HEALTH SAFETY AND ENVIRONMET MANUAL

TKM COLLEGE OF ENGINEERING

PREFACE

Health Safety and Environmental manual is a guide towards the achievement of a safe work and healthy environment at TKM College of Engineering. A healthy and safe environment is critical to achieve excellence in teaching and research and this manual describes the standards and guidelines that should be followed to keep accidents to a minimum. Cooperation among all employees and students are requested for the implementation of applicable guidelines to upgrade the safety in the campus.

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INTRODUCTION

1 INTRODUCTION

TKM College of Engineering, a Govt. Aided institution under Kerala Technological University is firmly committed in providing a safe and healthy environment for all students, faculty, staff and visitors. Safety is the responsibility of every employee and students. Training and education about the safety procedures and operations are essential to create a safe environment inside the campus. All employee and students have the responsibility for maintaining an effective environmental health and safety program. Its success can only be achieved through the cooperation and support of all employees and students of this institution. All should accept the challenge of maintaining an accident free and healthy environment. The positive attitude towards safety, the knowledge of safe practices and actions are the key elements that determine the success of the safety programme.

The purpose of this manual is to provide basic safe operating practices to be applied uniformly in the TKMCE campus including all laboratories in order to ensure a safe environment for the faculty, staff and students.

1.1 RESPONSIBILITIES

Students, staff and faculty of TKMCE shall be responsible for complying with oral and written safety rules, regulations, and procedures required for the assigned task. All employees and students are responsible and accountable for occupational health and safety procedure and its protection as described in this manual.

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ENVIRONMENTAL HEALTH AND SAFETY POLICY

2 ENVIRONMENTAL HEALTH AND SAFETY POLICY

2.1 POLICY

TKM College of Engineering is committed to provide a safe, secure and healthy environment for all faculty, staff, students, and visitors.

2.2 PRINCIPLES

Good environmental health and safety practices are the responsibility of every faculty member, staff, student and visitor at TKMCE. This responsibility cannot be transferred or delegated.

TKMCE shall make all reasonable efforts to:

- Protect the health and safety of faculty, staff, students, visitors, and the surrounding community.
- Provide safe workplaces - academic, research and administrative.
- Provide information and training to faculty, staff, students and visitors about potential environmental, health and safety hazards.
- Identify and correct environmental health and safety hazards, and encourage the reporting of hazards and safety-related incidents.
- Comply with applicable environmental health and safety laws, regulations and consensus standards.

2.3 CAMPUS SAFETY AND SECURITY COMMITTEE.

The duties and responsibilities of campus safety and security committee is as follows.

To communicate safety and security information and coordinate responses to safety and security issues and concerns.

The committee should meet routinely to review trends, issues and concerns pertinent to the college campus, establish priorities for educating the campus community, and develop plans and assign responsibilities for addressing the issues.

If any member of the College community has a safety or security issue or concern, it may be addressed to the campus safety and security committee of the college.

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EMERGENCY CONTACT NUMBERS

3 EMERGENCY CONTACT NUMBERS

Principal	0474-2712022. 9847072024
College Office	0474-2712024. 0474-2713129. 0474-2711591
College Gate	0474-2712024 Extn: 204
Campus Doctor	7025055633
College Vehicle (For Emergency)	0474-2713126
Administrative Officer	04742713126, 04742708353
Library	04742713933
Placement Cell	0474271312
Help Desk (Maintenance)	9446235854
Hospitals	
Medicity	0474-2721520, 2721519
N.S. Hospital	0474-2723199
District Hospital	0474-2768667
Police	100, 0474-2711155
Fire	101, 0474-2746200, 0474-2522490
Ambulance	108

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EMERGENCY AND FIRE EVACUATION

4 EMERGENCY AND FIRE EVACUATION

4.1 INTRODUCTION

In the event of an emergency an emergency plan should be implemented. This plan would include evaluation of the facility if deemed appropriate. It is essential that all employees and students should know how to act and react during emergency. It is necessary that a written emergency response plan be developed and all employees are trained on how to act accordingly.

4.2 FIRES (Building/Laboratory Fires)

The following steps are recommended if fire occurs

- Initiate a building evacuation using the emergency alarm
- Dial 101 to notify public safety and seek the help of fire department
- 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 on the floor and roll tosmother the fire. If a Co-worker catches fire lower the person to the floor and roll him/her to smother the flames. Usea safety shower immediately thereafter
- Use the nearest safe exit route to exit the building
- Proceed to the nearest assembly point
- Never use an elevator if the building fire alarm is activated
- Use stairwells to evacuate the building
- Do not re-enter the building, until authorized to do so by the person in charge of assembly point or the fire department

4.3 ASSEMBLY POINTS

Assembly Point 1 - Football Court

Assembly Point 2 - Tennis Court

Assembly Point 3 - Front yard of Mechanical block

Safety Remainder

- *Check all appliances in your office before leaving and turn them off.*
- *Use electrical extension cords properly. Examine the cords periodically for safe service*

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MEDICAL EMERGENCIES

5 MEDICAL EMERGENCIES

The injuries in the laboratories 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. Proper training will help to prevent injuries from glass ware, toxic chemicals, burns and electrical shock.

In the event of any personal injury the initial responsibility forfirst aid rests with the first person(s) at the scene, who should reactquickly but in a calm and reassuring manner. The person assumingresponsibility should

- Immediately call for medical help
- Report the suspected type of injury or illness, location of victimand type of assistance required
- Send a person to meet the ambulance crew at the likelyentrance of the building
- Not move the injured person except when necessary to prevent further injury.

Safety Reminder
Telephone numbers for medical emergency should be posted in each laboratory/office

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GENERAL LAB SAFETY

6 GENERAL LAB SAFETY

Laboratory workers are expected to take responsibility for their own safety by learning the locations of, and how to use emergency equipment as well as being proficient in emergency procedures.

6.1 ACCESS TO HAND WASHING FACILITIES

All wet bench labs will have access to a sink suitable for hand washing.

6.2 EMERGENCY EQUIPMENT

Includes fire extinguishers, emergency eyewashes, and exits.

- All emergency equipment shall be prominently identified with signs.
- All wet bench labs shall have an emergency shower and eyewash within 10 second access from those locations where chemicals are handled
- All labs shall have a fire extinguisher of an appropriate type.

6.3 EMERGENCY EXITS/MEANS OF EGRESS

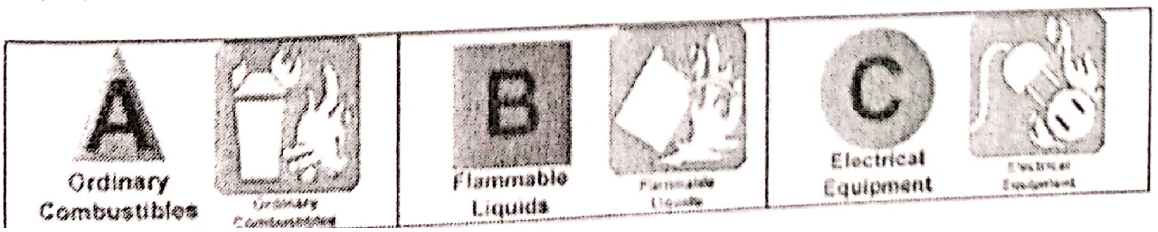
- Includes not only exit doors but the corridor, aisle, or stairwell thatyou must traverse to reach the exit.
- Main aisles inside the lab leading to the exit must be at least 48 inches wide and must not have "trip hazards" or other obstructions such as equipment (temporary or permanent), boxes, or supplies.
- All other aisles must be at least 36 inches wide
- Stair wells may not be used as storage areas for equipment, chemicalsetc.

6.4 FIRE EXTINGUISHERS

- All fire extinguishers need to be located in identified places.
- All persons working at TKMCE are required to take fire extinguisher training initially and annually

6.4.1 ABC Extinguishers

Dry Chemical Extinguishers are the most commonly found type of extinguishers. They are effective against paper fires (Class A fires), burning liquids (Class B fires), and electrical fires (Class C fires) However the ABC extinguisher is filled with monoammonium phosphate, a yellow powder that leaves a corrosive sticky residue that may be damaging to electrical equipment such as a computers, or other sensitive electrical equipment.



6.4.2 Carbon Dioxide Extinguishers

These are effective against burning liquids, such as hydrocarbons, and electrical fires (Class B and C fires). They are recommended for fires involving delicate instruments and optical systems because they do not damage such equipment. They are less effective against paper, trash or metal fires and SHOULD NOT be used against lithium or aluminium hydride fires.

