire Extinguisher Training

Fire extinguisher training, with live fire suppression, is required for all laboratory superintendents, technicians. This training covers what to do in the event of a fire, the behaviour of fire and how it spreads, the classes of fires, and the proper selection and use of a fire extinguisher. This training program will familiarize laboratory workers with the general principles of fire extinguisher use; give them confidence in their ability to operate the extinguisher; and remove some of the fear associated with putting out a fire by showing them that fire extinguishers do work in putting out fires. The safety committee should plan once a year for a fire drill (fire fighting work shop).

10.4 Waste Management Training

Waste management training is required for selected employees of the College, including faculty, staff, who are in laboratory supervisory positions where hazardous chemicals are in use. All staff members that have any coordination responsibilities for teaching labs must receive this training. Every teaching lab must have one or more individuals who have received this training and are responsible for following the procedures included in the training.

- Hazardous waste definitions and regulatory environment.
- Spill clean-up and chemical waste disposal procedures.
- Chemical waste storage and segregation guidelines.
- Waste minimization and drain disposal.

In the case of occurrence of any accident/ injury, take necessary emergency action (refer page no. 5 for emergency contact numbers) and then report the incident to Environmental Health and Safety Committee (EHSC) without any de

APPENDIX

APPENDIX I

Indian Standard

FIRE SAFETY IN EDUCATIONAL INSTITUTIONS — CODE OF PRACTICE

1 SCOPE

This code covers the fire safety requirements in educational institutions.

2 NORMATIVE REFERENCES

The Indian Standards listed in Annex A contain provisions which, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards are given in Annex A.

3 CLASSIFICATION

3.1 For the purpose of the standard, the classification of educational buildings should be as given in **3.1.1**.

3.1.1 All buildings shall be classified according to the use or the character of occupancy and shall be in accordance with IS 1641.

Buildings and structures under Group B shall be further subdivided as follows:

a) *Subdivision B-1 schools up to higher secondary level*
This subdivision shall include any building or a group of buildings under single management which is used for students not less than 20 in number.

b) *Subdivision B-2 all others/training institutions*
This subdivision shall include any building or a group of buildings under single management which is used for students not less than 100 in number.

NOTE — If residential accommodation is provided in the schools/institutions, it should be classified as building in subdivision **A-3**.

4 TYPES OF CONSTRUCTION

4.1 All educational buildings of permanent nature shall be of Type I construction having external shell and load bearing elements of 4 h fire resistance rating, while internal/non load bearing walls shall have 2 h fire resistance rating. Floors shall have same fire resistance as that of external shells, and false ceiling, if any shall have rating as laid down in IS 1642. Basements, if constructed should not be used for classrooms or laboratories/libraries and assembly halls.

4.2 All educational buildings not of permanent nature, may have constructions conforming to Type II or Type III construction as per IS 1642. All such buildings shall be restricted to ground and one upper floor only and the floor area not exceeding to 1 000 m^2 on each floor.

NOTE — Temporary structures such as tents or with thatched construction should not be allowed for housing educational institutions.

5 OCCUPANT LOAD

5.1 Occupant load shall be in accordance with IS 1644.

6 ARRANGEMENT OF EXIT

6.1 Exits from the upper floor should be so located that no point in the floor is more than 22.5 m from the nearest exit, for the Type I , Type II and Type III construction.

NOTE — Type IV construction is not allowed for construction of educational buildings.

6.2 Exits should be so arranged that at least two separate exits are available in every floor area. Exits shall be as remote from each other as practicable and so arranged that there are no pockets or dead ends of appreciable size in which occupants may be trapped.

6.3 Every room with a capacity of 45 persons in area shall have at least two doorways.

6.4 Elevators, lifts and escalators shall not be counted as exits.

6.5 Fire escapes constitute only means of the required exit and should not be taken into account in calculating the evacuation time of the building. Fire escapes shall always be kept in sound operating conditions.

7 CORRIDOR AND PASSAGE WAYS

7.1 Exit corridors and passage ways shall be of width not less than the aggregate required width of exit doorways leading from them in the direction of travel to the exterior.

7.2 Where stairways discharge through corridors and passageways, the height of corridors and passageways shall be not less than 2.4 m.

7.3 All internal staircase, lift, lobbies and corridors should be adequately ventilated and illuminated.

8 DOORWAYS

8.1 No exit doorway shall be less than 1 m in width except assembly halls where door width should not be less than 2 m.

8.2 The height of door shall not be less than 2 m.

8.3 These shall be opening outwardly.

8.4 Overhead or sliding door shall not be installed.

NOTE — In case of buildings where there is Central Corridor the door shall open inwards to allow smooth flow of traffic in the corridor.

8.5 These shall be openable from inside and shall not be opening immediately on flight.

9 STAIRCASE

9.1 Any building having area more than 500 m^2 on each floor and 15 m or more in height shall have minimum two staircases of enclosed type; at least one of these shall be on external wall and shall directly open to exterior, interior open space or to an open place of safety. Further the provision or otherwise of alternative staircase shall be subject to the requirements of travel distance being complied with.

9.2 Internal Staircases

9.2.1 Internal stairs shall be constructed of non-combustible materials throughout. Hollow combustible construction shall not be permitted.

9.2.2 Internal staircases shall be constructed as a self-contained unit with an external wall constituting at least one of its sides and shall be completely enclosed.

9.2.3 Staircase shall not be arranged round a lift shaft.

9.2.4 No gas piping shall be laid in the stairway.

9.2.5 Notwithstanding, the detailed provision for exits in the educational buildings, the width of staircase shall not be less than 1.5 m up to a height of 30 m.

NOTE — Buildings above 30 m height are not permitted.

9.2.6 Minimum width of treads shall not be less than 300 mm. The treads should be constructed and maintained in a manner to prevent slipping.

9.2.7 Maximum height of riser shall not be more than 150 mm and number shall be limited to 15 per flight.

9.2.8 Height of railing shall be more than 1 m. Gap between verticles should not exceed 200 mm. The gap should be reduced to 150 mm where small children are likely to use the staircase.

9.2.9 The number of people in between floor landings in staircase shall not be less than the population on each floor for the purpose of design of staircase.

The other main parameters for the design of staircase are as given below:

a) The minimum head room in a passage under the landing of a staircase and under the staircase shall be 2.2 m.

b) For building 15 m in height or more, access to main staircase shall be through a fire smoke check door or 1 h fire resistance rating. Fire resistance rating may be reduced to half an hour for residential buildings.

c) No living space, store or other fire risk shall open directly into the staircase or staircases.

d) External exit door of staircase enclosure at ground level shall open directly to the open spaces or through a draught lobby, if necessary.

e) The main staircase and external staircase shall be continuous from ground floor to the terrace level.

f) No electrical shafts/AC ducts or gas pipe, etc, shall pass through the staircases. Lift shall not open in staircase.

g) No combustible material shall be used for decoration/ wall panelling in the staircase.

h) Beams/columns and other building feature shall not reduce the head room/width of the staircase.

j) The exit sign with arrow indicating the way to the escape route shall be provided at a suitable height from the floor level on the wall and shall be illuminated by electric light connected to corridor circuits. All exit way marking signs shall be flush with the wall and so designed that no mechanical damage shall occur to them due to moving of furniture or other heavy equipments. Further, all landings of floor shall have floor indicating boards prominently indicating the number of floor as per bye-laws.

The floor indication board shall be placed on the wall immediately facing the flight of stairs and nearest to the landing. It shall be of size not less than 0.5 × 0.5 m.

k) Individual floors shall be prominently indicated on the wall facing the staircases.

m) In case of single staircase it shall terminate at the ground floor level and the access to the basement shall be by a separate staircase. However, the second staircase may lead to basement levels provided the same is separated at ground level by ventilated lobby with discharge points to two different ends through enclosures.

9.3 External Stairs

9.3.1 All external stairs shall be directly connected to the ground.

9.3.2 Entrance to the external staircases shall be separate and remote from the internal staircase.

9.3.3 Care shall be taken to ensure that no wall opening or window opens on to or close to a external staircase.

9.3.4 The route to the external stairs shall be free from obstructions at all times.

9.3.5 The external staircase shall be constructed of non-combustible materials, preferably of masonry and any doorway leading to it should have the required fire resistance.

9.3.6 No external staircase, used as a fire escape, should be inclined at an angle greater than 45^{o} to the horizontal.

9.3.7 External stairs shall have straight flight not less than 1 m wide with 200 mm treads and risers not more than 190 mm. The number of risers shall be limited to 15 per flight.

9.3.8 Hand rails shall be of a height not less than 1 m and not exceeding 1.2 m.

9.4 In case the educational building has got a mixed occupancy such as auditorium, etc, necessary recommendations for exits as per the requirements as given in SP 7 : 1983 shall be followed.

10 AIR CONDITIONING

10.1 In some educational institutions, a part of it may be having air conditioning arrangement. In case of room air conditioning, no extra precautions than laid down are required. In cases, like auditorium and laboratories having central air conditioning system, the measures as laid down in IS 1642 should apply.

11 CHIMNEYS

11.1 Where chimneys are used, the requirements shall be as laid down in IS 1642 and IS 1649.

12 RESTRICTION OF SPREAD OF FIRE AND SMOKE

12.1 The vertical shafts/ducts meant for electrical wiring, drainage pipes, etc, shall be effectively sealed at all floor levels and shall be enclosed by 2 h fire resistance enclosures. Wherever inspection doors are required, these shall be of not less than 1 h fire resistance.

12.2 The material chosen for other use shall be as far as non-combustible and the wood/other material shall be treated with fire retardant composition if its use is unavoidable.

12.3 The laboratories which are likely to have highly flammable material/chemicals, etc, should be located in separate block and adequate precautions shall be taken to have separate stores for keeping hazardous chemicals.

12.4 The adequate care shall be taken while using any gas for burners, etc, in laboratory/kitchens and necessary precaution shall be taken for storage of gas in form of bullet, tanks, battary or cylinders, etc, as per rules.

13 ELECTRICAL EQUIPMENT AND SAFETY RULES

13.1 Transformer building/HT and LT control panels having aggregate oil capacity greater than 2 000 litres shall be housed in separate rooms/enclosures 6 m away, properly fenced.

13.2 Staircases and corridors lighting shall have separate circuits.

13.3 Miniature Circuit Breakers/Earth Leakage Circuit Breakers shall be provided in the circuits.

13.4 Earth connection shall be provided in building which are 15 m or more in height.

13.5 The lighting protection system for the buildings shall generally conform to IS 2309.

14 FIRE SAFETY MEASURES

14.1 The requirements of wet riser, down comer installations and capacity of water storage tanks and fire pumps should be as given below:

a) For buildings less than 15 m in height:

Installations	*Minimum Requirements*
Hose reel	To be provided (For more than 2 storeyed buildings and covered area exceeding 1 000 m^2)
Wet riser	—
Down comer	To be provided
Yard hydrant	—
Automatic sprinkler system	To be provided (In case of the buildings having basement area 200 m^2 and more)
Manually operated electric fire alarm system	—

Installations	*Minimum Requirements*
Automatic detection and alarm system	—
Underground static water storage tank	50 000 l (If total covered area exceeds 1 500 m^2)
Terrace tank	10 000 l (In case of hose reel and 20 000 l in case the buildings having basement area 200 m^2 and more
Near underground static tank, (fire pump with) minimum pressure of 0.3 N/mm^2 at terrace level	One electric pump and one diesel pump of capacity 1 620 l/min and one electric pump of capacity 180 l/min
Pump at terrace level with minimum pressure of 0.3 N/mm^2	450 l/min, in case of hose reel (900 l/min in case of hose reel and in case the buildings having basement area 200 m^2 and more)

b) 15 m and above but not exceeding 30 m in height

Installation	*Minimum Requirements*
Hose reel	To be provided
Wet riser	To be provided
Down comer	To be provided
Yard hydrant	To be provided
Automatic sprinkler system	To be provided (In case the building is having a basement area 200 m^2 and more)
Manually operated electric fire alarm system	To be provided
Automatic detection and alarm system	Not to be provided
Under ground static water storage tank	10 000 l for every 100 m^2 with a minimum of 5 000 l up to maximum of 1 00 000 l
Terrace tank	20 000 l (30 000 l in case of the buildings having basement area 200 m^2 and more)
Near underground static tank, fire pump with minimum pressure of 0.3 N/mm^2 at terrace level	One electric and one diesel pump of capacity 2 850 l/min and one electrical pump of capacity 180 l/min)
Pump at terrace level with minimum pressure of 0.3 N/mm^2	900 l/min (1 620 l/min in case the buildings having basement area 200 m^2 and more)

14.2 Fire Detection and Alarm System

If automatic fire detection and alarm system is employed, the installation shall conform to IS 2189. The detectors, if provided, shall conform to IS 2175 and IS 11360.

