UNIVERSITY OF
KWAZULU-NATAL

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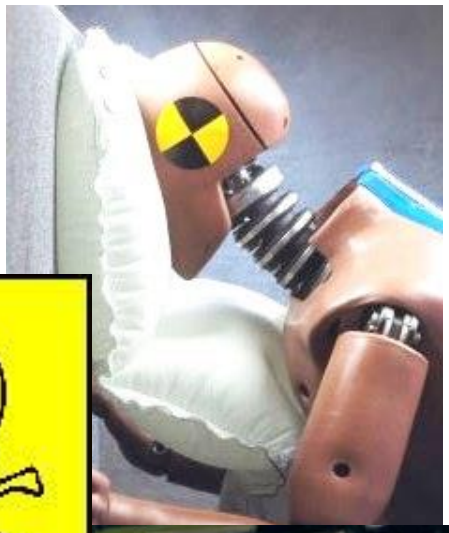
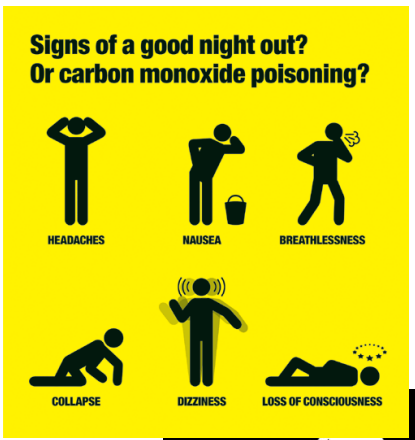
School of Engineering

SAFETY GUIDE

For Students, Staff, Visitors and Contractors





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APPENDICES

1. THE LAW THAT UPHOLDS SAFETY IN SOUTH AFRICA

Extract from the OCCUPATIONAL HEALTH AND SAFETY ACT (No.85 of 1993):

14. GENERAL DUTIES OF EMPLOYEES AT WORK

Every employee shall at work –

(a) Take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions;

(b) As regards any duty or requirement imposed on his employer or any other person by this Act, co-operate with such employer or person to enable that duty or requirement to be performed or complied with;

(c) Carry out any lawful order given to him, and obey the health and safety rules and procedures laid down by his employer or anyone authorized thereto by his employer;

(d) If any situation which is unsafe or unhealthy comes to his attention, as soon as practicable report such situation to his employer or to the health and safety representative for his workplace who shall report it to the employer; and

(e) If he is involved in any incident which may affect his health or has injured himself, report such incident to his employer or to anyone authorized by the employer, or to his health and safety representative, not later than the end of the particular shift during which the incident occurred, unless the circumstances were such that reporting the incident was not possible, in which case he shall report the incident as soon as practicable.

15. DUTY NOT TO INTERFERE WITH OR MISUSE THINGS

No person shall intentionally or recklessly interfere with, damage or misuse anything which is provided in the interest of health or safety.

Whether you are a student, staff member, contractor or visitor, in the context of this Act, you are regarded as an 'employer'. This means that the Act APPLIES TO YOU.

2. OCCUPATIONAL HEALTH AND SAFETY AT UKZN

The University of KwaZulu-Natal is subject to the codes of practice as defined in the Occupational Health and safety Act (85 of 1993) (OHSA).

The Act calls for an agreement between employers and employees on the management of occupational health and safety in the workplace. The agreement is an attempt to achieve a safe, healthy, risk-free working environment for all staff, students and visitors.

2.1 GOVERNANCE STRUCTURE

The Dean and Head of the School of Engineering is responsible to the Vice-Chancellor of UKZN for giving effect to the University's Safety Policy to ensure the health and safety of all staff, students, visitors and contractors and the safety of all buildings, areas, constructions, plant, equipment, processes, articles, substances and activities within the School of Engineering.

Under the Dean, Safety Representatives have been appointed for each discipline grouping who are primarily concerned with day-to-day safety matters, acting in liaison between the School and the

University's Risk Management Services (**RMS**), the Safety, Health and Environment (**SHE**) department and Campus Management Services (**CMS**). The Dean chairs the School Safety Committee and is a member of the University Safety Committee.

3. ENFORCEMENT OF SAFETY LAWS AND REGULATIONS

ANY PERSON WHO KNOWINGLY AND WILLFULLY CONTRAVENES ANY REGULATION OF THE SAID ACT IS GUILTY OF A CRIMINAL OFFENCE AND SHALL BE PROSECUTED TO THE FULLEST EXTENT OF THE LAW.

ANY PERSON WHO KNOWINGLY AND WILLFULLY COMPROMISES THE SAFETY OF HIMSELF AND/OR ANY OTHER PERSON/S WILL BE GUILTY OF A CRIMINAL OFFENCE AND SHALL BE PROSECUTED TO THE FULLEST EXTENT OF THE LAW.

ANY PERSON WHO KNOWINGLY AND WILLFULLY CONTRAVENES ANY SAFETY REGULATION PERTAINING TO THE UNIVERSITY OF KWAZULU-NATAL SHALL BE SUBJECT TO FULL DISCIPLINARY ACTION.

4. GENERAL SAFE PRACTICE FOR THE SCHOOL OF ENGINEERING

Read and comply with these basic safety regulations governing persons in the workplace under the auspices of the Occupational Health and Safety Act No. 85 of 1993. There are also specific safety procedures for various areas.

PREVENTION IS BETTER THAN CURE

The primary motive for all safety regulations, procedures and rules is to prevent injuries and accidents. Although every effort is made to ensure the safety of all in the School, accidents can and do happen.

Generally, equipment, machines and materials are only as safe as the person who is using it. Personal safety thus depends on a high level of individual safety-consciousness and an informed approach to safety issues.

Overconfidence and bad attitudes can also lead to accidents. Examine your attitudes to the tasks you perform: Do you have unsafe habits or procedures? Do you think "*it will never happen to me*"?

It is in YOUR best interests to improve the safety of the School and your own particular workplace to avoid you -or someone else- becoming an "accident statistic".

4.1 ACCIDENT PREVENTION

It is the aim of UKZN to maintain excellent Safety Record. All employees are expected to co-operate and assist in this regard.

a) The person in charge of new employees are responsible for ensuring that these employees are aware of the dangers involved in the work areas and in the tasks which they are doing and that they observe the SAFETY Rules. All new employees are to undergo a Safety Induction Programme at the earliest opportunity. This includes casuals and temporary employees.

b) Any employee who notices anything which might be or become dangerous to life or University property, must as soon as possible inform the person in charge of the area/department.

c) No person shall act in a manner which endangers or is likely to endanger or is likely or to endanger the safety of themselves or that of any other person.

d) An employee who observes or who becomes aware of any person disregarding any Safety Instruction shall immediately remind that person of the rule.

e) Fooling, skylarking, horseplay, practical joking, fighting or any way acting in an irresponsible or undignified manner is prohibited. This is also applies while travelling in passenger transport vehicles provided by the University.

f) No unauthorised person may enter a laboratory, workshop or any other place without obtaining prior permission of the person in charge.

g) No person shall damage, alter, remove, render ineffective or interfere with anything which has been provided for the protection or for the safety or health of personnel.

h) Firearms or any other dangerous weapons are not allowed on campus.