6.4.3 Met-L-X Extinguishers

These have special granular formulations and are effective against burning metal (Class D fires). Included in this category are fires involving magnesium, lithium, sodium, and potassium; alloys of reactive metals; and metal hydrides, metal alkyls, and other organo-metallics. These extinguishers are less effective against paper and trash, liquid or electrical fires.

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

FIRE EXTINGUISHER CHART

6.4.4 Using Fire Extinguishers

Never attempt to use a fire extinguisher if the fire is between you and the exit. In such a case the only appropriate course of action is to evacuate. If you do decide to fight a fire, have someone pull the fire alarm and evacuate the building while you fight the fire.

6.5 SPILL KITS AND SPILL CLEAN UP PROCEDURES

Chemical Spilled	**Clean-up Procedure**
Acids, organic	Apply sodium bicarbonate. Adsorb with spill pillow or vermiculite.
Acids, inorganic	Apply sodium bicarbonate/Calcium Oxide or sodium carbonate/calcium oxide. Adsorb with spill pillow or vermiculite. NOTE: Hydrofluoric acid is an exception to the General practice, see below.
Acid Chlorides	Do not use water. Absorb with sand or sodium bicarbonate.
Aldehydes	Absorb with spill pillow or vermiculite.
Aliphatic Amines	Apply sodium bisulphite. Adsorb with spill pillow or vermiculite.
Aromatic Amines	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Aromatic Halogenated Amines	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Azides	Absorb with spill pillow or vermiculite. Neutralize with 10% ceric ammonium nitrate solution.
Bases (caustic alkalis)	Neutralize with acid, citric acid, or commercial chemical neutralizers. Absorb with spill pillow or vermiculite.
Carbon Disulfide	Absorb with spill pillow or vermiculite
Chlorohydrins	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Cyanides	Cover solids with damp paper towel and push onto dust pan or use a HEPA filter vacuum to collect the solids. Absorb liquids with spill pillow or vermiculite.
Halides, organic or inorganic	Apply sodium bicarbonate.
Halogenated	
Hydrocarbons	Absorb with spill pillows or vermiculite.
Hydrazine Hydrofluoric Acid	Avoid organic matter. Apply "slaked lime". Adsorb with spill pillow or vermiculite. Apply calcium carbonate (limestone) or lime (calcium oxide) rather than sodium bicarbonate. The use of sodium bicarbonate will lead to the formation of sodium fluoride, which is considerably more toxic than calcium fluoride. Be careful in the use of spill pillows used to absorb the acid. Some pillows contain silicates which are incompatible with hydrofluoric acid.
Inorganic Salt Solutions	Apply soda ash
Mercaptans/Organic Sulphides	Neutralize with calcium hypochlorite solution. Absorb with spill pillow or vermiculite.
Nitriles	Sweep up solids. Absorb liquids with spill pillows or vermiculite.
Nanoparticles	Pick up particles with a HEPA or ULPA filtered vacuum.
Nitro compounds /Organic Nitriles	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Oxidizing Agents	Apply sodium bisulphite.
Phosphates, organic and related	Absorb with spill pillow or vermiculite.
Reducing Substances	Apply soda ash or sodium bicarbonate.

6.6 HOUSE KEEPING

A high standard of cleanliness will be maintained in laboratories and offices including its surroundings.

It is the responsibility of the supervisory teacher/staff to ensure that the students and staffs are properly instructed to keep a good house keeping in their areas.

Suitable containers shall be located in the areas and places to be defined for reception of waste materials, cleaning rags, waste etc. These receptacles will be cleaned periodically. Such receptacles will be provided with lids and will be soaked with water occasionally to prevent fire hazards.

Separate receptacles for collection of salvage materials shall be provided at suitable places, where steel or other scraps shall be deposited. Periodical removal of such material should be ensured. Suitable drip tray shall be fixed wherever oil, water or other solutions are likely to drop from machinery or plant. Periodical emptying of these trays shall be arranged.

Any grease, oil, acid or alkaline materials spill will be cleared up without delay. Free unobstructed access to safety or firefighting equipment's, electrical control panels, safety showers etc shall be ensured.

No pipe line or power cables shall be across pathways thus constituting a tripping hazard. Whenever it is necessary to depart from the standards of cleanliness as in the case of major maintenance operations, the area concerned will be suitably cordoned off and such areas being limited to the absolute minimum. Even during such maintenance operation everything possible should be done to prevent unnecessary accumulation of dirt etc. by proper removal of waste material. On completion of the work it is the responsibility of the concerned maintenance personnel to restore the proper standard cleanliness.

No inflammable liquid or fuel oil will be allowed to go into cable trenches which are generally kept covered. In the event of any accidental falling of spark, the cable trenches are likely to catch fire due to the accumulation of inflammable fluids or fuel oils.

- All lab users share the responsibilities of keeping their work stations and work areas free from the accumulation of materials and equipment. Clutter is a safety hazard that promotes trips and falls, chemical spills, and fires.
- Stock chemicals are to be returned to the storage cabinet when you are done with them and always returned to the cabinet before leaving at the end of the day.
- Dirty glassware is to be placed in appropriate containers- not left on lab benches or in sinks.
- Minor spills are to be cleaned up immediately by the lab staff; major spills are to be reported immediately.

- Eliminate safety hazards by maintaining laboratory work areas in a good state of order. Maintain at least two clear passages to laboratory exits.
- Always keep tables, fume hoods, floors, aisles and desks clear of unnecessary material.
- Wipe down bench tops and other laboratory surfaces after each use with an appropriate cleaning or disinfecting agent.
- Keep the laboratory floor dry at all times. Immediately attend to spills of chemicals or water, and notify other lab workers of potential slipping hazards.
- All machinery under repair or adjustment should be properly tagged prior to servicing. All service work should be done by authorized personnel. Sink traps and floor drains should be flushed and filled with water on a regular basis to prevent the escape of sewer gases or the release of chemical odors in the event of an emergency. Drains which will not be routinely used may be "topped" with 20-30 ml of mineral oil to prevent evaporation of water in the trap.

6.7 FIRE SAFETY

- All labs shall post the emergency shut locations off for natural gas, compressed air, or other "plumbed" gases and electricity in a prominent location. Additionally, these shut off locations shall be prominently marked, including marking breaker box switches. The existence and location of emergency shut offs shall be included in all new employee orientation programs and the lab's safety program. Be aware of ignition sources in lab areas such as open flames, heat, and electrical equipment.
- Be particularly aware of ignition sources which are less than 24" from the floor, such as vacuum pumps, computers, refrigerator compressors, and other floor mounted electrical equipment. Whenever possible, place vacuum pumps and other small electrical equipment on shelves or stands to elevate them at least 24" above the floor.
- Purchase and store flammable reagents in the smallest quantities available.
- Store flammable liquids that require refrigeration in flammable safe or explosion proof refrigerators.
- Store flammable liquids in appropriate safety cabinets and/or safety cans.
- Do not store incompatible reagents together (e.g., acids with flammables) Be aware of the condition of fire extinguishers. Inspect fire extinguishers monthly and record the inspection on the back of the tag.

6.8 ELECTRICAL SAFETY

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

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, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest. The chart below shows the general relationship between the degree of injury and amount of current for a 60-cycle hand-to-footpath 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 mill amperes of current flow.

Current	**Reaction**
1 Milliampere	Perception Level
5 Milliampere	Slight shocks felt; not painful but disturbing
6-30 Milliampere	Painful shock; “let-go” range
50-150 Milliampere	Extreme pain, respiratory arrest, severe muscular contraction
1000-4300 Milliampere	Ventricular fibrillations
10000+ Milliampere	Cardiac arrest, severe burns and probable death

In addition to the electrical shock hazards, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors.

Even loss of electrical power can result in extremely hazardous situations. Flammable or toxic vapors may be released as a chemical warms when a refrigerator or freezer fails. Fume hoods may cease to operate, allowing vapors to be released into the laboratory. If magnetic or mechanical stirrers fail to operate, safe mixing of reagents may be compromised.