14.3 First aid fire fighting appliances shall be provided and installed and maintained in accordance with IS 2190.

15 EMERGENCY AND ESCAPE LIGHTING

15.1 Emergency lighting shall be powered from a source independent of that supplying normal lighting.

15.2 The emergency lighting shall be provided to be put on within 5 second (preferably within 1 second) of the failure of the normal lighting supply.

15.3 Emergency lighting luminaries and their fittings shall be non-flammable.

15.4 It is essential that the wiring and installations of the emergency lighting systems are of high quality so as to ensure their perfect serviceability at all times.

15.5 The emergency lighting system shall be capable of continuous operation for a minimum duration of 1 h 30 min even for smallest premises.

15.6 It shall be ensured that the emergency lighting system is well maintained by periodical inspections and tests so as to ensure their perfect serviceability at all times.

15.7 Escape lighting shall be capable of:

a) Indicating clearly and unambiguously the escape routes,
b) Providing adequate illumination along such routes to allow safe movement of persons towards and through exit, and
c) Ensuring that fire alarm call point and fire-fighting equipments provided along the escape routes can be readily located.

15.8 Escape lighting luminaries shall be sited to cover the following locations:

a) Near each intersection of corridors,
b) At each exit door,
c) Near each change of direction in the escape route,
d) Near each staircases so that each flight of stair receives direct light,
e) Near any other change of floor level,
f) Outside each final exit and close to it,
g) Near each fire alarm call point,
h) Near fire-fighting equipment, and
j) To illuminate exit and safety signs as required by the enforcing authority.

NOTE — For the purpose of this clause 'near' is normally considered to be within 2 m measured horizontally.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
1641 : 1988	Code of practice for fire safety of buildings (general): General principles of fire grading and classification (*first revision*)	2189 : 1988	Code of practice for selection, installation and maintenance of automatic fire detection and alarm system (*second revision*)
1642 : 1989	Code of practice for fire safety of buildings (general): Details of construction (*first revision*)	2190 : 1992	Code of practice for selection, installation and maintenance of portable first-aid fire extinguishers (*third revision*)
1644 : 1988	Code of practice for fire safety of buildings (general): Exit requirements and personal hazard (*first revision*)	2309 : 1989	Code of practice for the protection of buildings and allied structures against lighting (*second revision*)
1649 : 1962	Code of practice for design and construction of flues chimneys for domestic heating appliances (*first revision*)	11360 : 1985	Specification for smoke detectors for use in automatic electrical fire alarm system
2175 : 1988	Specification for heat sensitive fire detectors for use in automatic fire alarm system (*second revision*)	SP 7 : 1983	National building code of India: Part IV Fire protection

APPENDIX II

List Of Explosives

Ammonium nitrate-fuel oil mixture.

Ammonium nitrate, (with more than 0.2 percent combustible substances) Ammonium perchlorate.

Ammonium picrate, (dry or wetted with less than 10 percent water, by mass) Azodiisobutyroitrile.

Barium azide (dry or wetted with less than 50 percent water, by mass) Barium styphnate.

Cyclotetramethylenetetranitramine, desensitized (or) Octogen, desensitized (or) HMX, desensitized.

Cyclotetramethylenetetranitramine, wetted (or) HMX, wetted (or) Octogen, wetted (with not less than 15 percent water, by mass).

Cyclotrimethylenetrinitramine, desensitized (or) Cyclonite, desensitized (or) Hexogen desensitized (or) RDX, desensitized, Hexogen, RDX, desensitized

Cyclotrimethylenetrinitramine, wetted (or) Cyclonite, wetted (or) Hexogen, wetted (or)RDX, wetted (with not less than 15 percent water, by mass).

Deflagrating metal salts of aromatic nitro derivatives.

2-Diazo-1 -Naphthol-4-S ulpho chloride.

2-Dtazo-l -Naphthol-S-SuIpho-ChIoride.

Diazodinitrophenol, wetted with not less than 40 percent water or mixture of alcohol and water, by mass.

Diethyleneglycoldinitrate, desensitized (with not less than 25 percent non-volatile water insoluble phlegmatizer, by mass.

Dinitroglycoluril (or) Dingu.

Dinitrophenol, (dry or wetted with less than 15 percent water, by mass).

Dinitrophenolates (alkali metals, dry or wetted with less than 15 percent water, by mass).

Dinitroresorcinol, (dry or wetted with less than 15 percent water, by mass).

N,N'-Dinitroso-N-N'-dimethyl terephthalamide not more than 72% is a paste.

N,N'-Dinitrosopentamethylenetetraamine not more than 82% with phlegmetizerDinitrosobenzene.

Dipicryl sulphide, (dry or wetted with less than 10 percent water, by mass).

Guanylnitrosaminoguanylidene hydrazine, wetted (with not lesl than 30 percent water,by mass).

Guanylnitrosaminoguanyltetrazene, wetted (or) Tetrazane, wetted (with not less than 30 percent water or mixture of alcohol and water, by mass).

Hexanitrodiphenylamine (Dipicrylamine; Hexyl)

Hexanitrostilbene

Hexatonal, cast

Hexolite, (dry or wetted with less than 15 percent water, by mass).

Lead azide, wetted (with not less than 20 percent water or mixture of alcohol and water by mass).

Lead mononitroresorcinate.

Lead styphnate, wetted (or) Lead trinitroresorcinate,.wetted (with not less than 20 percent water or mixture of alcohol and water, by mass).

Mannitol hexanitrate (Nitromannite), wetted (with not less than 40 percent water, bymass or mixture of alcohol and water).

5-Mercaptotetrazol-1 -acetic acid.

Mercury fulminate, wetted (with not less than 20 percent water, or mixture of alcohol and water, by mass.

Nitro urea.

5-Nitrobenzotriazol.

Nitrocellulose (dry or wetted with less than 25 percent water [or alcohol], by mass).

Nitrocellulose, plasticized (with not less than 18 percent plasticizing substance, by mass).

Nitrocellulose, (unmodified or plasticized with less than 18 percent plasticizing substance, by mass).

Nitrocellulose, wetted (with not less than 25 percent alcohol, by mass).

Nitroglycerin, desensitized (with not less than 40 percent non-volatile water in soluble phlegmatizer, by mass).

Nitroglycerin, solution in alcohol, (with more than 1 percent but not more than 10 percent nitrogylcerin).

Nitroguanidine (or) Picrite, (dry or wetted with less than 20 percent water, by mass).

Nitrosoguanidine.

Nitrostarch (dry or wetted with less than 20 percent water, by mass).

Nitrotriazolone (or) NTO

Octolite (or) Octol, (dry or wetted with less than 15 percent water, by mass).

Pentaerythritetetranitrate (or) Pentaerythritoltetranitrate (or) PETN, wetted (with not less than 25 percent water, by mass (or) Pentaerythritetetranitrate (or) Pentaerythritoltetranitrate (or) PETN, desensitized (with not less than 15o/o Phlegmetizer).

Pentaerythritetetranitrate (or) Pentaerythritoltetranitrate (or) PETN, (with not less than 7 percent wax by mass).

Pentolite, (dry or wetted with less than 15 percent water, by mass).

Potassium salts of aromatic nitro-derivatives, explosive.

RDX and HMX mixtures, wetted (with not less than 15 percent water by mass) (or) RDX and HMX mixtures, desensitized (with not less than 10 percent phlegmatizer by mass).

Sodium dinitro-o-cresolate, (dry or wetted with less than 15 percent water, by mass).

Sodium picramate, (dry or wetted with less than 20 percent water, by mass).

Sodium salts of aromatic nitro-derivatives, explosive.

Tetranitroaniline.

Tetrazol-1 -acetic acid.

Trinitro-meta-cresol.

Trinitroaniline (or) Picramide.

Trinitroanisole.

Trinitrobenzene, (dry or wetted with less than 30 percent water, by mass).

Trinitrobenzenesulphonic acid.

Trinitrobenzoic acid, (dry or wetted with less than 30 percent water, by mass).

Trinitrochlorobenzene (or) Picryl chloride.

Trinitrofluorenone.

Trinitronaphthalene

Trinitrophenetole.

Trinitrophenol (or) Picric acid, (dry or wetted with less than 30 percent water, by mass).

Trinitrophenylmethylnitramine (or) Tetryl

Trinitroresorcinol (or) Styphnic acid, (dry mixture of alcohol and water, by mass).

or wetted with less than 20 percent water, or

Trinitrotoluene and Trinitrobenzene mixtures (or) Trinitrotoluene (o0 TNT and trinitrobenzene mixtures (or) TNT and hexanitrostilbene mixtures and Hexanitrostilbene mixtures.

Trinitrotoluene mixtures containing Trinitrobenzene and Hexanitrostilbene (or) TNT mixtures containing trinitrobenzene and hexanitrostilbene.

Trinitrotoluene (or) TNT, (dry or wetted with less than 30 percent water, by mass)

Tritonal.

Urea nitrate, (dry or wetted with less than 20 percent water, by mass).

Zirconium picramate, (dry or wetted with less than 20 percent water, by mass).

APPENDIX III
Definition of Hazardous Waste

In addition to a number of "listed" solvents, acutely hazardous, and extremely hazardous substances, chemical wastes may be regulated as hazardous by the Environmental Protection Agency if they exhibit any of the following characteristics:

Ignitability

A waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

- It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, and has flash point less than 60"C (140"F), as determined by a Pensky-Martens Closed Cup Tester or a Seta Flash Closed Cup Tester, or as determined by an equivalent test method approved by the EPA.
- 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.
- It is an ignitable compressed gas.
- It is an oxidizer.

Corrosivity

A waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

- It is aqueous and has a pH less than or equal to 2, or greater than or equal to 12.5, as determined by a pH meter using either an EPA test method or an equivalent test method approved by the EPA.
- It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55"C (130'F), or in an equivalent test method approved by the EPA.

Reactivity

A waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

- lt is normally unstable and readily undergoes violent change without detonating, e.g. explosive polymerization.
- lt reacts violently with water.
- lt forms potentially explosive mixtures with water.
- When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
- lt is a cyanide or sulphide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors , or fumes in a quantity sufficient to present a danger to human health or the environment.
- It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
- It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure. .
- lt is a forbidden explosive, a Class A explosive, or a Class B explosive.