4.2 HAZARDS IN GENERAL

ENGINEERING LABORATORIES, WORKSHOPS AND WORK SITES
BEWARE: YOU ARE ENTERING A HAZARDOUS ENVIRONMENT!

***Hazard* - Any physical situation with the potential to cause harm.**

***Hazardous Agent* - Any physical, electrical, chemical, radioactive, or biological agent or substance which may cause harm to those exposed.**

Hazards to people and property abound in everyday life, and are often so obvious that they become "invisible".

Commonplace hazards account for more accidents than the recognised dangerous aspects of the School. You should always be aware of one's immediate environment and look out for potential hazards, for example: overhead objects, cables on pathways, swing doors/ladders, electrical hazards, hot surfaces/equipment or steam, slippery floors, lifting large or heavy objects, steep/uneven stairways, broken glass, loose/corroded flooring/steps, sharp objects, etc.

IF IT LOOKS UNSAFE, REPORT IT! YOU MAY SAVE A LIFE

4.3 RESPONSIBILITIES

The primary motivation for all safety activities, procedures and rules is that injuries and accidents are avoidable. Although every effort is made to ensure the safety of all in the School, accidents happen. Equipment is only as safe as the operator who is using it.

Personal safety thus depends on a high level of individual safety-consciousness and an informed approach to safety issues. This manual hopes to provide an awareness of these issues, and all who use the facilities are expected to familiarise themselves with its contents.

It is YOUR responsibility to immediately report any apparent unsafe condition to a member of staff or Safety Representative.

BE AWARE OF POTENTIAL ENVIRONMENTAL HAZARDS

4.4 DRUGS AND ALCOHOL

a) No person shall consume, offer to any other person, bring onto the premises or have in his possession intoxicating liquor whilst on the University premises. With the exception of places provided for this purpose.

b) No person in a state of intoxication shall enter or remain or be permitted to enter or remain on the premises.

4.5 EATING, DRINKING AND SMOKING

Eating, drinking and smoking is NOT permitted in Laboratories or Workshops.

4.6 LOOSE ITEMS AND BAGS

Bags or other loose items should not be brought into a workshop or laboratory as people can trip over them. Working areas must be kept in a neat and orderly condition as this prevents accidents. Always be patient, never rush in the workshop.

4.7 LIFTING HEAVY OBJECTS

Do not bend over any heavy or large objects when lifting, as this will strain the back. Bend the knees and grasp the object, straighten the legs to lift the object off the ground. The leg muscles are the strongest group of muscles in the body and one will not damage them as easily as the back muscles.

4.8 FOOTWARE

No sandals or open shoes are permitted in Engineering Laboratories or Workshops.

4.9 HAIR AND PERSONAL CLOTHING

In workshops with rotating machinery, loose clothing is not permitted. Long hair must be tied back.

4.10 PROTECTIVE CLOTHING (PPE)

Correct clothing can often minimize injury in the event of a small accident. The wearing of protective clothing is required (e.g. laboratory coat, apron, overalls, glasses, gloves, etc.) where necessary, and safety shoes at all times. Safety shoes must be fully closed, acid resistant, steel-capped approved safety shoes. No open back/open front/semi closed shoes are allowed. Safety glasses, masks or face shields are available where necessary, as are gloves and ear-plugs for further protection.

Protective clothing is also necessary in the event of an accident where there has been a wound which is bleeding. Anyone assisting an injured/bleeding person should wear gloves or other protective clothing to avoid coming into direct contact with the blood which might be infected. All blood spills should be considered infected and treated as such, with the areas being thoroughly cleansed and disinfected. Be aware of the threat of AIDS and possible infectious situations.

All protective clothing and equipment must be continuously worn in laboratories and workshops where and when required. This includes safety goggles, face shields, ear protection, dust or gas masks, helmets, etc.

4.11 HOUSEKEEPING

Always work in a neat, orderly manner. Ensure that the bench tops are always tidy and free of clutter as this allows for a safe and efficient worktop. The passageways, emergency exits, emergency equipment, electrical panels, etc. must be free from any obstacles at all times. Any tubing or cables must be properly located out of harm's way.

4.12 PREVENTING FALLING

Falls can be prevented.

- Always use handrails when using stairs.
- Use caution when walking on surfaces which contain oil, water or other adverse or unstable material or condition.
- Immediately clean up spills.
- Prevent fall hazards by keeping stairs, walkways, aisles and walk areas clear of boxes, loose materials, wires and other objects.
- Select shoes for comfort and safety that are compatible with your work environment.
- Do not stand or climb on a desk, chair, or other unstable surface to reach for an object. Use a ladder. A person using a ladder must be supported by an assistant.

4.13 CONFINED SPACES

The OSH. Act defines a confined space as a space that is large enough for an employee to enter or break the plane of entry, has restricted means of entry or exit, has unfavourable natural ventilation and is not designed for continuous employee occupancy.

Examples of confined spaces include, but are not limited to: tanks, tunnels, manholes, trenches, silos and vaults. Entry into confined space can be extremely dangerous. Possible hazards can include:

- Oxygen deficiency
- Fire, explosion hazards
- Exposure to dangerous vapours and toxics gases
- Physical hazards

4.14 WORKING ALONE OR AFTER HOURS

No person is permitted to work alone in a laboratory or workshop alone **without prior written authorisation**.

As a safety precaution, no one is allowed to undertaken experimental work in the School's workshops and laboratories after hours. Persons wishing to do so must obtain permission from their Supervisors and the Laboratory Technicians and must follow the prescribed conditions.

No experimental work can be undertaken in the workshops or laboratories by undergraduates without the supervision of a demonstrator or a member of staff. For staff or postgraduate students, careful consideration should be given to the increased risk of working alone or without a person within hearing distance.

IF IN DOUBT, ASK!

4.15 RISK ASSESSMENTS AND SAFE OPERATING PROCEDURES

- Supervisors of students engaged on experiment work must carry out formal Risk Assessments and draw up Safe Operating Procedures (SOPs) which must be approved by the discipline Academic Leader and Safety Representative.
- The supervisor must provide instruction, training and supervision to ensure, as far as reasonably practical, the health and safety of students and persons who may be affected by work. Risks must be regularly re-assessed.
- Do not use a machine if you have not been shown how to operate it safely by the instructor. Always use a guard when working on a machine. Keep hands away from moving/rotating machinery. Use hand tools carefully, keeping both hands behind the cutting edge.