6.8.1 GENERAL CAUSES OF ELECTRICITY HAZARDS

1. Design and manufacturing defects in electrical equipments.
2. Use of inferior quality electrical equipments and their part.
3. Not replacing the defective components in time.
4. Postponing the scheduled electrical maintenance work.
5. Neglecting the instruction from the concerned engineers.
6. Not using the shock proof appliances according to the electricvoltage.
7. Improper earthing of electrical appliances/equipments.
8. Unauthorized repairs in electrical lines.
9. Overloaded electrical equipments.
10. Insulation failure of cable/wires.
11. Electric short circuit.
12. Not carrying out insulation test and continuity test in time.
13. Improper joints in the electricalappliances/equipments/wires/cables.
14. Spark due to static electricity.
15. Lifting.
16. Presenceof inflammable /explosive materials and defects in the flame proof/explosive proof lighting arrangements in those areas.
17. Unauthorized starting equipments/system.
18. Failure in disconnecting a machinery before the start-up of maintenance work.
19. Neglecting the caution boards.
20. Neglecting the caution boards.
21. Running the electrical equipments beyond the prescribedperiod.
22. Working on the electrical lines/appliances by unqualifiedpersons.
23. Unprotected wires/cables which are subjected to extremetemperature and mechanical abrasion.

6.8.2 AVOIDING ELECTRICAL HAZARDS

- All equipment should be inspected before use.
- Make sure that all electrical cords are in good condition.
- All electrical outlets should be grounded and should accommodate a 3-pronged plug. Never remove the grounding prong or use an adapter to bypass the grounding on an electrical cord.
- All electrical outlets within 6 feet of a water source (sink, eyewash, etc.) must be equipped with a Ground Fault Circuit Interrupter (GFC) either on the outlet, or somewhere on the electrical line. Note- the GFC may be located at the circuit breaker box. All GFC outlets/ GFC equipped lines shall be clearly labelled.
- All electrical equipment must have 3 prong or polarized plugs(one prong wider than the other).
- Extension cords may only be used on temporary equipment (or equipment which must be moved frequently) and must be rated so as to be adequate for the equipment they serve.
- Permanent equipment (to be in place or has been in place more than 6 months) must have permanent wiring- not extension cords. Extension cords may not be ganged together.
- Power strips with surge protectors are allowed but may not beganged together.
- All labs should have instructions on where circuit breakers arelocated to deenergize circuits in the event of emergencies.
- Do not place power strips in front of fume hoods or any other location where liquids re routinely handled.

6.9 GAS CYLINDER SAFETY

6.9.1 General Rules for Handling Gas Cylinders

- All compressed gas cylinders shall be secured with chain or strap between the "waist" and "shoulder of the cylinder at all times. This includes empty cylinders.
- Cylinders not currently in use must be capped. ("in use" includes cylinders connected to equipment or processes used at least 3 times per week)
- Empty cylinders must be capped Limit the number of cylinders in the lab by keeping no more than 1back up cylinder for every cylinder in use.
- Cylinders must be kept away from electrical wiring where the cylinder could become part of the circuit.
- Store cylinders in well-ventilated areas designated and marked only for cylinders.
- Store cylinders in an upright position.
- Empty cylinders should be clearly marked and stored as carefully as those that are full because residual gas may be present.
- Mark empty cylinders EMPTY
- Keep valves closed on empty cylinders.
- Protect cylinders from corrosive vapors and sources of heat
- Do not store cylinders in egress areas near emergency exits, hallways, or under stairs.
- Do not keep cylinders more than 5 years past their hydrostatic test date (see receiving cylinders, below).

6.9.2 Receiving Cylinders

- Inspect all cylinders upon delivery for valve protection and hydrostatic test date, which should be within the past 5 years. The hydrostatic test date will be stamped into the collar of the cylinder.

  Do not accept the cylinder past its hydrostatic test certification

  Do not keep a cylinder past its hydrostatic test certification. (This is due to Department of Transportation regulations- it is not legal to transport a cylinder that is out of date, so technically, the gas supply company can't remove it if it is out of date.)

  Do not accept cylinders unless they are clearly labelled as to their contents. NEVER rely on cylinder colour as an indicator of the cylinder's contents

6.9.3 Moving/Transporting Cylinders

- Never move a cylinder that is not capped.
- Always use a cylinder cart to move cylinders from place to place, do not roll or "twirl" them from one place to another.
- Don't use the protective valve caps for moving or lifting cylinders.
- Don't drop a cylinder, or permit them to strike each other violently or be handled roughly.

6.9.4 Labelling Cylinders

- The cylinder, not the cap, must be labelled as to the contents and supplier. Do not rely on cylinder colour to identify cylinder contents: colour coding is not universal and varies from one supplier to another.
- Cylinder labels must be facing out so as to be visible to lab inspectors and emergency responders.

6.9.5 Cylinder Fittings/Gas Tubing

- Cylinder fittings vary between gas types, inert, oxidizing, corrosive, and flammable.
- Never use grease or Teflon tape to force a fitting- you may be putting together two types of incompatible fittings.
- Always use non-sparking tools (brass or aluminium) to work on flammable or oxidizing gas fittings.
- Flammable and poison gases may only be used with stainless steel tubing.

6.9.6 Regulators

- Must be marked for the maximum cylinder pressure. Cylinder pressure may not exceed 75% of the regulator's maximum rated pressure
- Must be equipped with two gauges: one to show the cylinder pressure and the other to show the outlet pressure. An exception to this is single stage regulators used for corrosive gases.
- Never use an adapter between the regulator and the source cylinder
- Never use an aid, such as Teflon tape to connect a regulator to a cylinder.

6.9.7 Cylinder Use

Be sure all connections are tight. Use soapy water to locate leaks.

- Keep cylinder valves, regulators, couplings, hose and apparatus clean and free of oil and grease.
- Keep cylinders away from open flames and sources of heat.
- Safety devices and valves shall not be tampered with, nor repairs attempted. Use flashback arrestors and reverse-flow check valves to prevent flashback when using oxy-fuel systems.
- Regulators shall be removed when moving cylinders, when work is completed, and when cylinders are empty.
- Cylinders shall be used and stored in an upright position.
- The cylinder valve should always be opened slowly. Always stand away from the face and in back of the gauge when opening the cylinder valve.
- When a special wrench is required to open a cylinder or manifold valve, the wrench shall be left in place on the valve stem when in use; this precaution is taken so the gas supply can be shut off quickly in case of an emergency; and that nothing shall be placed on top of a cylinder that may damage the safety device or interfere with the quick closing of the valve.
- Fire extinguishing equipment should be readily available when combustible materials can be exposed to welding or cutting operations using compressed cylinder gases.

6.10 MECHANICAL HAZARDS

6.10.1 WORK ON MOVING MACHINE AND SAFEGUARDING

1. GUARDING AND FENCING:

Most of the accidents are due to lack of guarding of machines in motion. So safeguarding is essential.

a. To prevent direct contact with the moving parts of machine.
b. To prevent injury caused out of the work in process, e.g. Fly of metal chips from machine tool, splashing of hot metal or chemical.
c. To prevent from human failure such as distraction, fatigue, over confidence, worry, illness, anger and deliberate chance taking.

2. PRECAUTION TO BE TAKEN

a. No guard should be dismantled or adjusted or removed by any reason by anyone, unless specific instruction from the lab instructor.
b. Machine should not be started without putting guards.
c. Inform the superintendent, if any guard is defective or missing.
d. Staff and students should not be permitted to work on or around moving machinery and mechanical equipment wearing muffler, loose turbans or clothing, or long chain(jewelry).
e. Whenever guards or devices are removed to make repairs or adjustments of service equipment (lubrication and maintenance) the power for the equipment should be turned OFF and main switch locked and tagged.

Also, handrails and fencing provided along floor, floor opening steps, stairs, and walkways should be maintained properly. If it is necessary to remove a section of fencing for any work, it will be the responsibility of whoever is in charge of the work to ensure that they are cordoned off and displayed caution notice until they are replaced.

6.10.2 WELDING AND GAS CUTTING

Welding and gas cutting job is quite common in workshops. Cuts, burnings, eye diseases, and fire are certain hazards which are connected with welding and gas cutting. It is true that most of us are ignorant and careless about the hazards connected with these jobs.

6.10.2.1 GAS WELDING AND CUTTING

Oxygen, acetylene, hydrogen, propane, butane, etc. are the important gases that are used for gas cutting and welding. But most commonly acetylene and oxygen are used for the purpose.

1.STORAGE OF OXYGEN AND ACETYLENE CYLINDERS

1. Acetylene cylinders should not be stored near source of heat radiation such as radiators, furnaces, ovens etc.
2. Oil, grease and other flammable materials should not be storedwith acetylene cylinders.
3. Oxygen cylinders should not be stored along with acetylenecylinders.
4. Keep all the cylinders in upright position. Enough protection should be given to valves. Care should be taken to see that they are not stored near falling bodies, vehicles gangway etc. that may damage the cylinders.

2. HOW TO USE

1. All the cylinders should be used in upright position.
2. Unsuitable instruments, meters,, etc., should not be forcefully used or connected.
3. Open valves slowly, specifically supplied tools should be used toopen it.
4. Do not use cylinders without pressure regulators and meters.
   Grease or oil should not be used to lubricate valve threads or connections.