Toxicity

A waste exhibits the characteristic of toxicity if a representative sample of the waste hasany of the following properties

- Any chemical at the right dose could be toxic to humans. However, there are some chemicals that are known to be hazardous at very low concentrations, over a very short exposure time, or after repeated exposures. These chemicals are the toxins, poisons, and carcinogens.
- A toxin may be mutagenic and cause a heritable change in the gene structure or may also be teratogenic and cause a malformation of an embryo. Pregnant women and persons in their childbearing years should not work with or, at a minimum, use extreme caution while handling these materials.
- The toxicity of a material is due to its ability to interfere with the metabolism of living tissue. An acute toxin can cause an adverse effect after a single or short duration exposure. A chronic toxin causes an adverse effect after repeated exposures, after a long duration single exposure, or after a long latency period. Carcinogens are examples of chronic toxins that have a long latency period before the effects of the exposure are observed. See Table 11.1, which follows for a list of toxic substances.

Table 11.1: Toxicity characteristic constituents

Arsenic Barium Benzene Cadmium Carbon tetrachloride Chlordane Chlorobenzene Chloroform Chromium o-Cresol m-Cresol p-Cresol Cresol 2,4-D	1,4-Dichlorobenzene 1,2-Dichloroethane 1,1-Dichloroethylene 2,4-Dinitrotoluene Endrin 72-20-8 Heptachlor (and its epoxide) Hexachlorobenzene Hexachlorobutadiene Hexachlorethane 1 Lead Lindane Mercury	Methoxychlor Methyl ethyl ketone Nitrobenzene Pentrachlorophenol Pyridine Selenium Silver Tetrachloroethylene Toxaphene Trichloroethylene 2,4,*Trichlorophenol 2,4,6-Trichlorophenol 2,4,*TP (Silvex) Vinyl chloride
Toxicity: A waste exhibits the characteristic of toxicity if the extract from a representative sample of the waste contains any of the contaminants listed in Table-I at a concentration equal to or greater than the respective regulatory level. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this section.		

APPENDIX IV

Chemicals used in the laboratory of an engineering institution

Sodium Hydroxide

IMPORTANT PROPERTIES

PHYSICAL APPEARANCE	Viscous liquid and flakes
COLOR	Colorless to slightly colored
BOILING POINT	145°C (50%)
UPPER EXPLOSIVE LIMIT	Non-flammable
L***OWER EXPLOSIVE LIMIT***	Non-flammable
CHEMICAL REACTIVITY	Stable
FLAMMABILITY OF THE PRODUCT	Non-flammable.

HEALTH HAZARDS

Very hazardous in case of skin contact, of eye contact (irritant, corrosive), of ingestion, of inhalation. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

FIRST AID

Eye Contact: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes .Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Get medical attention immediately.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention. Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation.

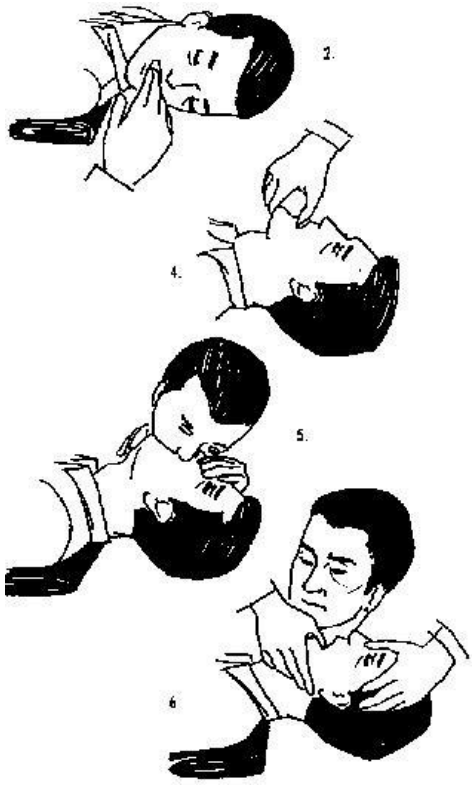

Fig 11.1 Artificial Breathing

CARDIO PULMONARY RESUSCITATION:

1. **CALL:**Check the victim for unresponsiveness. If the person is notresponsive and not breathing or not breathing normally. Call Emergency number and return to the victim. If possible bring the phone next to the person and place on speaker mode.

2. **PUMP:**If the victim is still not breathing normally, coughing ormoving, begin chest compressions. Push down in the center of the chest 2-2.4 inches 30 times. Pump hard and fast at the rate of 100 - 120/minute, faster than once per second.

3. **BLOW:** Tilt the head back and lift the chin. Pinch nose and cover themouth with yours and blow until you see the chest rise. Give 2 breaths. Each breath should take 1 second. It is shown in fig 11.xx CONTINUE WITH 30 PUMPS AND 2 BREATHS UNTIL HELP ARRIVES

WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Oxalic Acid

IMPORTANT PROPERTIES

PHYSICAL APPEARANCE	Solid Powder, dust Granular
COLOR	White
BOILING POINT	149-160°C (300-320°F)
CHEMICAL REACTIVITY	Stable under normal temperature conditions and recommended use
TOXIC DOSE 1 - LD 50	7500 mg/kg (oral rat)

HEALTH HAZARDS

Skin Contact: Skin contact may cause irritation with symptoms of redness,swelling, itching and pain.

Eye Contact: Eye contact may cause irritation with symptoms of redness,swelling, itching and pain. May cause corneal injury.

Inhalation: Inhalation of Oxalic Acid produces irritation of respiratory tract,cough and vomiting

PERSONAL PROTECTION

Eyes: Use chemical safety goggles or eyeglasses. A face shield may also benecessary. Maintain eye was fountain and safety showers in the immediate work area.

Skin: Wear impervious protective clothing including apron, boots and rubbergloves as appropriate.

Ventilation: Use local ventilation if dusting is a problem, to maintain air levelsbelow the recommended exposure limit.

FIRST AID

Eyes: In case of contact, immediately flush eyes with plenty of water for at least15 minutes. Get medical aid immediately.

Skin: In case of contact, immediately flush skin with plenty of water for at least15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.

Inhalation: If inhaled, remove to fresh air. If not breathing give artificialrespiration. If breathing is difficult give oxygen. Get medical aid immediately

FIRE AND EXPLOSION HAZARDS

Oxalic Acid is combustible below 101°C (215 °F). Decomposition products include carbon monoxide and formic acid which are toxic and flammable. Reacts explosively with strong oxidizing materials and some silver compounds.

Sodium thio sulphate

IMPORTANT PROPERTIES

PHYSICAL	*Solid Powder, dust*
APPEARANCE COLOR	*Granular White*
BOILING POINT	*100 deg C (212.00°F)*
UPPER EXPLOSIVE LIMIT	*Not available*
LOWER EXPLOSIVE LIMIT	*Not available*
CHEMICAL REACTIVITY	Stable under normal temperature conditions and recommended use.

HEALTH HAZARDS

Eye: May cause eye irritation.

Skin: May cause skin irritation. May be harmful if absorbed through the skin.

Ingestion:

May cause irritation of the digestive tract.May be harmful if swallowed.**Inhalation:** May cause respiratory tract irritation. May be harmful if inhaled. **Chronic**: Prolonged or repeated skin contact may cause dermatitis.

PERSONAL PROTECTION

Eyes: Wear chemical splash goggles.

Skin: Wear appropriate protective gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

FIRST AID

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the up per and lower eyelids. Get medical aid.

Skin:

Get medical aid. Flush skin with plenty of water for at least 15 minutes while rem oving contaminated clothing and shoes.

Ingestion: Get medical aid. Wash mouth out with water. Inhalation:

Remove from exposure and move to fresh air immediately. Get medical aid.

FIRE AND EXPLOSION HAZARD

Fire: Not considered to be a fire hazard.

Explosion: Not considered to be an explosion hazard.

Carbon Tetra Chloride

IMPORTANT PROPERTIES

PHYSICAL	Liquid
APPEARANCE COLOR	Clear, colorless
BOILING POINT	76 deg C @ 760 mm Hg
UPPER EXPLOSIVE LIMIT	No data available
LOWER EXPLOSIVE LIMIT	No data available
CHEMICAL REACTIVITY	Stable under normal temperature conditions and recommended use.

HEALTH HAZARDS

INHALATION: irritation, digestive disorders, headache, drowsiness, dizziness,loss of Co-ordination, lung congestion, effects on the brain, convulsions, coma **SKIN CONTACT:** irritation, rash, absorption may occur, digestive disorders,headache, drowsiness, dizziness, loss of coordination, lung congestion, effects on the brain, convulsions, and coma.

EYE CONTACT: irritation

INGESTION: irritation, digestive disorders, headache, drowsiness, dizziness,loss of coordination, lung congestion, effects on the brain, convulsions, coma

FIRST AID

Inhalation: If adverse effects occur, remove to uncontaminated area. Giveartificial respiration if not breathing. Get immediate medical attention.

Skin contact: Wash skin with soap and water for at least 15 minutes whileremoving contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

Eye contact: Flush eyes with plenty of water for at least 15 minutes. Then getimmediate medical attention.

Ingestion: If swallowed, drink plenty of water, do NOT induce vomiting. Getimmediate medical attention. Induce vomiting only at the instructions of a physician. Do not give anything by mouth to unconscious or convulsive person.

PERSONAL PROTECTION

Eye/face protection Face shield and safety glasses Use equipment for eyeprotection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

SKIN PROTECTION

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

FIRE AND EXPLOSION HAZARDS: Slight fire hazard.
EXTINGUISHING MEDIA: regular dry chemical, regular foam, water

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk.Fight large fires from a protected location or safe distance. Stay away from the ends of tanks. dike for later disposal. Do not scatter

Hydrochloric acid

IMPORTANT PROPERTIES

PHYSICAL APPEARANCE	Liquid
COLOR	Clear, colorless
BOILING POINT	76 deg C @ 760 mm Hg (168.80*f*F)
UPPER EXPLOSIVE LIMIT	No data available
LOWER EXPLOSIVE LIMIT	No data available
CHEMICAL REACTIVITY	Stable under normal temperature conditions and recommended use.

TOXIC DOSE TOXICITY:

LD50 (ORAL-RAT)(MG/KG)	2800
LD50 (ORAL-MOUSE)(G/KG)	12.8
LD50 (IPR-RAT)(MG/KG)	1500
LD50 (SKN-RAT) (MG/KG)	5070

HEALTH HAZARDS

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion The substance may be toxic to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System,

teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation.

PERSONAL PROTECTION

Ventilation: *Provide local exhaust, preferably mechanical.*

Respiratory protection*: If necessary use an approved respirator with acid vaporcartridges.*

Eye protection*: Wear chemical safety glasses with a face shield for splashprotection.*

Skin and body protection: Wear neoprene or rubber gloves, apron and other protective clothing appropriate to the risk of exposure.

FIRST AID

Eye Contact: Check for and remove any contact lenses. In case of contact,immediately flush eyes with plenty of water for at least 15minutes. Cold water may be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water forat least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion: If swallowed, do not induce vomiting unless directed to do so bymedical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

FIRE AND EXPLOSION HAZARDS

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks

Potassium Hydroxide

IMPORTANT PROPERTIES

PHYSICAL APPEARANCE	,	Liquid
COLOR		Clear to slightly turbid

BOILING POINT	271 - 293 F
UPPER EXPLOSIVE LIMIT	No data available
LOWER EXPLOSIVE LIMIT Chemical Stability**:**	No data available Stable. Readily absorbs carbon dioxide and moisture from the air and deliquesces.

HEALTH HAZARDS

Eye: Causes severe eye burns. May cause irreversible eye injury. Contact maycause ulceration of the conjunctiva and cornea. Eye damage may be delayed.

Skin: Causes skin burns. May cause deep, penetrating ulcers of the skin.