- Read, understand and sign the prescribed Safety Commitment form.
- Acquaint yourself with the Standard Operating Procedures (SOPs) and safety risks associated with your laboratory/workshop equipment, materials and experimental work.
- Obey the particular safety rules of the area in which you work. Ensure that you have been taught how to operate the equipment. Listen carefully to the demonstrators and follow instructions.
- Wear full Personal Protective Equipment (PPE) i.e. closed shoes, laboratory coats, an apron, eye goggles, gloves and ear plugs (where necessary) when working in your laboratory area
- Be familiar with the fire drill and evacuation procedures. Know the location and use of emergency equipment such as: fire alarms, fire extinguishers, eye-wash stations/bottles, emergency shower, electrical plug/fuse box for your equipment, closest first aid box.
- Know where the emergency stop buttons are positioned in the workshop. You can use the emergency stop button to turn off all electrical power to machines.
- No experimental work is to be undertaken in the laboratories after hours without special arrangements being made with the relevant authorities.

5. INCIDENTS, ACCIDENTS & INJURIES: FIRST AID & FIRE

An accident is any event which causes damage to people and property. **Every accident, "near-miss" or equipment failure which could have caused an accident must be reported to the discipline's Safety Officer immediately.**

A NEAR MISS IS A WARNING TO BE TAKEN SERIOUSLY

Obviously the seriousness of these accidents will vary, the worst being injury to people, and the least being inexpensive damage to repairable/replaceable items.

5.1 FIRST AID

First Aid is the immediate emergency treatment provided for injury or sudden illness before professional medical care is available. Never minimize the seriousness of an injury or illness. If in doubt, seek medical attention. There are trained First-Aid staff in all Engineering areas. Their names and locations are listed on signage around the building.

DO NOT ATTEMPT TO RENDER FIRST AID UNLESS YOU KNOW WHAT YOU ARE DOING OTHERWISE INJURIES MAY BE AGGRAVATED.

IF YOU DON'T KNOW WHAT TO DO, CALL FOR HELP

5.2 FIRE PREVENTION

You have a personal responsibility in the prevention and control of fires. Familiarize yourself with the location of fire equipment in the area where you work and the proper method of turning in a fire alarm. If you are to use portable fire protection equipment (such as fire extinguishers), you must be trained in the use of portable fire protection equipment and updated as necessary.

Obey all rules, regulations and signs for fire safety such as those controlling smoking, open flames and other sources of ignition and those controlling the storage, handing and use of flammable liquids or other hazardous materials.

Practice good housekeeping and fire prevention.

a) Flammable liquid shall be handled and stored in approved safety containers equipped with flame arrestors and spring actuated caps.
b) Do not store acids and bases or oxidizers and reducers in the same cabinets due to the possibility of extremely volatile reaction between the two.
c) Store all poisons separately.
d) Keep hand operated fire equipment such as extinguishers, hoses, etc., fully accessible, mounted and unobstructed at all times.
e) If you use a fire extinguisher or any other fire equipment, notify your supervisor at once so that it can be immediately replaced and serviced.
f) If your clothing catches fire, smoother the flame by rolling on the floor or ground. Never run, as this could cause the flames to spread.
g) Do not clean clothing with gasoline, solvents or other flammable gasses or liquid. A spark may ignite your clothing.
h) Do not use oil or grease on any oxygen equipment such as cylinders. Oxygen under pressure unites with oil and grease with explosive violence.

5.3 FIRE EXTINGUISHERS

Know the location and operation of the fire extinguishers and fire alarms closest to your work station. The particular application of these extinguishers (electrical fire, chemical fire etc.) is also important.

Dry chemical extinguishers

(Blue label) particularly effective on flammable liquids, but may be used on any kind of fire.

Water extinguishers

(Red label) useful on rubbish or paper fires but should NOT be used on burning metals or electrical fires.

Carbon dioxide extinguishers

(Black label) useful for most fires EXCEPT those involving alkali metals and their oxides or peroxides (use soda ash).

- For a small, contained blaze, e.g. in a beaker, it is effective to cut off the oxygen supply by sealing the container. For electrical fires, remember to switch off the current before proceeding to douse the flames.
- It is important to attack a fire as soon as possible after it has started. The longer the fire burns the more difficult it is to extinguish.
- When a fire has already got out of control and the building/area is being evacuated, try to remember to close doors and windows to contain the blaze.

5.4 IN CASE OF A FIRE

Upon detecting a fire or smoke, proceed immediately to the nearest break glass unit which is normally situated at the entrance of any building and break the glass. This will activate an alarm in both the building you are in and the main console in the Risk Management Services duty room.
AND
Contact Risk Management Services (RMS) by dialling extension **3777 or 2540** to inform them of the situation. (**031-260-3777** or **031-260-2540**)

RMS will call the Emergency services immediately.

If you are unable to contact RMS, you may contact the Emergency Services yourself on **361-0000 or 10177**

If there are two or more of you who discover the fire, one person should raise the alarm whilst the remainder may endeavour to extinguish the fire with available fire fighting equipment.

On the activation of the fire alarm all staff, students, visitors and contractors, other than Emergency teams are to report to their respective Assembly Areas. **NO** person should re-enter the building until given the **"ALL CLEAR"** by the senior person in charge of the Emergency Services.

THE FIRE AND EVACUATION ALARM IS A CONTINOUS BELL/SIREN SOUND

5.5 EVACUATION

An evacuation of a building will always be ordered where there is any possibility of danger to human life.

In the unlikely event of a fire or other emergency necessitating an evacuation of the premises the following guidelines should be observed.

- Do not panic.
- Laboratories and Workshop - isolate equipment to make the area safe and then proceed to the assembly point.
- Offices and lecture theatres – close the room door/s and windows on leaving but do not lock (except if a drill has been announced) as open access is required in the event of a fire or bomb-scare evacuation. All staff, students and visitors to proceed to the assembly point.

- Walking briskly, proceed to the designated assembly point by via the nearest escape route which is indicated by evacuation signs.
- Remain at the assembly point until further notice. Do not re-enter the building until instructed to do so.
- When notified by the sounding of the alarm, or instructed by the Evacuation Marshall or the Head of Department, leave the building immediately do not ask questions. **STAY CALM.**
- Proceed to the nearest emergency exit and leave the building through the shortest predetermined route.
- Escape routes are indicated by the escape symbolic signs.
- If you are aware of any disabled persons in the area, bring it to the attention of the person in charge or assist that person to safety.
- DO NOT stop to search for friends, the fastest way for them to be located is for everyone to proceed to the assembly point.
- **DO NOT GO BACK INTO THE BUILDING**
- **DO NOT RUN** – Move at a steady rate in a downward movement.
- **DO NOT USE LIFTS** – You could get trapped
- **DO NOT TALK UNNECESSARILY** – As you may miss vital instructions
- Follow instructions from the persons in charge of your department.
- Take only personal belongings, ensuring that you leave one arm free
- Close all windows and the last person out of each room, close the door.
- Remain at the Assembly point where a role call will be taken.