3. HANDLING OF ACETYLENE CYLINDERS

1. Cylinders should not be dragged. The marks or number stamped on them should not be removed.
2. Do not lift or shift a cylinder using electromagnets.
3. During transportation care should be taken even if cylinder are empty that there should not be any violent collision between them.
4. Protective caps should be provided so that valve should not be damaged.

6.10.2.2 SAFETY RULES, REGARDING WELDING TORCHES ANDCYLINDERS

Gauges showing the cylinder and regulator pressures: Non return require valve and safety valve on the regulator and welding torches special attention and regular check:

Non return valve on oxygen and acetylene lines for leakage and cracks, mixing nozzle for leakage and clogging etc. to be checked. Check the threaded joints, washers and nipples for leakage.

Check additional oxygen line and valve on the cutting torch for leakage.

Those who involve in the welding operation should practice the following precautions in the use of torches and cylinders.

- Check the smooth flow of gas through the nozzle before use.
- Check leakage in the nozzle hoses and in the joints and see that these are rectified before use
- Let in oxygen first before acetylene prior to lighting and close acetylene first before oxygen after the job is over.
- Keep the cylinders, particularly acetylene cylinder upright chained or secured.
- Use friction lighter and not matches for lighting torches.
- Crank open the acetylene valve and not suddenly.
- Any defects noticed, should be promptly attended to and if necessary, sent for repair, inspection and test to the shops.
- Always use welding screens, and goggles and other protective equipment.
- Do not interchange the oxygen and acetylene nipples for connection of the hose.
- Does not drop, hammer or rough handle cylinders in any way.
- Always protect hose from being run over, flying sparks, hot slag, hot objects and open flame.
- Do not allow hose and oxygen cylinders to come in contact with oil or grease.
- All connection between regulators, adaptors, and cylinder valves should be tight. Leak should be tested with soap water and never with flame.
- Oxygen and acetylene cylinders should not be stored together while in store.
- Cylinder valves should be tightly closed before handling cylinders.
- Keep spark and flame away from the acetylene cylinder and rubber hose.

- Acetylene cylinder key for opening cylinder valve must be kept on the valve stem while cylinder is in use.
  If leak occurs in an acetylene cylinder, take cylinder out in the open air, keeping well away from fires, open lights and other sources of ignition

STATIC ELECTRICITY

Static electricity is produced by the continuous friction of a bad conductor material on the surface of metals. This electricity should be properly earthed to avoid sparks and thereby explosions.

6.10.2.3 ARC WELDING

Either AC or DC can be used for welding by using a transformer or a rectifier.. In any case the welding voltage may not exceed 100 volts. Even though the voltage is less the current ranges from 70-600 amperes. the current should not exceed more than the value since we cannot give protection from the heat generated in the welding to the welders. We know that a person gets electric shocks even at 20 milliamps. Hence we can imagine the severity of an electric shock getting from welding.

Fire during electric arc welding are very common. It is caused by any of the following reasons: Improper earthling of welding transformer and job.

Poor condition of welding cables. Bad house keeping in surrounding area.

Inadequate or lack of covering of combustible materials to prevent their contact with welding sparks. If fire occurs, extinguish the flames by water, and or extinguisher completely. Keep cylinders cool by spraying water on them; and Repair the blow pipe for any faults in it.

6.10.2.4 PREVENTION OF WELDING FIRE

Welding transformers should be properly earthed at the secondary winding and return cable should be as good as the line cable.

Fire retardant brattice cloth can be used to cover up combustible materials in the neighbourhood.

Electrical burns are different from fire burns as the burning caused by the former one is very deep compared to the latter. It is difficult to find out the severity of electrical burns by external inspection and hence it is difficult to cure the burns medically.

Cover the affected part with a sterile cloth. If the burning is a major one do not remove cloth from the affected part.

If breathing has stopped give artificial breathing and call a doctor immediately.

Safety reminder:

Sharps and glass in the regular trash can injure the people who pick up your trash. Please think of others when you discard these items and discard them in to the appropriate containers!

7

CHEMICAL SAFETY

7 CHEMICAL SAFETY

A hazardous Chemical/substance is a chemical which may pose an unreasonable risk to the health of anyone and safety of the environment. It is a chemical that is somewhat toxic, inflammable or explosive or corrosive or poisonous or radioactive or having other hazardous properties. The environment (Protection) Act (India) defines "Hazardous Substance" as any substance or preparation which by reason of its chemical or physic-chemical which by reason of its chemical or physicochemical properties or handling is liable to cause harm to human being or other living creatures, plants micro-organism property or environment.

7.1 CONTROLLING CHEMICAL EXPOSURE

The following measures are used to prevent chemical exposures whenever possible or to reduce them to safe levels when prevention is not possible.

7.1.1 Chemical Hygiene

- All wet bench laboratories shall have hand washing facilities to include a sink with warm water, soap, and hand towels.
- No eating, drinking, smoking, applying cosmetics, removing/inserting contact lenses, or putting anything in your mouth is allowed in laboratories.
- Nothing associated with food is allowed in laboratories (except when the food is the object of the research). This includes no storage of food in laboratory refrigerators, no storage of food or food-utensils in laboratory cabinets.
- Do not wash food dishes or utensils in laboratory sinks.
- No chemicals/lab samples or laboratory glassware or utensils are allowed in break rooms or offices.
- Unless you are transporting chemicals between labs, gloves should not be worn outside of the laboratory.
- Change your gloves before touching computer keyboard/mouse, telephones, and door handles
- Hands shall be washed with soap and water as appropriate throughout the day; after taking off gloves; before leaving the lab; before eating, drinking, and after using the bathroom.

Safety reminder

Mouth pipetting is strictly forbidden.

7.1.2 Engineering Controls

After hygiene, engineering controls are the next most important means of controlling exposure to hazardous chemicals. Engineering controls are anything that is built or installed to separate people from chemical, biological or physical hazards, and can include fume hoods, glove boxes. Etc.

7.2 CHEMICAL WASTE DISPOSAL

7.2.1 Solvents and Organics

- Do not allow to go down the drain-ever.
- Shall be containerized with compatible materials. Usually this is halogenated or non-halogenated solvents.
- The empty containers should be left overnight in a fume hood toevaporate any remaining residue
- Deface the container label (a big X with a wide tipped marker will suffice)
- Discard uncapped container in the appropriate waste container(glass disposal box, if appropriate)

7.2.2 Acids and Bases

- May not go down the drain (Except in facilities equipped with an "active" acid-base neutralization system- if you are not sure if your lab has one of these ASK before putting acids and bases down the drain.)
- Get containerized with compatible materials
- Triple rinse empty container, pouring the rinsate down the drain
- Deface the container label (a big X with a wide tipped marker will suffice)
- Discard uncapped container in the appropriate waste container (glass disposal box, if appropriate)
- In lab waste neutralization is allowed but should be undertaken with caution.

7.2.3 Waste Containers

Ensure the availability of suitable waste containers for waste disposal. Multiple small containers, such as sample vials containing research products if any, should be consolidated into single packages.

7.2.4 Labelling of Waste

- WASTE CONTAINERS MUST BE LABELED BEFORE THE WASTE GOES INTO THEM (Remember you can always change the label if the contents deviate from what you expected.)

7.2.5 Used Oil

Used oil means any oil that has been refined from crude oil, or any synthetic oil, that has been used, and as a result of such use is contaminated by physical or chemical impurities. Examples of used oil include pump oil, motor oil, hydraulic fluid, lubricants and oil coolants. Containers and aboveground tanks used to store used oil must be labelled or marked clearly with the words "Used Oil", and NOT "Waste Oil."

7.2.6 Lab Clean Outs

Annual lab clean outs are a mandatory safety practice. Regular clean outs prevent the accumulation of unwanted chemicals, including those that become dangerous with age.

7.3 CHEMICAL STORAGE

7.3.1 General Storage Guidelines for Solids and Liquids

Use sources such as MSDSS for guidance on storage, incompatibility, reactivity and stability for chemicals.

- Do not tip bottles when returning them to a shelf. Shelves must have enough clearance to accommodate the largest container.
- Do not store chemicals (except cleaners) under sinks. Use approved flammable storage lockers, corrosive storage lockers, shelves or cabinets.
- Avoid stockpiling chemicals.
- Conduct periodic cleanouts to prevent accumulating unnecessary chemicals.
- Do not sort and store chemicals alphabetically unless they have first been separated into hazard classes
- Avoid exposure of chemicals to heat or direct sunlight. This may lead to the deterioration of storage containers and labels, as well as the degradation of the chemicals. Some time-sensitive chemicals such as peroxide-formers (see below) can be affected as well.
- Store solids on shelves or in cabinets.
- Avoid storing chemicals on countertops or in fume hoods except for those being currently used.