Ingestion: Harmful if swallowed. May cause circulatory system failure.Maycause perforation of the digestive tract. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.

Inhalation: Harmful if inhaled. Irritation may lead to chemical pneumonitis andpulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.

Chronic: Prolonged or repeated skin contact may cause dermatitis. Prolonged orrepeated eye contact may cause conjunctivitis.

PERSONAL PROTECTION

Eyes:Chemical goggles, full-face shield, or a full-face respirator is to be worn atall times when product is handled. Contact lenses should not be worn; they may contribute to severe eye injury.

Respiratory: If engineering controls and work practices are not effective incontrolling exposure to this material, then wear suitable personal protective equipment including approved respiratory protection.

Gloves: Impervious gloves of chemically resistant material (rubber or PVC)should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse.

Clothing: Body suits, aprons, and/or coveralls of chemical resistant material should be worn. Wash contaminated clothing and dry thoroughly before reuse.

Footwear: No special footwear is required other than what is mandated at place ofwork.

FIRST AID

Eye Contact: Check for and remove any contact lenses. In case of contact,immediately flush eyes with plenty of water for at least 15minutes. Cold water may be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water forat least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion: DO NOT induce vomiting unless directed to do so by medicalpersonnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

FIRE AND EXPLOSION HAZARDS

UNUSUAL FIRE/EXPLOSION HAZARDS: This material is corrosive to allhuman tissue. It will react violently with many organic chemicals, especially nitro carbons and chlorocarbons. Caustic potash reacts with zinc, aluminum, tin, and other active metals liberating flammable hydrogen gas. Dilution with water evolves large amounts of heat.

Acetic acid

IMPORTANT PROPERTIES

PHYSICAL APPEARANCE	Colorless liquid
COLOR	Clear, colorless liquid
FLASH POINT	39^{U} C
UPPER EXPLOSIVE LIMIT	No data available
LOWER EXPLOSIVE LIMIT	No data available

HEALTH HAZARDS

Eye: Causes severe eye irritation. Contact with liquid or vapor causes severeburns and possible irreversible eye damage.

Skin: Causes skin burns. May be harmful if absorbed through the skin. Contactwith the skin may cause blackening and hyperkeratosis of the skin of the hands. **Ingestion:** May cause severe and permanent damage to the digestive tract. Causessevere pain, nausea, vomiting, diarrhea, and shock.May cause polyuria, oliguria and anuria.Rapidly absorbed from the gastrointestinal tract.

Inhalation: Effects may be delayed. Causes chemical burns to the respiratorytract. Exposure may lead to bronchitis, pharyngitis, and dental erosion. May be absorbed through the lungs.

PERSONAL PROTECTION

Engineering Controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Splash goggles. Synthetic apron.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves (impervious).

FIRST AID

Inhalation: If adverse effects occur, remove to uncontaminated area. Giveartificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

Skin contact: Wash skin with soap and water for at least 15 minutes whileremoving contaminated clothing and shoes. Get immediate medical attention. Thoroughly clean and dry contaminated clothing and shoes before reuse. Destroy contaminated shoes.

Eye contact: Immediately flush eyes with plenty of water for at least 15 minutes.Then get immediate medical attention.

Ingestion: If swallowed, drink plenty of water, do NOT induce vomiting. Getimmediate medical attention.

FIRE AND EXPLOSION HAZARDS

Fire Hazards in Presence of Various Substances: Flammable in presence ofopen flames and sparks, of heat. Slightly flammable in presence of oxidizing materials of metals.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.

FIRE FIGHTING MEASURES

For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Use water spray to cool fire-exposed containers. For large fires, use water spray, fog or alcohol-resistant foam.

Handling: Wash thoroughly after handling. Remove contaminated clothing andwash before reuse. Use only in a well-ventilated area. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Avoid contact with heat, sparks and flame. Do not get on skin or in eyes. Do not ingest or inhale.

Discard contaminated shoes. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.

Storage: Keep away from heat, sparks, and flame. Keep from freezing. Keepfrom contact with oxidizing materials. Store in a cool, dry, well-ventilated area away from incompatible substances.Corrosives area. Do not store near alkaline substances. Acetic acid should be kept above its freezing point (62°F), since it will expand as it solidifies and may break container.

Sulphuric acid

PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE: ODOR:	Liquid.(Thick oily liquid.)Odorless, but has a choking odor when hot.
TASTE:	Marked acid
COLOR:	taste.(Strong.)Colorless.
BOILING POINT:	270°C (518°F) - 340 deg. C Decomposes at 340 deg. C -
MELTING POINT:	35°C (-31°F) to 10.36 deg. C (93% to 100% purity)
SOLUBILITY:	Easily soluble in cold water. Sulphuric is soluble in water with liberation of much heat. Soluble in ethyl alcohol.
FLAMMABILITY OF THE PRODUCT:	Non-flammable.
STABILITY:	The product is stable.

Corrosivity:

Extremely corrosive in presence of aluminum, of copper, of stainless steel.Highly corrosive in presence of stainless steel(304). Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Hygroscopic.Strong oxidizer. Reacts violently with water and alcohol especially when water is added to the product Incompatible (can react explosively or dangerously) with the following: ACETIC ACID, ACRYLIC ACID, AMMONIUM HYDROXIDE, CRESOL, CUMENE, DICHLOROETHYL ETHER, ETHYLENE CYANOHYDRIN, ETHYLENEIMINE, NITRIC ACID, 2-NITROPROPANE, PROPYLENE OXIDE, SULFOLANE, VINYLIDENE CHLORIDE, DIETHYLENE GLYCOL MONOMETHYL ETHER, ETHYL ACETATE, ETHYLENE CYANOHYDRIN, ETHYLENE GLYCOL MONOETHYL ETHERACETATE, GLYOXAL, METHYL ETHYL KETONE.

HEALTH EFFECTS:

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

FIRST AID MEASURES

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Fire Hazards in Presence of Various Substances: Combustible materials

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:

Metal acetylides (Monocesium and Monorubidium), and carbides ignite with concentrated sulphuric acid. White Phosphorous +boiling Sulphuric acid or its vapor ignites on contact. May ignite other combustible materials.May cause fire when sulphuric acid is mixed with Cyclopentadiene, cyclopentanone oxime, nitroaryl amines, hexalithiumdisilicide, phorphorous (III) oxide, and oxidizing agents such as chlorates, halogens, permanganates.

ACCIDENTAL RELEASE MEASURES

Small Spill:

Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If
necessary: Neutralize the residue with a dilute solution of sodium carbonate.

HANDLING AND STORAGE

Precautions:

Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:

Hygroscopic.Reacts.violently with water. Keep container tightly closed. Keep container in a cool, well-ventilated area. D Do not store above 23°C (73.4°F).

PERSONAL PROTECTION

Engineering Controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Face shield. Full suit.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.Boots.

Mercuric sulfate

PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE:	Solid.
BOILING POINT:	Not available.
SOLUBILITY:	Not available.
STABILITY:	The product is stable.
CORROSIVITY:	Non-corrosive in presence of glass
Flammability of the Product:	Non-flammable.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

CARCINOGENIC EFFECTS: Classified A5 (Not suspected for human.) by ACGIH. The substance is toxic to kidneys, lungs, the nervous system, mucous membranes.

Health Effects:

Extremely hazardous in case of ingestion.Very hazardous in case of inhalation.Hazardous in case of skin contact (irritant), of eye contact (irritant).Slightly hazardous in case of skin contact (permeator). Severe over-exposure can result in death.

FIRST AID MEASURES

Eye Contact: Check for and remove any contact lenses. Do not use an eyeointment. Seek medical attention.

Skin Contact:

After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminatedskin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediatemedical attention.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waist band. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:

Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

PERSONAL PROTECTION

Engineering Controls:

Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection: Splash goggles. Lab coat. Dust respirator. Be sure to use anapproved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Dust respirator. Boots.Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

ACCIDENTAL RELEASE MEASURES

Small Spill: Use appropriate tools to put the spilled solid in a convenient wastedisposal container.

HANDLING AND STORAGE

Precautions:

Keep locked up. Do not ingest. Do not breathe dust. Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes

Storage:

Keep container tightly closed. Keep in a cool, well-ventilated place. Highly toxic or infectious materials should be stored in a separate locked safety storage cabinet or room.

Sodium carbonate

PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE**:** Solid. (Solid powder.)
ODOR: Odorless.

TASTE:	Alkaline.
BOILING POINT:	Not available.
MELTING POINT:	851°C (1563.8°F)
SOLUBILITY:	Soluble in hot water, glycerol. Partially soluble in cold water. Insoluble in acetone, alcohol.

Flammability of the Product: Non-flammable.
Fire Hazards in Presence of Various Substances: Not applicable

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:

Sodium carbonate can ignite and burn fiercely in contact with fluoride. Sodium Carbonate in contact with fluorine decomposed at ordinary temperature with incandescence.

Special Remarks on Explosion Hazards:

Reacts explosively with red-hot aluminum metal. Sodium carbonate + ammonia in arabic gum solution will explode.

HEALTH EFFECTS

Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant).

FIRST AID MEASURES

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:

In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
DO NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.
Serious Ingestion: Not available.

ACCIDENTAL RELEASE MEASURES

Small Spill: Use appropriate tools to put the spilled solid in a convenient wastedisposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

PERSONAL PROTECTION

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Stability: The product is stable.
Special Remarks on Reactivity: Hygroscopic. Combines with water withevolution of heat.
Toxic Effects on Humans: Hazardous in case of skin contact (irritant), ofingestion, of inhalation (lung irritant).

HANDLING AND STORAGE

Precautions:
Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as acids.
Storage:
Hygroscopic. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 24°C (75.2°F). Hygroscopic

Cobalt Octoate

PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Purple color
PHYSICAL STATE :	Liquid 313-390ºF for Mineral Spirits
Explosion Limits in Air-Lower (%)	0.7 for mineral spirits
Explosion Limits in Air-Upper (%)	8.9 for mineral spirits

Auto-ignition Temp (° F) 445 for mineral spirits

TOXICOLOGICAL INFORMATION

There is no specific data for this product

HAZARDS IDENTIFICATION

Combustible liquid. Keep away from heat and all sources of ignition. May cause sensitization by skin contact which may produce allergic contact dermatitis.May cause sensitization by inhalation which may produce occupational asthma.May cause eye, skin and respiratory tract irritation. May be harmful if inhaled or swallowed. Aspiration hazard if swallowed. Can enter lungs and cause damage.

HEALTH EFFECTS

Inhalation: Although no data exists for this product, Cobalt metal powder is aknown allergen that produces characteristic symptoms of asthma, such as wheezing, dry cough, and labored breathing. Usually the asthma symptoms appear 4-6 hours after exposure and often worsen again later in the same day.

Ingestion: May cause headache, dizziness, nausea, and vomiting, gastrointestinalirritation and central nervous system depression. Swallowing small amounts during handling is not likely to cause harmful effects; swallowing large amounts may be harmful. Symptoms may include gastrointestinal irritation (nausea, vomiting, diarrhea), central nervous system depression (dizziness, drowsiness, weakness, fatigue, nausea, headache, unconsciousness). This material can enter the lungs during swallowing or vomiting and cause lung inflammation and/or damage. Small amounts of this product aspirated into the respiratory system during ingestion or vomiting may cause mild to severe pulmonary injury, possibly progressing to death.

Skin Contact: Based on data for Cobalt metal powder, may cause allergiccontact dermatitis if there is prior sensitization. Most rashes associated with cobalt occur on the hands and appear within the first year of occupational exposure to cobalt. Exposure may cause skin irritation. Prolonged or repeated exposure may dry the skin. Symptoms may include redness, burning, drying and cracking, and skin damage. Pre-existing skin disorders may be aggravated by exposure to this material. May cause skin defatting with prolonged exposure.