6. MECHANICAL HAZARDS

6.1 MACHINERY WITH MOVING PARTS

Most reciprocating/rotating machines, rollers, belt drives, etc. even when driven by small motors are highly geared or carry considerable momentum. No such equipment may be operated without the express permission of the person "responsible" for the equipment. (This person is required to obtain the permission of the discipline Safety Representative when the equipment is installed, moved, or modified).

6.2 MACHINERY OPERATION STANDING INSTRUCTIONS

In terms of the Occupational Health and Safety Act, the following standing instructions are issued:

a) The employer is required by law to provide various safety devices in connection with machinery.

b) Loose outer clothing must not be worn by persons working near moving machinery and persons with long hair must wear caps or nets to confine the hair.

c) Unless there is a special apparatus approved by the Inspector, driving belts must not be unshipped whilst machinery is in motion.

d) Machinery in motion must not be cleaned, repaired, adjusted or oiled except in special cases, and then it may be done by an authorized competent person only.

e) No person other than an authorized competent person shall trespass within the fences of machinery in motion. Any occurrence liable to cause danger to persons must be reported immediately to your supervisor. .

f) No person operating machinery shall depute any other person to do his work and no other persons may operate such machinery except with the sanction of his official superior.

g) Any person intending to start a machine will before doing so, satisfy himself that no other person is endangered**.**

6.3 GRINDING MACHINES

Only authorized personnel may use grinding machinery, and then only with the correct eye protection (goggles). Do not use grinding machines with chipped or cracked stone/disc. Before using the equipment ensure that the gap between the stone and the work rest does not exceed 3 mm. Do not grind aluminium or other soft metals.

Be familiar with the emergency stop buttons or trip mechanisms.

6.4 NOISE AND ULTRASOUND

High noise levels may damage the hearing and exposure should be kept at a minimum. Where high noise levels are encountered, the level should be monitored, and attempts made to muffle or contain the noise.

If the noise level is 85 dB(A) or higher, and cannot be reduced in anyway, the noisy zone must be demarcated, and only people wearing hearing protectors (ear muffs or ear plugs) are permitted to enter this zone. Wherever high noise levels are encountered in the department, the Safety Representative must be notified, and every effort made to reduce the noise output.

Ultrasound equipment must also be placed in a demarcated area and people entering this area should wear hearing protectors. Unauthorised people may not operate ultrasound equipment, and the Health and Safety Officer must be aware of the location of the equipment, and the safety precautions taken during operation.

6.5 LADDERS

Inspect all ladders before use, and never use a ladder with cracked tiles or rungs, nor loose or missing rungs. Wooden ladders should not be painted so that cracks are readily visible, they may be coated with a clear varnish or wood preservative. Ladders must have non slip feet and must be standing on level, solid ground. When in use, ladders must be supported by a person holding the bottom, or the upper reaches must be lashed to a solid object.

7. ELECTRICAL HAZARDS

Only qualified electricians are authorised to do any type of work on electrical distribution and lighting circuits. Servicing of electronic equipment also requires specialised personnel.

Many electrically-powered laboratory or workshop equipment can pose a significant hazard to users, particularly when mishandled or not 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.

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.

The chart below shows the general relationship between the degree of injury and amount of current for a 50–60 Hz 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 Amperes of current. (Source: Princeton University, USA):

Current (1A = 1000mA)	Reaction
1 milliamp ere (mA)	Perception level
5 mA	Slight shock felt; not painful but disturbing
6 - 30 mA	Painful shock; "let-go" range
50 - 150 mA	Extreme pain, respiratory arrest, severe muscular contraction
1 - 4.3 A	Ventricular fibrillation
10 A or more	Cardiac arrest, severe burns and probable death

7.1 POWER FAILURES

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 vapours to be released into the laboratory.
- Flammable or toxic vapours may be released as a chemical warms when a refrigerator or freezer fails.

7.2 ELECTRICAL HAZARD PROTECTION

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

- **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.
- **Shielding:** Live parts of electric equipment operating at 50 volts or more (must be guarded against accidental contact. Plexiglas shields may be used to protect against exposed live parts.
- **Earthing:** Only equipment with three-pin plugs should be used in the laboratory. The large third pin provides a path to earth for internal electrical short circuits, thereby protecting the user from a potential electrical shock.
- **Circuit protection devices:** These devices, such as fuses, circuit breakers, isolating switches and earth-leakage circuit breakers are designed to automatically shut off the flow of electricity in the event of an earth-fault, overload or short-circuit in the wiring system.
  - Fuses and circuit breakers 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 earth-leakage circuit breaker is designed to shutoff electric power if an earth fault is detected, protecting the user from a potential electrical shock. It is particularly useful near sinks and wet locations.

Keep in mind that sparks from electrical equipment can serve as an ignition source for flammable or explosive vapours or combustible materials.

7.3 SPARKING: MOTORS AND SWITCHES

Ideally AC induction motors are spark-free. Motors that cause sparking are universal motors and most types of DC motors, having brushed-commutators.

On-off switches and speed controls may produce a spark when they are used because they have exposed contacts.

Proper earthing of equipment and containers is necessary to avoid sparks.

7.4 STATIC ELECTRICITY

Static electricity is an imbalance of electric charges within or on the surface of a material. The charge remains until it is able to move away by means of an electric current or electrical discharge. Static electricity is named in contrast with current electricity, which flows through wires or other conductors and transmits energy.

Some common potential sources of sparks are:

- Metal tanks and containers. (Static electricity)
- Plastic lab aprons. (Static electricity)
- Metal clamps, nipples, or wire used with no conducting hoses. (Static electricity)
- High-pressure gas cylinders upon discharge. (Static electricity)

A static electric charge is created whenever two surfaces contact and separate, and at least one of the surfaces has a high resistance to electrical current (and is therefore an electrical insulator). The effects of static electricity are familiar to most people because people can feel, hear, and even see the spark as the excess charge is neutralised when brought close to a large electrical conductor (for example, a path to ground), or a region with an excess charge of the opposite polarity (positive or

negative). The familiar phenomenon of a static shock–more specifically, an electrostatic discharge– is caused by the neutralization of charge.