7.3.2 Acids

Storage requirements are provided below. Consult the chemical's Material Safety Data Sheet for specific storage and incompatibility.

- Store acids and bases separately from each other and from other incompatible chemicals. For example, store oxidizing acids (such as nitric, perchloric, and sulfuric acids) separately from combustible and flammable liquids/materials.
- Segregate acids from reactive metals such as sodium, potassium, and magnesium.
- Nitric acid and hydrochloric acid may be stored in the same corrosive storage cabinet, but they must be kept in separate drip trays. These can combine to form chlorine and nitrosyl chloride gases both are toxic.
- Segregate organic acids (acetic, formic, etc.) from mineral acids (nitric, hydrochloric, etc) by use of separate secondary containers. These acids are combustible and will react if they come in contact with an oxidizing acid.
- Segregate acids from chemicals that could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulphide and calcium carbide.
- Store in a cool, dry environment free from extremes of temperature and humidity.
- Store in sealed, air-impermeable containers. Containers with tight fitting caps are necessary. Containers with loose-fitting lids or glass stoppers should not be used.

- Do not store piranha etch (a mixture of 98% sulfuric acid and 30% hydrogen peroxide in ratios ranging from 2-4:1), aqua regia (1:3 mixture of concentrated nitric and hydrochloric acids), or Nitol (a mixture of nitric acid and ethanol that becomes explosive if the nitric acid exceeds 10%). Make these solutions just prior to use and dispose of left-over material with the process waste in a "vent- able" container. (See Waste, below)
- Use storage cabinets specifically designed for corrosives. These should be connected to exhaust ventilation whenever possible. Usually, at least one of the cabinets directly under the fume hood will be passively connected to the fume hood exhaust.
- Use secondary containment for all liquids. Do not store aqueous sodium and potassium hydroxide solutions in aluminium drip trays. These will corrode aluminium and compromise its integrity.

7.3.3 Bases

Storage requirements are provided below: Consult the chemical's MSDS for specific storage and incompatibility.

- Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials.
- Do not store aqueous sodium and potassium hydroxide solutions in aluminium drip trays. These will corrode aluminium.
- Store in a cool, dry environment free from extremes of temperature and humidity.
- Store in sealed, air-impermeable containers. Containers with tight fitting caps are necessary. Containers with loose-fitting lids or glass stoppers should not be used.
- Use storage cabinets specifically designed for corrosives. These should be connected to exhaust ventilation whenever possible. Usually, at least one of the cabinets directly under the fume hood will be passively connected to the fume hood exhaust.
- Use secondary containment for all liquids. Do not store aqueous sodium and potassium hydroxide solutions in aluminium drip trays. These will corrode aluminium and compromise its integrity.

Flammable Storage Lockers and Refrigerators

- Store flammable and combustible liquids in a cool, dry environment free from extremes of temperature and humidity.
- Keep away from heat, flames, and other sources of ignition.
- Ensure caps and lids are securely tightened on all containers. This prevents evaporation of contents. Teflon liners can be inserted into caps to help form a tighter seal.
- Ordinary domestic refrigerators and freezers must not be used for storing flammable liquids because they contain electrical components (light bulbs, switches, contacts and motors) that are potential ignition sources which may initiate a fire or an explosion if flammable vapors are present.
- Refrigerators and freezers for storing flammable liquids (including ethanol) must be designed, constructed and approved for that purpose.

- Domestic refrigerator/freezers as well as units that have been modified to remove spark sources are not acceptable.

7.3.4 Oxidizers

Oxidizers are compounds that supply their own oxygen and heat (ignition source) when in contact with organic compounds. These are chemicals that can react vigorously and explode.

Common oxidizing liquids and solids include:

Bromine	nitric acid
Bromates	nitrites
Chlorinated isocyanurates	perborates
Chlorates	perchlorates
Chromates	perchloric acid
Dichromates	periodates
Hydroperoxides	permanganates
Hypochlorites	peroxides
Inorganic peroxides	peroxy acids
Ketone peroxides	per sulphates
nitrates	

Storage requirements are provided below. Consult the chemical's Material Safety Data Sheet for specific storage and incompatibility.

- Store in non-combustible secondary containment (glass). Do not store directly on combustible shelving.
- Keep away from combustible and flammable materials.
- Keep away from reducing agents such as zinc, alkali metals, and formic acid.

7.3.5 Water Reactive

Water reactive are chemicals that react with water, sometimes violently, and may produce toxic or flammable gases. Examples of water reactive substances include sodium, potassium, and phosphorous pentachloride.

Storage requirements are provided below. Consult the chemical's MSDS for specific storage and incompatibility.

- Store in a cool, dry place, away from any water source.
- Make certain that a Class D fire extinguisher is available in case of fire.
- Separate alkali metals from incompatible chemicals. In addition to being water-reactive, alkali metals can also react with oxygen, acids, halogenated hydrocarbons, and carbon dioxide). Consult the MSDS for specific storage guidelines.
- Store all metals in the container provided by the manufacturer.
- Store alkali metals under mineral oil or in an inert atmosphere. NOTE: Lithium may react with nitrogen. Containers should be stored in a cool, dry environment, away from light and free from extremes of temperature and humidity.
- Use secondary containment.

7.3.6 Refrigerators

Domestic refrigerators used for storing non-flammable chemicals, samples or media must be labelled simply " NO FOOD, NO FLAMMABLES". Refrigerators and freezers for storing flammable liquids must be designed, constructed, approved, and labelled for that purpose. These refrigerators must be labelled "NO FOOD". NOTE: Ethanol-water solutions greater than or equal to 15% ethanol must be stored in a flammable safe refrigerator).

8

CRYOGENIC AND NANO MATERIALS

8 CRYOGENIC AND NANO MATERIALS

8.1 CRYOGENIC MATERIALS.

Cryogenic liquids have boiling points less than -150°C. Liquid nitrogen, liquid oxygen and carbon dioxide are the most common cryogenic materials used in the laboratory. Hazards may include fire, explosion, embrittlement, pressure build-up, frostbite and asphyxiation.

Many of the safety precautions observed for compressed gases also apply to cryogenic liquids. Two additional hazards are created from the unique properties of cryogenic liquids:

Extremely Low Temperatures -The cold boil-off vapor of cryogenic liquids rapidly freezes human tissue. Cold burns and frostbite caused by exposure to cryogenic liquids can result in extensive tissue damage. Also, proper materials selection is important in cryogenic conditions. Most metals become stronger upon exposure to cold temperatures, but materials such as carbon steel, plastics and rubber become brittle or even fracture under stress at these temperatures. Proper material selection is important. Cold burns and frostbite caused by cryogenic liquids can result in extensive tissue damage.

Vaporization - All cryogenic liquids produce large volumes of gas when they vaporize. Liquid nitrogen will expand 696 times as it vaporizes. The expansion ratio of argon is 1: 847, hydrogen is 1:851 and oxygen is 1:862. If these liquids vaporize in a sealed container, they can produce enormous pressures that could rupture the vessel. For this reason, pressurized cryogenic containers are usually protected with multiple pressure relief devices. The expansion ratio of cryogenic liquids, (except oxygen) in an enclosed area can significantly reduce the percentage of oxygen in the area and cause asphyxiation. Vaporization of liquid oxygen can produce an oxygen-rich atmosphere, which will support and accelerate the combustion of other materials. Vaporization of liquid hydrogen can form an extremely flammable mixture with air.

Properties of Common Cryogenic Materials

Gas	Gas Boiling Point (oC)	Liquid to Gas Volume Expansion
Helium	-268.9	1-757
Hydrogen	-252.7	1-851
Nitrogen	-195.8	1-696
Fluorine	-187.0	1-888
Argon	-185.7	1-847
Oxygen	-183.0	1-860
Methane	-161.4	1-579

Most cryogenic liquids are odourless, colourless, and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, the cold boil-off gases condense the moisture in the air, creating a highly visible fog.

Always handle these liquids carefully to avoid skin burns and frostbite. Exposure that may be too brief to affect the skin of the face or hands may damage delicate tissues, such as the eyes.