Eye Contact: May cause eye irritation.

FIRST AID MEASURES

Inhalation: Move the exposed person to fresh air at once. If indicated, a qualifiedpre-hospital medical provider (such as a first responder or EMT) may give oxygen. Contact a physician.

Ingestion: Aspiration hazard. Do not induce vomiting or give anything by mouthbecause this material can enter the lungs and cause severe lung damage. If the victim is drowsy or unconscious, place on left side with head down. If possible, do not leave victim unattended. Seek immediate medical attention..

Skin Contact: Wash thoroughly with soap and plenty of clean water. If irritationoccurs, contact a physician.

Eye Contact: Flush immediately with large amounts of water and continueflushing for 15 minutes or until irritation subsides, whichever is longer.

FIRE FIGHTING MEASURES

Fire: Flash point (ºF): 100, minimum

Explosion: Explosion Limits in Air-Lower (%) 0.7 for mineral spirits **Explosion Limits in Air-Upper (%)** 8.9 for mineral spirits
Auto-ignition Temp (° F) 445 for mineral spirits

Fire Extinguishing Media: Dry chemical, carbon dioxide, Halon, or foam. Waterspray is recommended to cool or protect exposed materials or structures. Water may be ineffective for extinguishment, unless used under favorable conditions by experienced fire fighters. Halon may decompose into toxic materials. Carbon dioxide can displace oxygen. Use caution when applying Halon or carbon dioxide in confined spaces. Avoid spraying water directly into storage containers due to danger of boil-over.

Special Information: During fire, a water spray can scatter flames and should beused by experienced fire-fighters. Fire-fighters should wear self-contained breathing apparatus with a full face piece operated in the positive pressure demand mode when fighting fires. In addition, wear appropriate protective equipment as conditions warrant. Isolate damage area, keep unauthorized personnel out. Stop spill/release if it can be done with minimal risk. Move undamaged containers from danger area if it can be done with minimal risk. Water spray may be useful in minimizing or dispersing vapors. Cool equipment exposed to fire with water, if it can be done with minimal risk. Avoid spreading burning liquid with water used for cooling purposes.

ACCIDENTAL RELEASE MEASURES

Eliminate all ignition sources. Spilled material may be absorbed into an appropriate absorbent material. Prevent spilled material from entering sewers, storm drains, other authorized treatment drainage systems, and natural waterways. Stop spill/release if it can be done with minimal risk. Stay upwind and away from spill/release. Isolate danger and keep unauthorized personnel out. Use non-sparking tools and explosion-proof equipment. Recover by pumping (use an explosion-proof or hand pump) or with a suitable absorbent. Consult an expert on disposal of recovered material and ensure conformity to local disposal regulations.

HANDLING AND STORAGE

Cobalt carboxylates may cause the ignition of rags or paper goods or other oxidizable materials. Keep container closed. Handle and open containers with care. Open container slowly to relieve any pressure.

Storage:

Keep container(s) tightly closed. Use and store this material in a cool, dry, well-ventilated area away from heat, direct sunlight, hot metal surfaces, and all sources

of ignition. Post "NO SMOKING OR OPEN FLAME." Store only in approved containers. Keep away from any incompatible material. Protect container(s) against physical damage.

PERSONAL PROTECTION

Ventilation System: Provide sufficient mechanical (general and/or local exhaust)ventilation to maintain exposure below TLV(S).

Personal Respirators: When exposures are not adequately controlled, userespirator approved for protection from organic vapors. If workplace exposure limit(s) of product or any component is exceeded, a NIOSH approved air supplied respirator is advised in absence of proper environmental control. OSHA regulations also permit other NIOSH respirators (negative pressure type) under specified conditions (See your industrial hygienist). Engineering or administrative controls should be implemented to reduce exposure.

Skin Protection: Appropriate disposable gloves are acceptable. Resistant glovessuch as Nitrile rubber can be worn. Consult your safety equipment supplier.

Eye Protection: Wear safety glasses or goggles to protect against exposure.Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. Consult your safety representative.

Other Protective Equipment:

Eye wash and quick-drench shower facilities. Impervious clothing and boots are recommended. Thoroughly clean shoes and wash contaminated clothing before reuse.

Benzoyl peroxide

PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE:	Solid.
Decomposition temperature	
BOILING POINT:	103°C (217.4°F)
MELTING POINT:	104.5°C (220.1°F)
SOLUBILITY:	Very slightly soluble in cold water.

Incompatibility with various substances:

Highly reactive with acids, alkalis. Reactive with combustible materials, metals. The product may undergo hazardous decomposition, condensation or polymerization, it may react violently with water to emit toxic gases or it may become self reactive under conditions of shock or increase in temperature or pressure.

Special Remarks on Reactivity: Not available.

Toxic Effects on Humans:

Extremely hazardous in case of ingestion.Very hazardous in case of skin contact (irritant) or inhalation.

Special Remarks on other Toxic Effects on Humans: Not available.
Flammability of the Product: May be combustible at high temperature.
Auto-Ignition Temperature: 80°C (176°F)

Fire Hazards in Presence of Various Substances: Flammable in presence ofcombustible materials.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of static discharge: Not available. Explosive in presence of heat. Slightly explosive in presence of shocks, of combustible materials

Health Effects:

Extremely hazardous in case of ingestion.Very hazardous in case of skin contact (irritant), of eye contact (irritant), inhalation. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Personal Protection

Safety glasses.Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves (impervious).

FIRST AID MEASURES

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

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FIRE FIGHTING MEDIA AND INSTRUCTIONS:

Oxidizing material. Do not use water jet. Use flooding quantities of water. Avoid contact with organic materials.

Special Remarks on Fire Hazards: Not available. **Special Remarks on Explosion Hazards:** Not available.

HANDLING AND STORAGE

Precautions:

Keep locked up.. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.. Keep away from direct sunlight or strong incandescent light. Empty containers pose a fire risk; evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Avoid shock and friction. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as combustible materials, metals, acids, alkalis.

Storage:

Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Do not store above 40°C (104°F).

Ammonia Solution

PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE :	A clear colourless liquid
COLOUR :	<5 Hazen Units
ODOUR :	Pungent
BOILING POINT :	23^{o}C @ 33.5% (w/w), 40oC @ 25% w/w)
FLAMMABLE LIMITS :	16% to 27% (v/v)
SOLUBILITY IN WATER :	Miscible
STABILITY:	Ammonia solution is stable under normal conditions of storage, handling and use. Hazardous Reactions and Can react violently if in contact with acids, halogens, hypochlorite or mercury

HEALTH HAZARDS

Eye Contact: Corrosive. Causes severe burns to all parts of the body **Inhalation** Ammonia vapor is toxic by inhalation

FIRST AID

IN ALL CASES OF CONTAMINATION OBTAIN IMMEDIATE MEDICAL ATTENTION

Skin contact.

Drench with large quantities of water whilst removing contaminated clothing. Continue to wash the affected area until medical attention arrives.

Eye contact.

Immediately irrigate with eyewash solution or clean water. Obtain assistance to hold eyelids apart. Continue irrigation until medical attention arrives.

Ingestion.

Do not induce vomiting. Wash out mouth with water and give 200-300ml (half a pint) of water to drink.

Inhalation.

Remove patient from source of exposure wearing breathing protection as appropriate to the prevailing conditions. Keep warm and at rest in fresh air. Apply artificial resuscitation if breathing has ceased or shows of failing.

Handling

Avoid contact with skin and eyes. Provide adequate ventilation and use only in well ventilated areas. Atmospheric levels should be controlled in compliance with the Workplace Exposure Limit, (WEL). Eye wash equipment must be provided at handling points.

Basic personal protective equipment, (PPE), includes PVC or rubber gloves, chemical goggles, Wellingtons or rubber boots and PVC overalls or apron. Individuals should make a judgement as to whether equivalent items are suitable for avoiding contact. Respiratory protection should be worn where there is a risk of breathing vapors.

Storage Keep storage equipment properly closed and vented to a safe location.Keep away from all heat and ignition sources of ignition. Provide adequate containment, either by means of a bund or a „double-skinned" storage tank.

Suitable containers can be manufactured from a range of materials including mild steel, stainless steel, polyethylene and polypropylene. Containers made from, or containing copper, copper alloy, zinc or zinc alloy are unsuitable.

Sodium Sulfate Anhydrous

PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE:	Solid.(Crystals solid.Crystalline powder.Granular solid.Powdered solid.)
BOILING POINT:	1100°C (2012°F)
MELTING POINT:	888°C (1630.4°F)
SPECIFIC GRAVITY:	2.671 (Water = 1)
SOLUBILITY:	Soluble in cold water, hydrogen iodide, and glycerol.. Insoluble in alcohol

Flammability of the Product: Non-flammable.

Health Hazards:

Hazardous in case of eye contact (irritant).Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

FIRST AID

Eye Contact:

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:

Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. get medical attention if symptoms appear.

FIRE AND EXPLOSION DATA

Auto-IgnitionTemperature:	Not applicable
Flash Points:	Not applicable
Flammable Limits:	Not applicable
Products of Combustion:	Not available
Fire Hazards in Presence of Various Substances:	Not applicable
Explosion Hazards in Presence of Various Substances:	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions:	Not applicable.
Special Remarks on Fire Hazards:	Not available.
Special Remarks on Explosion Hazards	**:** At a temperature of 800 C, sodium sulfate and aluminum will explode.

HANDLING AND STORAGE

Precautions:

Do not ingest. Do not breathe dust. Avoid contact with eyes. Wear suitable protective clothing. If ingested, seek medical advice

immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, metals.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilatedarea. Hygroscopic

PERSONAL PROTECTION

Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Exposure Limits: Not available.

Methyl alcohol

PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE: ODOR: Alcohol like.	Liquid. Pungent when crude.
BOILING POINT:	64.5°C (148.1°F) -
MELTING POINT:	97.8°C (-144°F)
SPECIFIC GRAVITY:	0.7915 (Water = 1)
SOLUBILITY:	Easily soluble in cold water, hot water

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Potential Acute Health Effects: Hazardous in case of skin contact (irritant), ofeye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator). Severe over-exposure can result in death.

FIRST AID

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 464°C (867.2°F)

Fire Hazards in Presence of Various Substances:

Highly flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Explosive in presence of open flames and sparks, of heat.

Fire Fighting Media and Instructions:

Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam water spray or fog.

Special Remarks on Fire Hazards:

Explosive in the form of vapor when exposed to heat or flame.Vapor may travel considerable distance to source of ignition and flash back. When heated to decomposition, it emits acrid smoke and irritating fumes. CAUTION: MAY BURN WITH NEAR INVISIBLE FLAME

Special Remarks on Explosion Hazards:

Forms an explosive mixture with air due to its low flash point. Explosive when mixed with Choroform + sodium methoxide and diethyl zinc. It boils violently and explodes.

HANDLING AND STORAGE

Precautions: Keep locked up.. Keep away from heat. Keep away from sources ofignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, metals, acids.

Storage: Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

PERSONAL PROTECTION:

Splash goggles. Lab coat.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Benzene

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance:	Liquid
Boiling Point:	80.1 (176.2°F)
Melting Point:	5.5°C (41.9°F)
Solubility:	Miscible in alcohol, chloroform, carbon disulfide oils, carbon tetrachloride, glacial acetic acid, diethyl ether, acetone. Very slightly soluble in cold water.
Health Effects:	Very hazardous in case of eye contact (irritant), of inhalation. Hazardous in case of skin contact (irritant, permeator), of ingestion. Inflammation of the eye is characterized by redness, watering, and itching.