Removing or preventing a buildup of static charge can be as simple as opening a window or using a humidifier to increase the moisture content of the air, making the atmosphere more conductive. Air ionizers can perform the same task.

Items that are particularly sensitive to static discharge may be treated with the application of an antistatic agent, which adds a conducting surface layer that ensures any excess charge is evenly distributed. Fabric softeners and dryer sheets used in washing machines and clothes dryers are an example of an antistatic agent used to prevent and remove static cling.

Many semiconductor devices used in electronics are particularly sensitive to static discharge. Conductive antistatic bags are commonly used to protect such components. People who work on circuits that contain these devices often ground themselves with a conductive antistatic strap.

In the industrial settings such as paint or flour plants as well as in hospitals, antistatic safety boots are sometimes used to prevent a buildup of static charge due to contact with the floor. These shoes have soles with good conductivity. Anti-static shoes should not be confused with insulating shoes, which provide exactly the opposite benefit — some protection against serious electric shocks from the mains voltage.

7.5 GENERAL ELECTRICAL SAFE PRACTICE

- Problems relating to electrical cabling, machinery, switches, instruments and other apparatus must be reported immediately to the Principal Technician or Safety Representative. This must also be done in the case of electric shocks.
- You cannot ‘see’ electricity – you can only observe -or feel- its effects.
- 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 of and how to operate isolating 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.
- Place exposed electrical conductors behind shields.
- Minimize the potential for water or chemical spills on or near electrical equipment.
- Turn off power to equipment before inspecting it.
- Check circuits for proper earthing with respect to the power source.
- Never change wiring with the circuit plugged into power source.
- Never plug leads into power sources unless they are connected to an established circuit.
- Keep access to electrical panels and isolating 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, where possible, keep one hand either in a pocket or behind your back to avoid making a closed circuit through the body.
- Avoid touching circuits with wet hands or wet materials.
- Do not insert another fuse of larger capacity if an instrument keeps blowing fuses - this is a symptom requiring expert repairs.
- 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 should ideally not be used in place of permanently installed receptacles. If additional outlets are required have them installed by an electrician.
- Unqualified persons may **not** engage in electrical reticulation of mains voltages or greater.
- Inspect all equipment before use for damage to cables and plugs, and check for any moisture present. Refer any problems to the Electrical Technician or Safety Representative. Never work with bare feet or wet shoes on a concrete floor.
- When equipment is moved to a new location, make sure that the circuit can carry the extra load.
- DO NOT improvise connections between non-matching plugs.
- Where flammable or volatile substances are being handled, use caution with electrical equipment such as heater thermostats or stirrer motors.
- Consider the effect of possible electrostatic charge build-up on certain equipment when dealing with flammable materials.

7.6 HIGH VOLTAGE OR CURRENT

Only trained electricians should repair of high voltage or high current equipment.

8. CHEMICAL HAZARDS

8.1 GENERAL LABORATORY PRACTICE

Aim to avoid emergencies by careful planning of your work in all stages:

a) Choice of location
- need for fumehoods (for toxic volatiles)
- need for fire-fighting equipment, guards, signs, etc.
- accessibility of controls (no obstruction by screens, hot pipes, etc.)
- do not block passageways

b) The materials of construction
- resist corrosion
- withstand heat/pressure etc.
- correct choice of glassware

c) Required safety protection, e.g. gloves, glasses, etc.

d) Review the completed installation and make a “dummy” run to check procedures

e) Dismantle equipment and discard all chemicals in the correct manner. Return all materials to designed stations. Consult Laboratory Technicians.

8.2 HOUSEKEEPING

Always work in a neat, orderly manner. Ensure that the bench tops are always tidy and free of clutter as this allows for a safe and efficient worktop. The passageways, emergency exits, emergency equipment, electrical panels, etc. must be free from any obstacles at all times. Any tubing or cables must be properly located out of harm’s way.

All chemicals and equipment must be neatly stored in its proper place after use. Glassware must be properly cleaned before returning to its place of storage. Glassware and apparatus that is chipped or broken may not be used. These must be removed immediately and either sent for repairs or disposed of in the proper manner.

Spills must be cleaned up immediately.

Bottles and containers must not be left open when they are not in use.

Bunsen burners must not be left unattended with the flame burning.

Do not remove any items from another person’s work area or locker without their permission and **always leave the workplace clean and tidy for the next person to use.**

8.3 LABELS

Proper labelling forms a part of housekeeping. However, many people overlook the importance of labels thereby making it necessary to highlight its vital role in safety under its own heading.

A label is not just a name tag identifying the contents of a container. It is also a means of conveying the hazards of the chemical to all other persons. Labels may not be removed from the container. If a chemical has been transferred from one container to another, it is then the responsibility of that person to ensure that the new container has been labelled accordingly. All containers (whether it contains store bought chemicals, chemicals prepared in the laboratory or waste chemicals) must be clearly labelled with the following information:

- contents of the container (the chemical name rather than the chemical formula)
- name and address of the manufacturer
- date that the container was opened/date on which the chemical was prepared
- physical and health hazards

- recommended personal protective equipment

This information provides all users with the basic necessary data to safely handle that chemical.

In cases where it is impractical to print all data on the label, a MSDS (Material Safety and Data Sheet) must be printed and be readily available.

8.4 MATERIAL SAFETY AND DATA SHEET (MSDS)

A MSDS is an important document that informs the user of potential health effects and the safe handling of a particular chemical. It is highly recommended that a MSDS of the chemical be carefully read and understood before one begins working with the chemical, as this document contains more information than the label on the container.

The following sixteen categories of information can be found on a MSDS:

1. Identification - product name, trade name, synonyms, chemical formula, CAS number, manufacturer's name, emergency numbers
2. Hazards Identification - hazardous ingredients, exposure limits when known
3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage information
8. Exposure controls/personal protection
9. Physical & chemical properties
10. Stability & reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

Please remember that all the information you may need may not necessarily be found on a MSDS. Therefore, you are advised to consult a health and safety specialist, health nurse or family doctor for further information. However, it is still necessary to present the appropriate MSDS to the medical personnel when seeking their help in the case of accidents.

8.5 VENTILATION

Every effort should be made to keep the environment unpolluted. An effective ventilation system is essential in a laboratory. This minimises the exposure to waste products and other chemical odours. When necessary, a fume hood must be used. To determine whether or not the use of a fume hood is required, look at the physical characteristics, quantity and toxicity of the materials to be used. The experimental procedure also needs to be taken into consideration.

8.6 HANDLING CHEMICALS

As there is a correct method of handling every chemical, it is extremely important to read the label and to consult the MSDS for that chemical. Personal protective equipment (laboratory coats, goggles, etc.) and closed shoes must be used at all times.

Containers must then be opened with care ensuring that stoppers do not pop out under pressure.