8.1.1 General Rules Regarding Handling of Cryogenic Materials

- Labs using cryogenic materials must have a specific Standard Operation Procedure (SOP) that covers not only how the material is to be used, but how the Dewar's are to be transported
- Cryogenic liquefied gases should be stored in cool and properly ventilated space.
- Cryogenic materials shall not be used in a confined space with inadequate ventilation due to the potential for asphyxiation. (This includes cold rooms and warm rooms)
- Cryogenic materials shall not be warmed in closed containers.
- Dewars shall be inspected daily for ice plug formation.
- Cryogenic materials containers shall have relief devices that have been engineered into the containers or closed systems.
- TAMPERING WITH OR ALTERING THE PRESSURE RELIEF VALVE ON ACRYOGENIC STORAGE VESSEL IS STRICTLY FORBIDDEN
- Boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids. Perform these tasks slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid.
- Use extreme caution with cryotubes. An explosion hazard exists if liquid nitrogenhas entered the tube through any defects or cracks and may expand rapidly causing an explosion/shrapnel hazard
- Never touch un-insulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even non-metallic materials are dangerous to touch at low temperatures.
- Use wooden or rubber tongs to remove small items from cryogenic liquid baths. Cryogenic gloves are for indirect or splash protection only, they are not designed to protect against immersion into cryogenic liquids.
- Cylinders and dewars should not be filled to more than 80% of capacity. since expansion of gases during warming may cause excessive pressure buildup. Come into contact with cryogenic liquids and vapor.

8.2 COOLING BATHS AND DRY ICE

- Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air, because oxygen can condense from the air, leading to an explosion hazard.
- Wear insulated, dry gloves and a face shield when handling dry ice.
- Add dry ice slowly to the liquid portion of the cooling bath to avoid foaming over.

Do not lower your head into a dry ice chest, since suffocation can result from carbon dioxide build-up.

8.3 EMERGENCIES INVOLVING CRYOGENIC MATERIALS

- Anticipate emergency situations, and ensure the availability of proper handling equipment in the lab.
- Check the MSDS to determine what is appropriate.
- In the event of a spill or adverse reaction notify lab personnel immediately that an incident has occurred.
- Do not attempt to clean up a spilled cryogen.
- If a flammable or oxidizing gas is involved, evacuate and pull the fire alarm. If you can do so, turn off all ignition sources at the breaker box on your way out of the building.
- If skin comes in contact with a cryogen or dry ice, run the area of skin under lukewarm water for 15 minutes (do not use hot or cold water). Seek professional medical attention.

Remedial steps to prevent asphyxiation include:

1. Make users fully aware of the asphyxiation hazard.
2. Adhere strictly to work permits covering entry into vessels and closed spaces. Work permits for opens areas should take account of any vents that may be located in these areas.
3. Clear identify nitrogen and argon lines.
4. Avoid the possibility of inert gas being vented into an inadequately ventilated area.
5. Do not use synthetic air for breathing unless it has been carefully checked.
6. Forbid entry into a vessel which has been closed for some time even if it is thought to contain air, until the atmosphere has been checked.
7. Pipelines feeding nitrogen and argon vessel should be blanked or broken before access is allowed. Valves should never be relied upon to hold back gas.
8. Make composition checks in such a way as to ensure that the whole of the space being worked in is breathable.
9. Remember that argon, being heavy, is especially prone to form layers at low points
10. Appreciate the danger of inert gas accumulation from gradual leaks under enclosures such as acoustic hoods
11. When work is carried out in enclosed spaces, ensure that a helper is always standing by, and that suitable breathing equipment and rescue lines are always available.

8.4 NANO MATERIALS

The emerging field of nano-technology is an exciting, constantly changing science: even the definition of what is a "nano" particle has been refined in the last few years to include any intentionally manufactured particle which is less than 100 nm (1/100000m) in any dimension. Research in and uses for nano particles has advanced rapidly in recent years and, unfortunately, far outdistanced what we know about these materials from a safety standpoint. What we do know is this: nano-sized particles of common materials have different properties than their micro-sized counter parts. This is what makes them so interesting and potentially useful. What is NOT known is- do these tiny particles have health effects that are different from larger particles of the same material? So far, research on the health effects of these materials is limited and inconclusive.

9

WORKING WITH HIGH PRESSURE SYSTEMS

9 WORKING WITH HIGH PRESSURE SYSTEMS

High-pressure reactions are those experiments that are carried out at pressures above one atmosphere. This includes most hydrogenation reactions since explosive oxygen-hydrogen mixtures can be formed as a result of these reactions.

9.1 OPERATIONAL PRACTICES

- Service lines shall not be connected to any closed apparatus incapable of withstanding the maximum pressure of the service line (air, water, etc.).
- All pressure systems shall be protected with appropriate pressure relief devices.
- The pressure-relief device shall be installed so that the discharge is directed away from the area where a person could be affected (preferably toward the back of a hood)
- Pressure-relief devices shall be inspected periodically by lab staff. Orifices on both sides of the pressure-relief device should be checked for obstruction.
- Pressure gauges with pressure ranges about twice the working pressure of the system shall be used.
- Containers, fittings, and other equipment to be used when working with pressure vessels shall be chosen to able to withstand the stresses imposed by the given pressures and temperatures.
- The pressure levels of high-pressure devices shall be monitored periodically.

10

APPROPRIATE LAB ATTIRE

10 APPROPRIATE LAB ATTIRE

Personal attire while in the laboratory plays a major role in determining the level of risk of exposure to hazardous agents and of physical injury. Appropriate clothing provides an extra layer of protection against spills and splashes of hazardous materials. Appropriate clothing covers the torso, legs, and feet. Therefore, the following practices shall be adhered to TKMCE laboratories:

Allowed	**Not Allowed**	**Explanation**
Hair must be kept away from the eyes. Long hair must be tied back. Hair longer than 6 inches from the nape of the neck must also pinned up (Use of hair nets or hats is acceptable)	Hair must not impede vision, come in contact with the work, or open flames.	Hair can impede vision. Long hair can fall onto the lab bench/come in contact with chemicals or biologicals. Long hair is also a hazard around rotating equipment and open flames such as Bunsen burners or alcohol burners
Clothing that accommodates lab coat use.	Loose or flowing tops with wide/bell sleeves; outerwear coats or shawls that make it difficult to don a lab coat	Wearing this type of clothing makes it difficult/uncomfortable to wear a lab coat: The wearer may be tempted to do without the lab coat. Loose sleeves may also be dragged across the bench becoming contaminated and are a hazard around rotating equipment and open flames.
Long pants that cover the wearer to the ankle	Ripped jeans, shorts, capris, or skirts.	Chemicals splash up after they hit the floor; likewise shattered glass bounces up and can inflict injury on unprotected skin.
Completely enclosed shoes that cover the instep of the foot: preferably, of leather which can be wiped clean.	Sandals, open toe, open back, or open weave shoes; shoes with holes in the top or sides;	Shoes need to protect the wearer from chemicals, hot liquids, and shattered glass. Cloth shoes can absorb chemicals or hot liquids and hold them against the skin until they can be removed.

11

PERSONAL PROTECTIVE EQUIPMENT

11 PERSONAL PROTECTIVE EQUIPMENT

Protective Equipment (PPE) includes safety glasses, goggles, face shields, gloves, lab coats, aprons, ear plugs, and respirators. Personal protective equipment is carefully selected to ensure that it is compatible with the chemicals and the process used.

11.1 Eye Protection

- Safety glasses or chemical goggles must be donned before entering any wet bench lab.
- Safety glasses must meet the ANSI Z87.1 standard for impact resistance and have side shields for splash protection.
- Chemical goggles may be required for certain processes where safety glasses are deemed inadequate
- Safety glasses or goggles must be worn over prescription glasses. Safety glasses worn over prescription glasses must be of a type intended for this purpose (Often referred to as Over the Glass Safety Glasses). Regular prescription glasses will not provide adequate protection in this case.
- Prescription safety glasses are acceptable as long as they have side shields for splash protection. Side shields must also meet the Z87.1standard for impact resistance and be non-vented.
- Safety glasses or goggles are required all labs where soldering or machining/grinding occurs.

11.2 Lab Coats

- Shall be donned before handling chemicals, biologicals, or unsealed radiological sources.
- Shall cover the wearer to the knees.

11.3 Gloves for Protection against Heat or Cold

Thermal gloves for cryogenic applications are commercially available in a variety of lengths to be appropriate for the application. One should remember, however, that no cryo-protective glove is intended to provide protection against direct immersion in cryogenic liquids. Cryo protective aprons are also available.

A number of glove styles are commercially available for hot work processes, most of them involving layers of leather, Kevlar, and insulating foam. Like any other piece of personal protective equipment, thermally protective gloves must be chosen based on appropriate length, level of protection required, and also the level of dexterity required to accomplish the task at hand.