FIRST AID

Eye Contact: Check for and remove any contact lenses. In case of contact,immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water.Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminatedskin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation: Evacuate the victim to a safe area as soon as possible.Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion: DO NOT induce vomiting unless directed to do so by medicalpersonnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.
Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: Flammable.
Auto-Ignition Temperature: 497.78°C (928°F)

Fire Hazards in Presence of Various Substances:

Highly flammable in presence of open flames and sparks, of heat. Slightly flammable to flammable in presence of oxidizing materials.Non-flammable in presence of shocks.

Fire Fighting Media and Instructions:

Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

ACCIDENTAL RELEASE MEASURES

Small Spill: Absorb with an inert material and put the spilled material in anappropriate waste disposal.

Large Spill: Flammable liquid. Keep away from heat. Keep away from sources ofignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas. Be careful that the product is not present at a concentration level above TLV.

HANDLING AND STORAGE

Precautions: Keep locked up.. Keep away from heat. Keep away from sources ofignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids.

Storage: Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

PERSONAL PROTECTION

Splash goggles. Lab coat.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill: Splash goggles. Full suit.Vaporrespirator. Boots.Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product.

Acetone

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance:	Liquid
Boiling Point:	56.2°C (133.2°F)
Melting Point:	-95.35 (-139.6°F)
Critical Temperature:	235°C (455°F)
Solubility:	Easily soluble in cold water, hot water.

Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

FIRST AID

Eye Contact: Check for and remove any contact lenses. Immediately flush eyeswith running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.

Skin Contact: In case of contact, immediately flush skin with plenty of water.Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminatedskin with an anti-bacterial cream. Seek medical attention.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation: Evacuate the victim to a safe area as soon as possible.Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion: Do NOT induce vomiting unless directed to do so by medicalpersonnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 465°C (869°F)

Fire Hazards in Presence of Various Substances: Highly flammable inpresence of open flames and sparks, of heat.

Explosion Hazards in Presence of Various Substances: Risks of explosion ofthe product in presence of mechanical impact: Not available. Slightly explosive in presence of open flames and sparks, of oxidizing materials, of acids.

Fire Fighting Media and Instructions: Flammable liquid, soluble or dispersedin water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

ACCIDENTAL RELEASE MEASURES

Small Spill: Dilute with water and mop up, or absorb with an inert dry materialand place in an appropriate waste disposal container.

HANDLING AND STORAGE

Precautions: Keep locked up. Keep away from heat. Keep away from sources ofignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, acids, alkalis.

Storage: Store in a segregated and approved area (flammables area) . Keepcontainer in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Keep away from direct sunlight and heat and avoid all possible sources of ignition (spark or flame).

PERSONAL PROTECTION:

Splash goggles, Lab-coat, Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Turpentine

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance:	Liquid.
Boiling Point:	165°C (329°F)
Melting Point:	-55°C (-67°F)
Solubility:	Very slightly soluble in methanol, diethyl ether, n-octanol. Insoluble in cold water, hot water.
Health Effects:	Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator).

FIRST AID

Eye Contact: Check for and remove any contact lenses. In case of contact,immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Skin Contact: In case of contact, immediately flush skin with plenty of water.Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminatedskin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Evacuate the victim to a safe area as soon as possible.Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.

Ingestion: Do NOT induce vomiting unless directed to do so by medicalpersonnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 253°C (487.4°F)

Fire Hazards in Presence of Various Substances: Flammable in presence ofoxidizing materials.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions:

Flammable liquid, insoluble in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray or fog. Cool containing vessels with water jet in order to prevent pressure build-up, auto-ignition or explosion.

ACCIDENTAL RELEASE MEASURES

Small Spill: Absorb with an inert material and put the spilled material in anappropriate waste disposal.

Large Spill: Toxic flammable liquid, insoluble or very slightly soluble in water.Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal.

HANDLING AND STORAGE

Precautions: Keep away from heat. Keep away from sources of ignition. Groundall equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents.

Storage: Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

PERSONAL PROTECTION:

Splash goggles. Lab coat.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill: Splash goggles. Full suit.Vaporrespirator. Boots.Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Methyl methacrylate

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance:	Liquid.
Boiling Point:	100°C (212°F)
Melting Point:	-48°C (-54.4°F)
Solubility:	Partially soluble in cold water.
Stability and Reactivity Data:	
Stability:	The product is stable.
Instability Temperature:	Not available.
Conditions of Instability:	Not available.
Incompatibility with various substances:	Reactive with metals, acids, alkalis
Corrosivity:	Non-corrosive in presence of glass.
Special Remarks on Reactivity:	Not available.
Special Remarks on Corrosivity:	Not available.
Polymerization:	Yes

Health Effects:

Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

FIRST AID

Eye Contact: Check for and remove any contact lenses. Immediately flush eyeswith running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact: After contact with skin, wash immediately with plenty of water.Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminatedskin with an anti-bacterial cream. Seek medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediatemedical attention.

Serious Inhalation: Evacuate the victim to a safe area as soon as possible.Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:

Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 421°C (789.8°F)

Fire Hazards in Presence of Various Substances: Flammable in presence ofopen flames and sparks.

Explosion Hazards in Presence of Various Substances: Risks of explosion ofthe product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Explosive in presence of heat.

Fire Fighting Media and Instructions: Flammable liquid, soluble or dispersedin water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

ACCIDENTAL RELEASE MEASURES

Small Spill: Dilute with water and mop up, or absorb with an inert dry materialand place in an appropriate waste disposal container.

Large Spill: Flammable liquid. Keep away from heat. Keep away from sources ofignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources.

HANDLING AND STORAGE

Precautions: Keep away from heat. Keep away from sources of ignition. Groundall equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes Keep away from incompatibles such as metals, acids, alkalis.

Storage: Flammable materials should be stored in a separate safety storagecabinet or room. Keep away from heat. Keep away from sources of ignition. Keep container tightly closed. Keep in a cool, well-ventilated place. Ground all equipment containing material. A refrigerated room would be preferable for materials with a flash point lower than 37.8°C (100°F).

PERSONAL PROTECTION:

Splash goggles. Lab coat.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill: Splash goggles. Full suit.Vaporrespirator. Boots.Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Methyl Ethyl Ketone Peroxide (MEKP)

PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AND ODOR:	Water white liquid with a slight odor.
BOILING POINT:	Unknown
SOLUBILITY IN WATER:	Slightly soluble in water.

STABILITY AND REACTIVITY

Stability: Stable when kept in original, closed container, out of direct sunlight attemperatures below 80°F (27°C).

Conditions to avoid: Contamination. Direct sunlight. Open flames. Prolongedstorage above 100°F (38°C).Storage above SADT.Storage near flammable or combustible materials.

Materials to avoid: Dimethylaniline, cobalt napthenate and other promoters,promoted resins, accelerators, oxidizing and reducing agents, strong acids, bases, metals, metal alloys and salts, sulphur compounds, amines or any hot material.

FIRE-FIGHTING MEASURES

Flash point >200ºF (93°C) C.O.C

Flammable limits: Unknown

Auto-ignition: POINT Unknown

Extinguishing media: Water from a safe distance–preferably with a fog nozzle.In case of very small fires, other means such as carbon dioxide, foam or dry chemical extinguishers may be effective. Dry chemical combined with MEKP formulations may re-ignite. Light water additives may be particularly effective at extinguishing MEKP fires

HEALTH HAZARDS

Skin contact: Severe skin irritant causes redness, blistering, and edema. **Eye Contact:** Eye contact causes severe corrosion and may cause blindness.

Ingestion: Human systemic effects by ingestion: changes in structure or functionof esophagus, nausea, or vomiting, and other gastrointestinal effects.

Inhalation: Moderately toxic by inhalation.

EFFECTS OF OVEREXPOSURE

Prolonged inhalation of vapors may cause mucous membrane irritation and vertigo.

FIRST AID

Skin: Immediately remove any contaminated clothing. Wash contaminated areathoroughly with soap and copious amounts of water for at least 15 minutes. If irritation or adverse symptoms develop seek medical attention.

Eyes: Remove any contact lenses at once. Flush eyes with water for at least 15minutes. Ensure adequate flushing by separating the eyelids with fingers. If irritation or adverse symptoms develop seek medical attention.

Ingestion: Do Not induce vomiting. Drink plenty of water. Immediately call aphysician. For aid to physician, suggest local Poison Control Center.

Inhalation: Remove to fresh air, if coughing, breathing becomes labored,irritation develops or other symptoms develop, seek medical attention at once, even if symptoms develop.

ACCIDENTAL RELEASE MEASURES

Steps to be taken in event of spill: Dike spill to prevent runoff from enteringdrains, sewers, streams, etc. Wet spilled material with water and absorb with an inert absorbent material such as perlite, vermiculite, or sand. Sweep up using non-sparking tools and place in a clean polyethylene drum or a polyethylene pail. DO NOT place into a steel container, lined or unlined, as a decomposition may occur. Treat any contaminated cardboard packaging as hazardous waste. Wet container contents with additional water prior to sealing.

HANDLING AND STORAGE

HANDLING

Rotate stock using the oldest material first. Avoid contact with skin, eyes and clothing. Keep containers closed to prevent contamination. Keep away from sources of heat, sparks or flame. Do not add to hot solvents or monomers as a violent decomposition and/or reaction may result. When using spray equipment, never spray raw MEKP onto curing or into raw resin or flues. Keep MEKP in its original container. DO NOT USE NEAR FOOD OR DRINK. Wash thoroughly after handling.

STORAGE

The stability of MEKP formulations is directly related to the shipping and storage temperature history. Cool storage at 80°F or below is recommended for longer shelf life and stability. Prolonged storage at elevated temperatures of 100°F and

higher will cause product degradation, gassing and potential container rupture which can result in a fire and/orexplosion. Store out of direct sunlight in a well ventilated area away from combustible and incompatible materials.

PERSONAL PROTECTION

Respiratory protection If airborne concentrations are expected to exceedacceptable levels wears an approved air-purifying respirator with an organic vapor cartridge or canister

eye protection Safety goggles recommended. Permanent eyewash is highlyrecommended.

Hand protection Protective gloves recommended, solvent resistant, such as butylrubber, nitrile or neoprene.

Polyvinyl alcohol

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance: Solid. (Powdered solid.Amorphous solidpowder.)

Boiling Point: Not available.

Melting Point: Decomposition @ Softens at about 200°C with decomposition.228 deg. C.

Solubility: Soluble in cold water, hot water. Insoluble in diethyl ether, acetone,petroleum solvents, aromatic hydrocarbons, esters.Practically insoluble in animal and vegetable oils and chlorinated hydrocarbons.

Reactivity: Incompatible with oxidizing agents (perchlorates, nitrates, etc.),reactive metals (sodium, calcium, zinc. etc.), sodium or calcium hypochlorite, materials reactive with hydroxyl compounds. Reaction with peroxides may result in violent decomposition of peroxide possibly creating and explosion.

Health Effects: Slightly hazardous in case of skin contact (irritant), of eyecontact (irritant), of ingestion, of inhalation.

FIRST AID

Eye Contact: Check for and remove any contact lenses. In case of contact,immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

Skin Contact: Wash with soap and water. Cover the irritated skin with anemollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion: Do NOT induce vomiting unless directed to do so by medicalpersonnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Fire Hazards in Presence of Various Substances: Flammable in presence ofopen flames and sparks, of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances: Risks of explosion ofthe product in presence of mechanical impact: Not available. Slightly explosive in presence of open flames and sparks.