Splashing can occur when pouring liquids out. A spill tray must be used as it prevents the liquid from spreading in the event of a spill. It is necessary to use a funnel when pouring out of small

containers and a pump when transferring from larger vessels. In the case of large drums, it is safer to have a tap fitted onto the drum and to have that drum securely mounted.

A range of apparatus is available for transfer of liquids from one container to another.

The smelling, tasting or inhaling of any chemical is strictly forbidden. Using your mouth to draw liquids into a pipette is not allowed. Only a proper pipette filling device, e.g. pipette bulb, may be used to siphon liquids into a pipette.

Avoid skin contact with any chemical at all times. It is essential that laboratory coats, long pants, closed shoes be used to minimize skin exposure to chemical contamination. When necessary, request the use of gloves. Long, unconfined hair hinders safety as it can obscure vision, catch alight or catch onto equipment.

When carrying a container, you are not to carry it by the lid as this may break under the weight. Use a tray, trolley or caddy instead. If none of these are available, hold the container with both hands with one hand lending support at the bottom.

A mature, professional code of contact is demanded when in a laboratory and working with chemicals. This means that:

- unauthorised experiments, practical jokes and horseplay will not be tolerated
- there is to be no distracting or startling other laboratory users
- you do not work alone in a laboratory at any given time
- chemicals are to be used only as directed and for their intended use

8.7 HYGIENE

Careless actions could lead to the ingestion of chemicals. Do not store any food, drinks, cigarettes or cosmetic products in an area which contains chemicals. It is forbidden to eat, drink, smoke or apply cosmetics in any of the laboratories. Be careful when using stationery (pens, pencils, etc.) in the laboratory.

Hands need to be thoroughly washed before leaving the laboratory, even if gloves were used.

8.8 HANDLING OF GLASSWARE

Make sure that glassware selected is suited to the application, and the glassware is not damaged in such a way as to cause failure to the vessel or tube, or to cause injury to the person using the equipment. Glassware should be treated with due consideration to the limits of its strengths, heat resistance and ability to withstand pressure or vacuum. Where glassware is under pressure there should be a protective shield erected to contain chemicals and glass fragments should implosion occur.

Mishandling of glassware can lead to serious injuries. Glassware must be inspected for cracks and chips before use. Any damaged glassware must be immediately discarded into a specially labelled box for broken glass. After use, glassware should be well washed and properly stored. Always carry long lengths of glass tubes in a vertical position.

8.9 PLASTIC TUBING

Rubber and plastic tubing tend to get hard and crack over a period of time. It is therefore necessary to check them for damages and replace as required. Long lengths of tubing must be properly identified and secured out of the way. Care must be taken when choosing tubing to be used with organic solvents.

8.10 LARGE SCALE EQUIPMENT

Larger scale work carries all the hazards of the smaller scale laboratory work, and in some cases magnifies these dangers. Anyone working on larger scale equipment must be familiar with the laboratory safety procedures. Before a new chemical process is carried out on a pilot plant scale, the important physical and chemical properties of the materials involved must be known, and the

potential dangers identified. Wherever possible, sight-glasses or other indicators displaying the state of the material in these vessels should be utilised.

The following rules and practices must be observed when working with larger scale equipment.

- Prepare a comprehensive flowsheet of the process, showing all valves, pipes, temperatures, pressures, etc.
- All equipment must be tested AND safety instructions including a simple description of the process and a shutdown procedure must be prepared prior to starting up. Pieces of equipment must be labelled for reference in the operating manual. This should be checked by the Supervisor of the project.
- A HAZOP analysis must be undertaken by the student, and presented to the Discipline's HAZOP Team.
- A "dummy" run should be made prior to the initial process run, to serve as a practice run and a means to check the performance of the equipment.
- Regular servicing and maintenance of all equipment is required.
- At the end of the project the equipment and all other apparatus used must be thoroughly cleaned and dismantled, the chemicals safely disposed of, and the equipment stored for use on other projects.

Be aware of connections to the water main supply, i.e. just as water flows out the pipe; with connections and back pressure, one can have materials being transferred into the main supply.

CHEMICAL MATERIALS

8.11 FLAMMABLE MATERIALS

Do not keep large volumes of flammable materials in the laboratories, (including waste chemicals). Smoking is prohibited in ALL laboratories. Steam or hot water should be used wherever possible to heat flammable liquids to avoid ignition. Where flame or electricity is used, a metal catch pan (of sufficient volume to hold the liquid) should be placed underneath. Waste chemicals should be clearly labelled as such.

8.12 EXPLOSIVE MATERIALS

Potential reaction violence or explosions can be predicted. One way is through the calculations of the heats of reactions, all possible reactions should be considered not just the desired reactions; consider also the intermediates and by-products. Reactions which produce gas could also be explosive if not vented.

Chemical structure is also helpful in recognizing explosive organic compounds. The following groups could be explosive: $-ONO_2$, $-ON_2$, -ON, $=N-NO_2$, -N=N-, -O-O,$-N_3$,-C=C-. Two or more such groups in a molecule could make the compound more dangerous.

Remember that often dangerous reactions are described in literature without any warning of their explosive nature.

Peroxides that form in common laboratory solvents have been one of most frequent causes of laboratory explosions. These may occur during distillation or after a distillation has been performed, on dismantling the apparatus. They have also been known to occur on opening, or moving bottles of solvents (e.g. ether, cyclohexene, branched chain saturated hydrocarbons or alkyl-substituted cycloaliphatics. Special care should be taken with waste bottle where reactions might have taken place).

Where the possibility of explosion exists, limit the scale of the reaction performed to as small as possible, shield all people in the area with adequate safety protection and clothing, if possible conduct the operation by remote control, and know the location and use of the nearest fire

extinguisher in your work station. Often dilution or cooling of an explosive material can render it non-explosive. Remember that the small scale experiment without explosion must never be taken as proof of the absence of hazard when scaling the operation up. Gas mixtures in particular must be treated with care.

Always consult your supervisor if in doubt.

8.13 TOXIC CHEMICALS AND SKIN HAZARDS

All chemicals should be regarded as toxic unless toxicity studies have proved them harmless.

The three main mechanisms for poisonous materials to enter the human body are listed below. Poisoning by any of these routes may be acute, chronic, or even fatal.

8.14 SWALLOWING: -with food, drink, or saliva. To avoid accidental contamination, food and cigarettes are not allowed in the laboratories, and the hands should be washed carefully after working with chemicals and before eating, drinking or smoking. Pipette bulbs should be used unless the chemicals are known to be non-toxic, and chemicals should NEVER BE TASTED.