11.4 Administrative Controls

Administrative Controls are things that you can do to prevent chemical exposures that don't involve Engineering Controls (things you build or install) or Personal Protective Equipment (things you wear) and include thing like proper handling procedures and personnel rotation.

It is the responsibility of the faculty and staff to ensure that all persons working in his/her laboratory are made aware of all the reasonably anticipated hazards of the laboratory including but not limited to chemical, biological, physical, and electrical hazards.

11.5 Occupational Health

Workplace Occupational Health is an important issue for TKMCE and its employees. Scientific research and other work activities involving the use of chemical, biological, and/or radiological materials has the potential to expose employees to health hazards. These hazards can create both short-term and long-term health issues. TKMCE is strongly committed to protecting the health of all its employees through awareness, training, medical evaluations, engineering controls and appropriate workplace protective measures.

11.6 VISITORS

It is the responsibility of the faculty and staff in charge to ensure that visitors have received all appropriate training before being allowed to enter in TKMCE labs including basic lab safety, waste handling procedures, and lab/process specific safety training. These persons must also be provided with basic personal protective equipment (PPE) such as safety glasses, gloves, and lab coats if they cannot provide their own.

12

SAFETY TRAINING

12 SAFTEY TRAINING.

All persons working in TKMCE labs must be formally oriented to the lab and its hazards prior to starting work by the lab Instructor.

Additionally, they are required to provide standard operating procedures. for processes which are inherently hazardous (highly reactive, pyrophoric, water reactive, etc.) or that involve highly/ extremely toxic materials, or highly reactive materials. Highly toxic materials include. materials that have an LD50 less than 50mg/kg by oral exposure or an LC50 of less than 200 ppm by inhalation exposure. Extremely toxic. materials have an LD50 of less than 5 mg/kg by oral exposure.

The following lists the information that should be provided by the lab Instructor and technician

- The 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 OSHA regulated substances or recommended exposure limits (for example, 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 odour of hazardous chemicals when being released)
- The physical and health hazards of chemicals in the work area Lab superintendents, Instructors and technicians must be re-trained when new equipment or hazards are introduced into their workplace, as well as upon reassignment to different workplaces that involve new equipment or 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 employees can be assigned work in or around hazardous chemicals.

12.1 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 should include,

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

12.2 FIRE EXTINGUISHER TRAINING

Fire extinguisher training with live suppression is required for all Lab superintendents, instructors and lab staff. This training program will give them confidence in their ability to operate the extinguisher in the case of any emergency.

The training covers

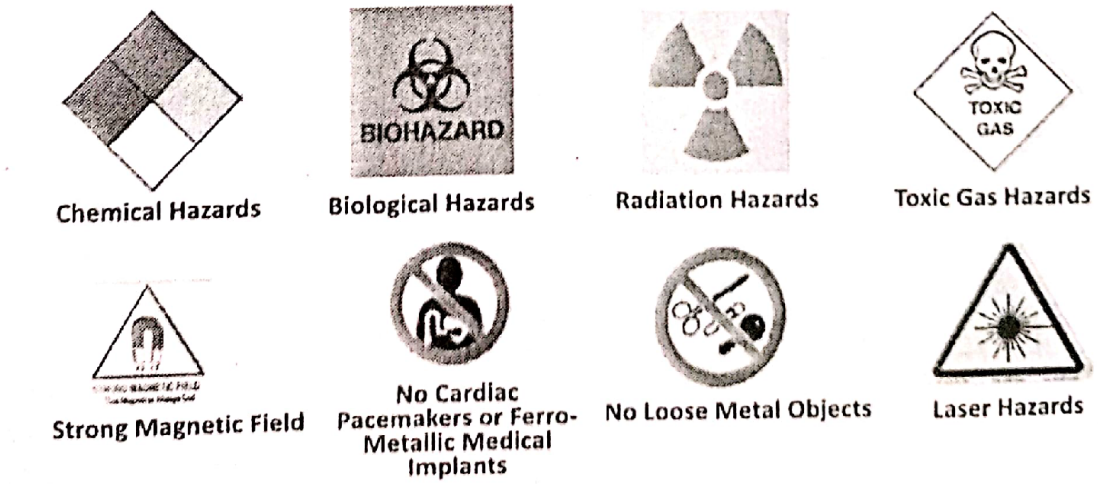
- What to do in the event of fire
- The behaviour of the fire and how it spreads
- The classes of fires
- The proper selection and use of a fire extinguisher

12.3 EXTERIOR LAB DOORS

All exterior lab doors (to the hall or to the outside of the building) must be posted with an emergency notification card that has the name and emergency contact telephone numbers

All persons entering the laboratory must have had a minimum, basic instruction in hazard avoidance for the hazards indicated on the door.

All persons entering must have safety training appropriate for the hazards listed below:



12.4 LABELLING CONTAINERS

1.Primary containers

A primary container is the one in which the material was received from the manufacturer.

The chemical or chemical product should be clearly labelled as to the contents; display the appropriate hazard warnings; and list the name and address of the manufacturer.

2.Secondary containers

A secondary container is one to which a chemical or chemical product is transferred or the container in which a new chemical product/reagent is made and stored.

3.Immediate use containers are containers which are only expected to last one work shift and are not intended to leave the control of the person who filled them. Immediate use containers must be labelled with the name of the chemical they contain- in English, and the name of the person who is using them.

4. Vials and Test Tubes (Sample Containers)

Vials and test tubes may have hazard labels affixed to the rack or container in which they are held, rather than on each vial or test tube, so long as every vial or test tube in the rack or container presents the same hazard. Lab notebook reference numbers are not an acceptable substitute for chemical name and hazard identification.

6.Unlabelled Containers

If a container is found in the workplace that is unlabelled or carries a defaced label, the employee should immediately notify a supervisor. Supervisor/staff in charge should take necessary steps to label it correctly

13

STATUTORY REGULATIONS

13 STATUTORY REGULATIONS

FACTORIES ACT 1948 AND KERALA GOVT RULES 1957

1.HEALTH

RECORD OF WHITE WASHING

Section 11 of Factories act Rule 16 of Kerala Government stipulates that a register shall be kept to record the date of white washing, Colour washing and Varnishing Etc.

RULE 34-39 DRINKING WATER

One water centre for 500 persons each. Which shall be well maintained and cleaned.

2.SAFETY

Rules 53-69 of Kerala Govt. rules under / section 21 Factories Act and section 22 and 54 guarding of Machinery and section 22 work on or a near machinery, every moving part of a prime mover, Fly wheel, Stock bar projecting from, generator motor, Rotary Convertor, Transmission Machinery and dangerous parts of machinery.

RULE 55

Guarding of machine tools such as gears and wheels of drilling machinery

RULE 56

Guarding of emery and abrasive wheel.

RULE 57

Floor should be non-slippery by making clean from chips, grease oils etc.

RULE 60

Lubrication of machine shall be done by an experienced person.

RULE 61

All service platforms should be fenced.

RULE 62

Machinery or Motor shall not be cleaned by cotton waste, rags or similar materials.

RULE 65 Convenient access should be given to all parts of machinery which requires attention while in motion.

RULE 66 No additional weight shall be kept on safety valve of boiler.

RULE 68 Display of periodicals, Safety posters.

RULE 69A A register of specially trained workers shall be kept in form No. 34

14

SAFETY SLOGANS

14 SAFETY SLOGANS

The following safety slogans can be posted in the appropriate places of your laboratories and offices.

1. SAFETY IS EVERYBODY'S BUSINESS
2. SAFETY IS AN EVERY DAY JOB
3. LIFE IS PRECIOUS. BE SAFETY CONSCIOUS
4. THINK LEISURELY ACT QUICKLY
5. ACCIDENTS DO NOT HAPPEN. THEY ARE CAUSED
6. ACCIDENTS BRING TEARS. SAFETY BRING CHEERS
7. ACCIDENT STARTS WHERE SAFETY ENDS
8. ARE YOU DOING ALL YOU CAN TO PREVENT ACCIDENTS?
9. 'ABC' OF SAFETY: ALWAYS BE CAREFUL
10. KILL FIRE BEFORE IT KILLS YOU
11. SAFETY IN MIND, ALWAYS KEEPS ACCIDENT BEHIND
12. LEARN NOT TO BURN
13. DO NOT MONKEY WITH ANYTHING WITHOUT UNDERSTANDING
14. CARELESSNESS RESULTS IN DISASTER. AVOID IT
15. CHANCE TAKER IS AN ACCIDENT MAKER
16. NO COMPROMISE ON SAFETY

15

FIRST AID TREATMENT

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The severity of any injury can often be limited to a considerable extent by prompt application of proper first aid measures. The following are some first aid measures that are to be taken according to the circumstances.