Fire Fighting Media and Instructions: SMALL FIRE: Use DRY chemicalpowder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

ACCIDENTAL RELEASE MEASURES

Small Spill: Use appropriate tools to put the spilled solid in a convenient wastedisposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill: Use a shovel to put the material into a convenient waste disposalcontainer. Finish cleaning by spreading water on the contaminated surface and allow evacuating through the sanitary system.

HANDLING AND STORAGE

Precautions: Keep away from heat. Keep away from sources of ignition. Emptycontainers pose a fire risk; evaporate the residue under a fume hood. est. Do not breathe dust. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, metals, acids, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilatedarea.

PERSONAL PROTECTION

Safety glasses.Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill: Splash goggles. Full suit. Dustrespirator. Boots.Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Glycerin

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance:	Liquid. (Viscous (Syrupy) liquid.)
Boiling Point:	290°C (554°F)
Melting Point:	19°C (66.2°F)

Solubility: Miscible in cold water, hot water and alcohol. Partially soluble inacetone.Very slightly soluble in diethyl ether (ethyl ether).Limited solubility in ethyl acetate. Insoluble in carbon tetrachloride, benzene, chloroform, petroleum ethers, and oils

Incompatibility with various substances: Highly reactive with oxidizing agents.

Special Remarks on Reactivity: Hygroscopic. Glycerin is incompatible withstrong oxidizers such as chromium trioxide, potassium chlorate, or potassium permanganate. Glycerin may react violently with acetic anhydride, aniline and nitrobenzene, chromic oxide, lead oxide and fluorine, phosphorous triiodide, ethylene oxide and heat, silver perchlorate, sodium peroxide, sodium hydride.

Health Effects: Slightly hazardous in case of skin contact (irritant, permeator), ofeye contact (irritant), of ingestion, of inhalation.

FIRST AID MEASURES

Eye Contact: Check for and remove any contact lenses. In case of contact,immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

Skin Contact: Wash with soap and water. Cover the irritated skin with anemollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation: Not available.

Ingestion: Do NOT induce vomiting unless directed to do so by medicalpersonnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

FIRE AND EXPLOSION DATA

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 370°

Fire Hazards in Presence of Various Substances: Slightly flammable toflammable in presence of open flames and sparks, of heat, of oxidizing materials. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances: Risks of explosion ofthe product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Explosive in the presence of oxidizing materials.

Fire Fighting Media and Instructions: SMALL FIRE: Use DRY chemicalpowder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

ACCIDENTAL RELEASE MEASURES

Small Spill: Dilute with water and mop up, or absorb with an inert dry materialand place in an appropriate waste disposal container. Finish cleaning by spreading

water on the contaminated surface and dispose of according to local and regional authority requirements.

HANDLING AND STORAGE

Precautions: Keep away from heat. Keep away from sources of ignition. Groundall equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilatedarea. Hygroscopic

PERSONAL PROTECTION

Safety glasses.Lab coat.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Formaldehyde

PHYSICAL AND CHEMICAL PROPERTIES

Physical state and appearance:	Liquid.
Boiling Point:	98°C (208.4°F)
Melting Point:	-15°C (5°F)
Solubility:	Easily soluble in cold water, hot water. Soluble in diethyl ether, acetone, alcohol
Stability:	The product is stable.
Instability Temperature:	Not available.
Conditions of Instability:	Heat, ignition sources (flames, sparks), incompatible materials
Incompatibility with various substances:	Reactive with oxidizing agents, reducing agents, acids, alkalis. Slightly reactive to reactive with metals.

FIRE AND EXPLOSION DATA

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 430°C (806°F)

Fire Hazards in Presence of Various Substances:

Flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks, of oxidizing materials, of reducing materials, of combustible materials, of organic materials, of metals, of acids, of alkalis.

Explosion Hazards in Presence of Various Substances: Non-explosive inpresence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions:

Flammable liquid, soluble or dispersed in water.
SMALL FIRE: Use DRY chemical powder.

LARGE FIRE: Use alcohol foam, water spray or fog. Cool containing vessels with water jet in order to prevent pressure build-up, auto-ignition or explosion.

HEALTH EFFECTS:

Very hazardous in case of eye contact (irritant), of ingestion, .Hazardous in case of skin contact (irritant, sensitizer, permeator), of eye contact (corrosive).Slightly hazardous in case of skin contact (corrosive). Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching.

FIRST AID MEASURES

Eye Contact: Check for and remove any contact lenses. Immediately flush eyeswith running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water.Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminatedskin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificialrespiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation: Evacuate the victim to a safe area as soon as possible.Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion: If swallowed, do not induce vomiting unless directed to do so bymedical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

ACCIDENTAL RELEASE MEASURES

Small Spill: Dilute with water and mop up, or absorb with an inert dry materialand place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill: Flammable liquid. Poisonous liquid. Keep away from heat. Keepaway from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate.

HANDLING AND STORAGE

Precautions: Keep away from heat. Keep away from sources of ignition. Groundall equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, acids, alkalis, moisture.

Storage: Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

PERSONAL PROTECTION

Safety glasses.Lab coat.Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves (impervious).

Personal Protection in Case of a Large Spill: Splash goggles. Full suit.Vaporrespirator. Boots.Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

FORMS

FORMS

CHEMICAL INVENTORY

Building: _____ Room # (s): _____ _____

Contact name: _____ Department: _____ Phone _____ Email _____

Chemical Name	CAS#	Average stored		Maximum Stored on Hand		Storage Method[2]	Physical Form[3]
		Quantity	Units[1]	Quantity	Units[1]		

1.milligram (mg), milliter (ml), pound (lb)...etc.

2. Metal can < 5 gal (MC1), Metal can > 5gal (MC2), Plastic container < 5 gal (PC1), Plastic container > 5 gal (PC2), Fiber/tic box
(FB), Glass Bottle (GB), Cylinder (C), Bag (B), Carboys (CR).

3. Solids (S), Liquids (L), Gas (G).

REQUEST FOR DISPOSAL- HAZARDOUS CHEMICALS

Requested by:	Department:	Phone:

Container Tag #	Contents Use full chemical or product name(s) List all components	% of Container	Total amount of contents	Physical State Solid or Liquid
		_____ 100%		
		_____ 100%		
		_____ 100%		

The materials listed are accurately described above and are packaged and labelled according to the procedures of the Government Engineering College Trichur Safety Manual.

Signature:…….. Date:……

(Must be a GCEK employee, e g. faculty or staff)

HAZARD REVIEW PREPARATION CHECKLIST

List/ Check Any of the Following that Apply
MSDSs Hazard

	Chemicals	Flammable	Reactive	Toxic	Corrosive	Radioactive
Liquids						
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
Solids						
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
Gases						
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___
	_____	___	___	___	___	___

Can these hazards exist?

- Explosion
- Struck By
- Electric Shock
- Air contamination
- Thermal Burn (cold)
- Muscle Strain
- Allergic Reaction
- Chemical Asphyxiation
- Laser
- Falls
- Electrocution
- Sharps / cuts
- Thermal Burn (hot)
- Soil contamination
- RF burn
- Exothermic Reaction
- Excessive Noise
- Pinch Points
- Implosion
- Caught Between
- Electric Burn
- Water contamination
- RF exposure
- Eye strain
- Oxygen Displacement
- Intense Light

REPORT OF AN INCIDENT

File #

PLEASE COMPLETE THIS FORM AND FORWARD IT TO THE HEAD OF THE DEPARTMENT WITHIN THREE DAYS OF THE INCIDENT

SERIOUS ACCIDENTS SHOULD BE REPORTED BY PHONE IMMEDIATELY TO HOD

Please use BLOCK CAPITALS

Part A: About the incident

1. On what date did the incident happen?

2. At what time did the incident happen?

3.Where did the incident happen?

Department:

Building:

Part of Building:

4. Name of person reporting incident.

5. Were there any witnesses? If so please give their name(s) and department(s).

6. Was anyone injured? If yes go to part B. If no go to part D

Yes

No

Part B: About the injured person

1. Full Name

2.Home address and telephone number

3. Age 4. Sex

5. GCEK Employee/Student Yes No

6. Job title/student Category

7. Department

Part C: About the injury

1. What was the injury? (e g. fracture, laceration, burn etc.)

2. What part of the body was injured?

3. What first aid treatment(if any) was given?

Part D: Describing what happened

1. Give as much detail as you can. For example:

•The name of any substance involved

•The name and type of any machine

• The events that led to the accident/incident

• The part played by any people

• What you were doing at the time of the accident/incident

4.Who administered first aid?

I agree to submit a medical report of my injuries in respect of the accident referred to this form to the authority of GCEK

Sign and print name:

Signature of injured person/reporter of dangerous occurrence

Date:

*Delete if not appropriate

SAFETY SURVEY LIST

A.Working areas

Department:	Laboratory Superintendent: Email:	Date:
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
Adequate lighting in the work area?				
Laboratory work areas reasonably clean and tidy?				
Area kept as clean as work allows?				
Guards on fan blades are located within 2 m of the floor?				
Ladders and step-stools in good condition and used in the manner for which they were designed?				
Two and four-wheeled carts and hand trucks in good condition?				
List of emergency numbers, First Aid, and CPR certified employees clearly displayed7				
No foods, beverages, tobacco, or cosmetics in laboratory?				
Eating, drinking, use of tobacco, and use of cosmetics prohibited in the laboratory?				
No chipped or broken glassware in use?				

SAFETY SURVEY LIST

B. Means of Egress

Department:	Laboratory Superintendent: Email:	Date:
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
Stairs well lit?				
Stairs of sturdy design?				
Railings provided on all open sides of exposed stairways?				
Anti-skid walking surfaces on the stairs?				
Stairs clean?				
All non-exit doors and passages which could be mistaken for an exit marked as such?				
All exits clearly designated?				
All exits unobstructed?				
All exit signs illuminated? (They must be illuminated by general room lighting or internal				
lighting.) Emergency lighting provided for fire escape routes?				
Emergency lighting provided for fire escape routes?				
All fire doors unobstructed and free of locks and devices that could prevent free egress? Designated fire doors closed and operable?				
All fire doors side hinged and swing in the direction of the escape?				
Floors free from large holes?				
Floors free from litter and obstructions?				
Floors clean and dry?				
Drainage provided for continuously wet floors?				
Mats and carpeting in good condition?				
Aisles and passageways well lit?				
Aisles and passageways kept clear to provide safe movement of materials handling equipment or employees?				
No loose or protruding shelving or edging that could cause a safety problem?				
Covers or guard rails provided for open pits, vats, etc.?				
Guard rails provided for platforms greater than 1 m above the adjacent floor?				