8.15 INHALATION: breathing into the respiratory tract vapours, dust, gases, etc. Contamination of air by dust or vapours should be regarded as dangerous, although the acceptable level of exposure varies from chemical to chemical. DO NOT rely on the odour to determine the degree of contamination. BEWARE OF ASBESTOS, dry asbestos (insulation, piping, etc.) can produce small particles which become trapped in the bronchi and cause cancer, or even death. For a list of SOME materials toxic by inhalation, refer to Appendix C. To prevent hazards from toxic gases; supply adequate amounts of fresh air to working areas, use fumehoods whenever necessary, and whenever there is any doubt, know how to use gas masks and breathing apparatus, know the limitations of filter type masks, and finally give the alarm if toxic gases are released into any area.

8.16 ABSORPTION: through the skin or entrance through breaks in the skin (sores or cuts). Hands and face should be washed regularly when exposed to chemical dusts and vapours, and skin contact with all chemicals should be avoided by using gloves, face shields, etc.

8.17 DANGEROUS CHEMICALS

It is important to read carefully the labels on ALL bottles of chemicals and take note of any hazard signs or health warnings found there. ALWAYS consult the MSDS for the particular chemical.

Acids: Mineral acids are very corrosive and capable of producing serious injury or death if handled carelessly. When dealing with concentrated acids take the following precautions:

- Wear goggles/glasses when pouring
- Avoid contact with skin
- Spills on floor or bench should be cleaned up immediately, flushing with water or even dilute sodium carbonate or bicarbonate
- Do not use combustibles (cloth, paper, etc. to mop such spills)
- Always pour acid into water and never water into acid
- Avoid inhaling acid fumes

Alkalis: Avoid contact with either the solid or solution form of alkali material, wear goggles/glasses and gloves. If contact does occur, wash immediately with plenty of water. When making solutions always use cold water and wear protective clothing, add the alkali slowly preventing boiling or spluttering. Spillage should be flushed away immediately with water and dilute acetic acid. Avoid breathing the vapours, especially ammonia.

Mercury: Mercury and its compounds are extremely toxic.

- Should be stored in a cool, well ventilated place, clearly labelled and away from fire hazards
- Work should be done under a fume hood

- Spills should be cleared up immediately. Pick up droplets using a steel pipe or a glass pipette connected to a suction bulb. Calcium sulphide or water can be sprinkled in larger spills which cannot be cleared immediately.

Dry ice / Solid CO_2: At room temperature this turns to gaseous carbon dioxide which in high concentrations causes death by asphyxiation.

- Wear dry cotton gloves, and do not allow contact with the skin because of danger of frost bite
- When breaking ice up with a mallet, wear goggles/glasses to protect the eyes and take care not to endanger others working in the area
- Never store in gas tight containers
- When making mixture with liquids add the ice slowly and carefully to prevent splattering, wear goggles/glasses

Hazardous mixtures: The possibility that a hazardous mixture may be used or formed when carrying out a chemical reaction must never be overlooked. Stability of products and by-products, catalytic effect of structural materials, toxicity and flammability of the gases etc. must all be considered carefully.

Hazardous mixtures may also be formed when storing chemicals, or mixing waste materials. No list of hazardous mixtures can ever be complete, and thus each combination must be carefully considered.

8.18 CHEMICAL STORAGE

All chemicals (flammable, toxic, corrosive, etc.) must be stored under appropriate conditions. The store should be situated a distance away from the working area with only the minimum amount of chemicals being kept on the laboratory reagent shelf for the work being undertaken. Storage places of dangerous chemicals must bear the relevant warning sign. The store must be cool, clean, dry and have adequate ventilation. The reagent shelf must be no higher than eye level and it must be fitted with a barrier or lip to prevent chemicals from falling off.

All chemical containers must be properly labelled. Whether storing chemicals in the store or on the reagent shelf, you need to read the label on the container and the MSDS for specific storage information and for incompatibilities.

Do not arrange the chemicals in alphabetical order before separating into their different classes.

8.19 GUIDELINE FOR CHEMICAL STORAGE USING THE DIFFERENT GROUPS

Acids	Separate acids from bases and active metals such as sodium, potassium, magnesium. Segregate organic acids from inorganic acids. Segregate oxidizing acids (nitric, perchloric, chromic acids) from organic acids and flammable chemicals. Segregate acids from chemicals that liberate toxic gases upon contact (sodium cyanide, iron sulphide). Store large acid drums away from direct sunlight and heat sources. Store bottles of acid on shelf or approved acid cabinet. Always place acid containing vessels on a spill tray
Bases	Segregate bases from acids. Solutions of inorganic hydroxides to be stored in polyethylene containers. Always place alkaline containing vessels on a spill tray
Flammables	Safety drums containing flammable liquids must be grounded and bonded when liquids are transferred. Read up further on the transferring of flammable liquids. Except when trying to maintain the purity of the chemical, do not use glass containers for flammable liquids. Drums must be stored in a cool, dry place away from direct sunlight and

	ignition sources. Store highly volatile flammable liquids in an approved flammable storage cabinet or an approved flammable storage refrigerator.
Flammable Solids	These materials react violently in the presence of moisture and may create/yield flammable and toxic gases. Do not store under sinks. Elements lithium, potassium and sodium should be stored under kerosene or mineral oil.
Oxidisers	• Separate oxidisers from flammable and combustible materials. • Segregate from reducing agents such as zinc, alkaline metals and formic acid.
Reactive and Extremely Toxic Compounds	E.g. Arsenic compounds, cyanides, phenol, picric acid, hydrazine • Store individually in a plastic bag and also in a non-breakable secondary container.
Pyrophoric Substances	E.g. Cadmium, dichloroborane, manganese, titanium, zinc • Pyrophoric substances ignite spontaneously upon air contact. • Elemental phosphorous should be stored and cut under water.
Light-sensitive Chemicals	E.g. Bromine, mercuric salts, potassium ferrocyanide, sodium iodide • Avoid exposure to light to prevent decomposition • They must be stored in amber bottles. • If necessary, wrap bottle with foil but be sure to label the bottle and the outside of the foil.
Peroxide-forming Chemicals	E.g. acetaldehyde, cyclohexene, p-dioxane, ethyl ether, isopropyl ether, tetrahydrofuran Store peroxide-forming chemicals in airtight bottles. Label containers with date received and date opened. Depending on the chemical, it must be discarded 3 to 12 months after opening the bottle. Discard unopened containers of these chemicals according to the printed expiration date or 12 months after delivery date. Test for the presence of peroxides periodically.
Compressed Gases	Separate and clearly mark the full cylinders and the empty cylinders. All cylinders must be secured in an upright position by means of a chain or rack. Replace valve caps when cylinders are not in use. Do not store or use damaged or defective cylinders. Compressed gases must be stored away from all sources of heat. Cylinders too must be segregated by hazard classification and compatibility. Extremely hazardous gases must only be used and stored in ventilated safety cabinets. Lecture bottles of gas must be labelled with the chemical name, hazard, and date on which it was received. Lecture bottles must be disposed of in the same manner as the other waste chemicals.