15.1 GENERAL

Immediate action is necessary.

The help of the physician should be sought for, in case of serious injuries.

Do not attempt to give any first aid, unless you are sure.

15.2 SUGGESTED FIRST AID AND MEASURES

In the case of Gas poisoning or asphyxiation due to any one of the following gases.

Acetylene; Ammonia; Carbon-di-sulphide; Chlorine; Hydrogen sulphide; Sulphur dioxide

Move the patient to fresh air immediately.

Keep the patient warm using blankets.

The patient must not undertake any physical activity, he should preferably be put to bed.

If the patient becomes unconscious

- Lay him with head lower than the rest of the body,
- Loosen clothing around neck; see that there shall be plenty of air
- Sprinkle face and chest with cold water
- Rub his limbs towards the body.

If breathing is interrupted-Start artificial respiration.

15.3 BURNS FROM HOT MATERIAL OR FIRE

If the clothing adheres to the skin, do not attempt to remove it but cut clothing carefully around the burnt area. Get immediate medical attention from the physician.

15.4 BURNS FROM CORROSIVE FLUIDS

If the burns are from corrosive fluids like Ammonia; Caustic soda; Sulphuric acid; Sodium Chlorate,

Get the patient under a shower or if a shower is not available in the vicinity, wash the area of the burns with copious quantity of clean water.

Remove the contaminated clothing under the shower

The use of neutralizing agents are not recommended

After complete washing the burns should be covered with a clean preferably sterile cloth.

Get the medical attention of physician If the patient becomes unconscious, the procedure mention above should be adopted in the case eye injury irrigate the eye with copious amount of low-pressure clean water for about 15 minutes, Neutralizing should not be attempted. The help of the physician should be sought immediately.

15.5 ELECTRICAL SHOCKS

Get the patient to fresh air and keep him warm, If shock is severe send for the medical officer If the patient is unconscious lay him with legs and feet higher than his head, the procedure mentioned above should be adopted.

15.6 CUTS AND BRUISES

If the bleeding is copious it must be first stopped by a tourniquet. Under no condition tourniquet be held tight for fifteen minutes at a time, loosen it and allow the blood to flow for few seconds and again tighten it. Wipe out wound with clean and sterile cloth and get medical aid.

15.7 ACTION TO BE TAKEN IN THE EVENT OF FIRE

Duties of individual discovering the fire Shout FIRE; FIRE at the top voice attack the fire at once with first aid fire extinguishing equipment available

15.8 DUTIES OF THE PERSON NEXT ARRIVING THE SCENE

Operate the nearest fire alarm and help to put out fire.

15.9 DUTIES OF THE INCHARGE OR SENIOR MAN PRESENT

Call the fire brigade immediately if an outbreak of fire is discovered. No matter how small the outbreak appears to be or even if only suspected, give the precise address of the fire.

15.10 DUTIES OF OTHER MEMBER OF THE STAFF AND STUDENTS OF THE AFFECTED LABORATORY/BUILDING

On hearing the fire alarm, the members of the staff and students will go at once by the most direct route to the place of assembly.

15.11 DUTIES OF THE OFFICER IN CHARGE OF THE AFFECTED LABORATORY/BLDG

Ensure that the fire brigade has been called Supervise the first aid firefighting and evacuation and operations till the arrival of the fire brigade.

Note: If the persons discovering the fire is alone, the order in which the above essential things to be carried out must be decided according to the circumstances. The calling of the fire brigade must be given as much serious attention as the others.

15.12 ABC OF FIRE EXTINCTION

Give the alarm at once; attack the fire; Remove valuables and call the fire brigade immediately.

"KILL FIRE BEFORE IT KILLS YOU"

APPENDIX

APPENDIX

DEFENITIONS

Engineering Controls are built-in systems or equipment that protect people from lab hazards. They include fume hoods, biosafety cabinets, and building ventilation systems.

Flammable gases include gases that, at ambient temperature and pressure, form a flammable mixture with air at a concentration of 13% by volume or less or in a concentration range wider than 13% by volume regardless of the lower limit (29CFR1910.1200). Examples: hydrogen, acetylene, propane. Refer to Appendix A for more examples. Refer to the MSDS for specific flammable gases. Pyrophoric gases include gases that will ignite spontaneously on contact with air at temperatures of 1300F (54.40C) or below (29CFR1910.1200) Examples: Silane, disilane, diborane, and phosphine.

Flammable Safe/Explosion Proof Refrigerators- Flammable safe refrigerators have protected internal electrical components that cannot provide a source of ignition to the contents of the refrigerator or freezer, making them safe to store flammable materials. Explosion proof refrigerators have protected internal and external components and are safe for storage of flammable materials in areas where large amounts of flammable materials are used or there is a high potential for spills of flammable materials.

Material Safety Data Sheet (MSDS)- Document which manufacturers or distributors of chemicals are required to produce which describe the hazards of their chemical or chemical product and safety precautions/handling procedures/ Personal Protective Equipment that must be used to work with that chemical safely. The United States Occupational Safety Administration (USOSHA) requires MSDSs under 29 CFR 1910.1200 Hazard Communication.

National Fire Protection Association (NFPA) an international non profit organization established to reduce the worldwide burden of fire and other hazards. NFPA develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks. http://www.nfpa.org/categoryList.asp? categoryID=143&URL=About%20NFPA

Personal Protective Equipment (PPE) is protective equipment that is worn, such as safety glasses, lab coats, aprons, respirators, etc. PPE is considered a second line of defence against work place hazards and may only be used when other means of protections are not adequate or not feasible.

Permissible Exposure Limit (PEL)- Exposure limit established by the United States Occupational Safety and Health Administration as documented in the US code of Federal Regulations, 29 CFR 1910.1000. Usually based on an eight hour time weighted average (TWA), this is the maximum level to which a worker my be exposed for eight hours each day, 40 hours per week for a working lifetime without expectation of adverse health effects.

Primary container is the container in which a chemical or chemical product is received.

Radiation Producing Equipment/radiation producing devices (X-ray) include all equipment that has the potential for emitting ionizing radiation (X-rays) in excess of 0.5 mR/hr at 5 cm. X-ray diffractometers are common on campus. E-beam evaporators, e- beam lithographs and scanning electron microscopes produce x-rays as by product radiation and are considered radiation producing equipment.

Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6901 et seq. (1976), gives the US EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes.

Secondary container is a container to which a chemical or chemical product is transferred or the container in which a new chemical product/reagent is made and stored.

Secondary containment- a container or device intended to control accidental releases of chemicals or chemical waste to the surrounding area. Examples of small-scale secondary containment may be chemically resistant trays, bins or buckets under the chemical containers. These containers must be large enough to hold the entire contents of the largest bottle or container within them. Some chemicalstorage cabinets are equipped with a lip on the bottom shelf which creates a secondary container.

Select Agents are a group of federally regulated bacteria, viruses, toxins, and fungi that have the potential to pose a severe threat to public, animal, or plant health. The use and possession of these biologicals is restricted by the USA Patriot Act and the Public Health Security and Bioterrorism Preparedness and Response Act of 2002.

Tepid Water- water that is neither hot nor cold. Also referred to as lukewarm. Eye washes and emergency showers are required to provide water which is a mix of hot and cold water (tepid) water so as to prevent further injury to chemical exposure victims from water that is too hot or too cold.

Threshold Limit Value (TLV) - A consensus standard established by the American Conference of Governmental Industrial Hygienists (ACGIH). Usually based on an eight hour time weighted average (TWA) and are occasionally lower (more protective of the worker) than the OSHA PELS.

Toxic gases-gases that have been assigned a 3 or 4 heath hazard rating by the National Fire Protection Association (NFPA) or have a health hazard rating of 2 and have poor warning properties (taste, smell). For a more detailed definition of hazardous gases please see the GT Dangerous Gas Safety Program at

http://www.ehs.gatech.edu/chemical/dangerousGasSafetyProgram.pdf

United States Occupational Safety and Health Administration (US OSHA) is the main US government agency charged with enforcement of safety and health regulations http://www.osha.gov/

United States Environmental Protection Agency (US EPA) Provides environmental information, and enforces laws and regulations to protect human health and the environment http://www.epa.gov

Used Oil-Used oil means any oil that has been refined from crude oil, or any synthetic oil, that has been used, and as a result of such use is contaminated by physical or chemical impurities. Examples of used oil include motor oil, hydraulic fluid, lubricants and oil coolants.

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