SAFETY SURVEY LIST

C. Materials Handling and Storage

Department:	Laboratory Superintendent: Email:	**Date:**
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
Area free of the accumulation of materials that could cause tripping, fires, or explosions?				
Labeling appears on doors and cabinets?				
Storage shelving secure, in good condition, and not overloaded or crowded?				
Storage shelving provided with a lip on forward edge?				
Hazardous chemicals not stored on floor?				
Sufficient waste containers provided?				
Reagents used at the bench properly labelled to prevent accidental use of the wrong reagent or wash bottle?				
Containers labelled with the identity of contents and general hazard(s) of contents?				
Containers properly capped or sealed? Flammable liquids in quantities greater than one liter stored in safety cans designed for flammable liquid storage?				
Reagents used at the bench properly labelled to prevent accidental use of the wrong reagent or wash bottle?				
Containers labelled with the identity of contents and general hazard(s) of contents?				
Containers properly capped or sealed? Flammable liquids in quantities greater than one liter stored in safety cans designed for flammable liquid storage?				
Flammable and combustible liquids stored in containers labelled as such?				
Flammable and combustible liquids stored in approved cabinets marked "Flammable"?				
Cabinets properly ventilated?				
If flammable liquids are used in large volumes, is the mechanical ventilation adequate to remove				
Vapors before they reach hazardous concentrations?				
Stored combustibles and flammables separated from any heat source by at least 6 m?				
Areas where flammables are used or stored designated "NO SMOKING - NO OPEN FLAMES"?				
Metal drums used for storage and dispensing of flammable liquids properly grounded?				
Materials stored only with other compatible materials? (e.g., solvents, acids, bases, reactives, oxidizers, and toxins stored separately)				
Flammables in the laboratory are less than 1000 Liters				
Absence of leaking containers in storage areas				
Absence of corroded containers in storage areas				

SAFETY SURVEY LIST

D. Compressed Gases

Department:	Laboratory Superintendent: Email:	Date:
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
Each compressed gas cylinder marked with the identity of its contents?				
Compressed gas cylinders inspected visually for safe operating condition?				
Gas cylinders secured so they will not tip over or fall?				
Valve caps tightly in place on all gas cylinders that are not in use?				
All gas lines leading from compressed gas supplies labelled as to identity of gas, laboratory served, and emergency telephone numbers?				
Fewer than 3 cylinders in use in the laboratory?				
Fewer than 9 cylinders in the laboratory?				
Gas cylinder storage areas properly ventilated?				
Areas where flammable compressed gases are stored posted "NO SMOKING - NO OPEN FLAMES"?				
Oxygen cylinders not stored in the same vicinity of greasy or oily rags?				
Oxygen cylinders stored a minimum of 1 5 m from flammable gas cylinders or a minimum 2 m high fire wall with a 0.5 hour fire rating separates them?				

SAFETY SURVEY LIST

E. Electrical

Department:	Laboratory Superintendent: Email:	Date:
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
All electrical equipment properly grounded? (Double insulated tools are exempt.)				
All electrical equipment U.L. listed and/or F.M. approved?				
Breaker boxes that may need maintenance while live have a minimum of 30" width clearance in front of them?				
All circuit breakers and fused circuits labelled to indicate whether they are in the open (off) or closed (on) position?				
Properly rated fuses used?				
All electrically live parts guarded?				
Electrical boxes and panels covered with face-plates to prevent exposure to live wires?				
Tool, appliance, instrument, and extension cords in good repair?				
Has permanent wiring been installed to alleviate the use of extension cords?				
Electrical cords or other lines not suspended unsupported across rooms or passageways?				
Cords not routed over metal objects?				
Cords not run through holes in walls or ceilings or through doorways or windows?				
Cords not placed under carpet, rugs, or heavy objects?				
Cords not placed in pathways or other areas where repeated abuse can cause deterioration of insulation?				
Octopus (multi-outlet) plugs not used? Approved multiple outlets with circuit breakers used instead?				

SAFETY SURVEY LIST

F.General safety equipment

Department:	Laboratory Superintendent: Email:	Date:
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
Fire extinguishers located where flammable or combustible liquids are used?				
A fire extinguisher located between 3 m and 8 m of a door opening to rooms used for storage?				
Other extinguishers ready and accessible?				
Extinguishers mounted so that the top is not more than 1.5 m above the floor, and not more than 1 m if it weighs more than 20 kg?				
Extinguishers suitable for the class of fire anticipated in each area?				
Extinguishers inspected and labelled as inspected on a vearlv basis?				
Employees instructed in the proper use of fire extinguishers on an annual basis?				
Fire alarm boxes readily accessible and within normal path distance of 60 m?				
Fire alarm system tested on an annual basis?				
Eyewash and safety showers installed within 8 m of laboratory work areas where corrosive chemicals are used?				
Safety showers and eyewash fountains easily accessible?				
Employees familiar with operation of safety showers and eyewash fountains?				
Safety showers and eyewash fountains tested at least annually?				
First aid kits available, in good condition, and plainly marked?				
Explosion-proof refrigerators not used for storage of food?				
Fume hoods in proper operating condition?				
Function of fume hoods periodically checked and results recorded and posted?				
Equipment properly placed in fume hoods? (i.e., instruments elevated a minimum of 5 cm from hood floor.)				
Fume hoods not used for storage?				

SAFETY SURVEY LIST

G. Personal protection

Department:	Laboratory Superintendent: Email:	Date:
Building:	Room #:	Phone #:

Item	Yes	No	NA	Comments
Eye protection provided and used by all personnel when in the laboratory area?				
Eye protection provided for all guests that enter the laboratory?				
Proper laboratory clothing provided and used by all personnel when in the laboratory area?				
Laboratory clothing clean and in good repair?				
Gloves provided and used when needed?				
Proper gloves provided for each different operations?				
Employees who are required to wear steel toe shoes comply?				

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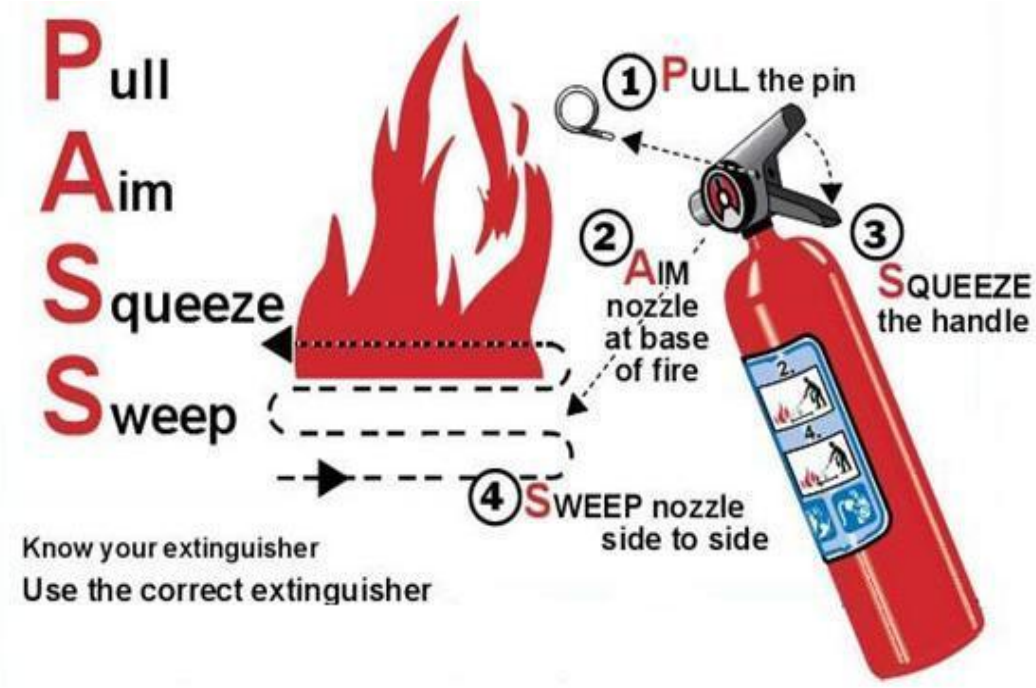
OPERATIONAL SEQUENCE OF A FIRE EXTINGUISHER



PRESENT EHS COMMITTEE MEMBERS

1) **Faculty in Charge**: Bijesh R (Mechanical Engg. Dept., 9539144860)

2) **Faculty (Electrical Engg. Dept.)**: Mr.Divyalal R K (9496291353)

3) **Faculty (Civil Engg. Dept.)**: Mr.Saji K P (9387021080)

4) **Faculty (Mechanical Engg. Dept.)**: Mr.Priyak N K(9495744282)

5) **Hostel Warden** : Mr. Syamnath K (9895041241)

6) **Sergeant, GCEK**: Mr. Rajan P (9656514190)

7) **AA GCEK:** Mrs. Mr.C.O.K.Noorudhin (9846444743)

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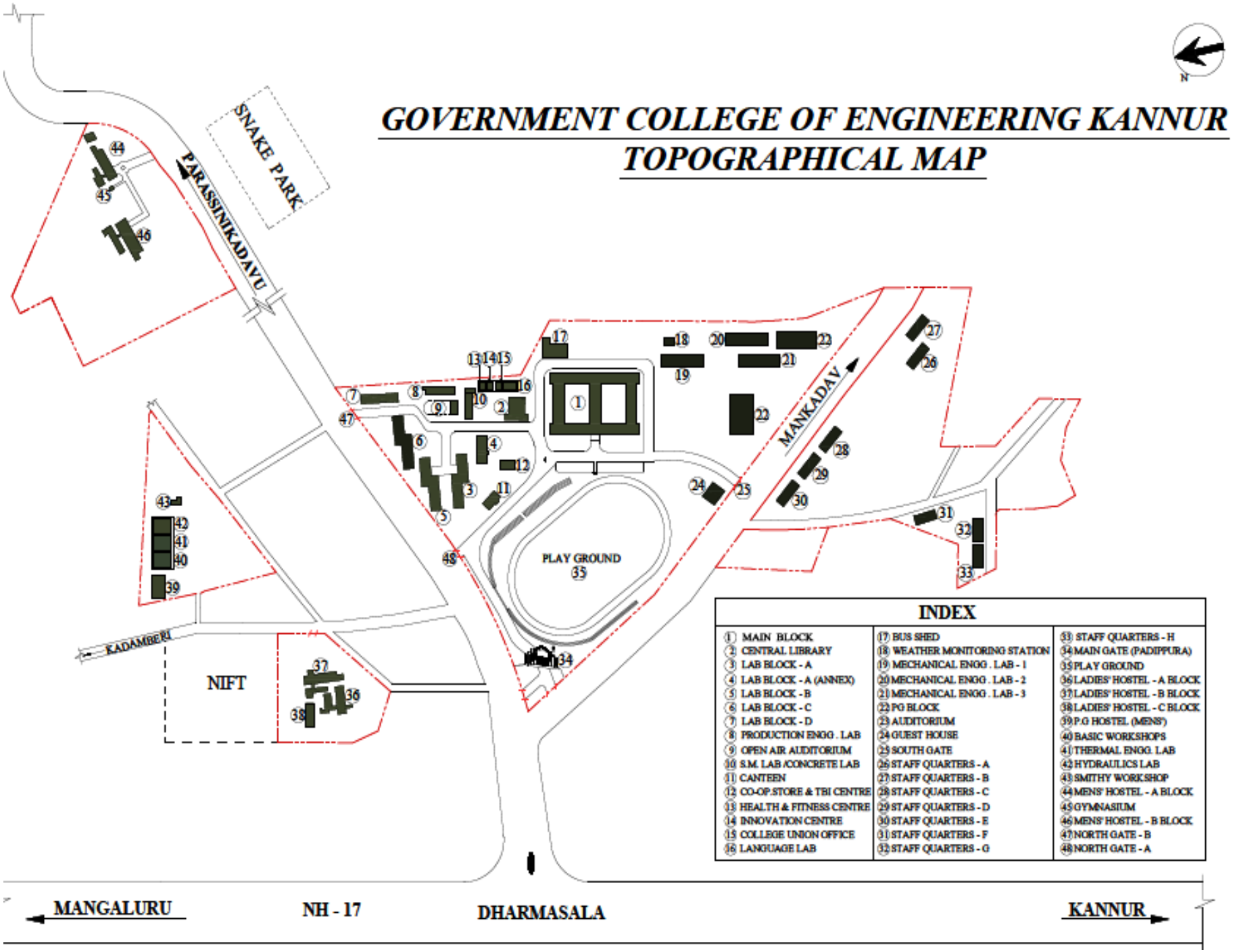

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