8.20 CHEMICAL SPILLS

Always anticipate spills as this will ensure that the required safety equipment will always be readily available. The MSDS will contain special spill clean-up information.

Chemical Spill	Possible Absorbent
Organic	Vermiculite may be used as an absorbent or cover spill with sufficient charcoal. Place used absorbent in a properly labelled bag for waste

	disposal
Acid	Neutralise spill liberally with sodium bicarbonate (soda ash). Avoid inhaling any dust.
Alkali	Neutralise with boric acid or citric acid.

The following are indications of a **Major spill**:

- too large to be handled by you.
- has caused or can cause injury to persons.
- involves materials listed in the table below.
- cannot be contained and spreads to endangering surrounding area.

Chemical Class	Example
Strong Acids – any concentrated acid that emits fumes or acid gases	Fuming sulphuric acid, Red nitric acid, Hydrofluoric acid, Perchloric acid
Strong Bases – any concentrated base that emits vapours	Ammonium hydroxide
Poison by inhalation - any chemical that emits vapours/gases that are toxic by inhalation at normal temperature and pressure	Phosphorous, Oxychloride, Titanium, Tetrachloride, Formates, Isocyanates
Reactive – any chemical that is sensitive to air, water, shock, friction &/or temperature	Dry picric acid, Lithium Aluminium hydride, Sodium borohydride, Phosphorous metal, Organic peroxides
Mercury – any mercury compound	Metallic mercury, Mercury salts, Aqueous mercury solutions
Extremely Toxic – any chemical that is readily absorbed through the skin and is extremely toxic at small concentrations	Benzene, Sodium cyanide

In the event of a **Minor Spill**

- Alert all personnel and, if necessary, evacuate the area.
- If a volatile, flammable material is spilled, turn off all sources of ignition and ventilate the area.
- Remove contaminated clothing immediately. This must be washed separately and depending on contamination, it must be disposed of as hazardous waste.
- If there was contact with the skin or the eye, ensure that the affected area is flushed with large amounts of water for at least fifteen minutes. Seek medical assistance.
- Using the proper personal protective equipment, contain the spill.
- Absorbents can be used to protect floor drains and other routes to environmental release.
- Distribute absorbent over the entire spill area. Working in a circular formation, start from the outside circling to the inside. This minimises splashing and spreading of the spilled substance.
- Once the spilled chemical has been completely absorbed, collect and place into an appropriate container. The container must be compatible with the collected waste.
- Properly label the container and store aside for waste disposal making sure that the waste is stored by compatibility.
- Decontaminate the area where the spill occurred with a mild detergent and water.
- All spills must be reported to your supervisor and/or member of the safety committee.

Solid spills are not usually emergencies. However, remember that they need to be collected into container using dampened cloths or paper towels as brushing of a dry material will result in it being airborne.

While the MSDS needs to be consulted in the event of chemical spills, the following guidelines can be generally applied:

8.21 MERCURY SPILLS

For large mercury spills, evacuate the area, close doors, alert your supervisors and do not allow anybody to walk through the spill area.

For a small mercury spill (broken thermometer, etc.), clean up immediately. Personal protective equipment (laboratory coat, closed shoes, eye-goggles) must be worn to prevent absorption via the skin and to protect the mercury from contaminating your clothing.

NEVER use a broom to sweep or an ordinary vacuum cleaner to suction spilled mercury as these procedures disperse the mercury into the air thereby spreading the contamination. The best way to collect the mercury is by using an index card or rubber squeegee to form a pile that can then be sucked up. Beads of mercury can be sucked up with a disposable pipette, a water-trapped vacuum line attached to a disposable pipette or a hand-operated vacuum pump. Another method of amalgamating mercury is by the use of mercury absorbing powders.

The mercury waste and all the materials used in the clean-up of the spill must be placed in a container immediately. This must then be labelled as hazardous waste and stored for disposal.

The area in which the spill took place must be thoroughly washed with a detergent solution, properly rinsed and allowed to dry before use.

8.22 CHEMICAL WASTE

The generation of waste when working with chemicals is normal. It is extremely important to minimise the amount of waste produced because lower waste production has a lower environmental impact.

A few ways of achieving this is to:

- take care that you do not over-order chemicals
- carry out your experiment correctly the first time so that the volume is reduced
- substitute toxic chemicals with less toxic chemicals.

Proper waste disposal is extremely important. Chemicals are not to be disposed of via the sewer or general solid waste system. Remember that what you wash away in the sink today, can land in your drinking and irrigation water tomorrow.

Waste must be properly collected and stored in a closed lid container. The following steps must be taken when collecting and storing waste prior to disposal:

- Make very sure that the container to be used has been thoroughly washed and dried. The container must be clean!
- When adding waste into a container that already contains waste, ensure that both waste are compatible. The mixing of incompatible chemicals is extremely dangerous!
- Waste containers must be properly separated out to avoid unwanted reactions in the event spills.
- The container must be properly labelled with at least the following information:
    a) the type of waste (composition of components must be stipulated in the case of multiple chemicals being present),
    b) name of person generating the waste
    c) date on which collection into the container started
    d) hazards of the chemical

Refer to Appendix E for a chemical incompatibility list.

Refer to Appendix F for WASTE CHEMICAL BOTTLE LABEL.

To save costs, empty reagent bottles (2.5L Winchester bottles) as well as 25L aluminium and plastic drums are usually used for collection and storage of waste products. In using these vessels, the following points need to be noted:

- Do not place acids or alkaline material in a metal container. Metal and glass containers should be used mainly for organic waste.
- Any container to be utilised for chemical waste storage must be thoroughly cleaned and must be free of any reagents. The solvent rinse from the container is classed as waste.
- The original label must be removed before pasting the new label on.
- The container must be kept on a spill tray in a well-ventilated room.

It is not acceptable to wash unwanted chemicals down the sink. If in doubt, ask a Laboratory Technician

8.23 DISPOSAL OF COD (CHEMICAL OXYGEN DEMAND) WASTE

As such a large volume of COD waste is generated in the Biochemical laboratory; it requires a special disposal procedure.

a) Identify appropriate bottles. These should be empty Winchester bottles (2.5 ℓ glass bottles).If the bottles have contained Conc. H_2SO_4, they need not be rinsed. If not, they MUST be rinsed out with water and drained. Label the bottles with proper stick on labels or ordinary paper, stuck-on with sticky tape, and label with marker pen “COD WASTE”

b) Pour COD waste into the bottle USING A FUNNEL

c) Store partially filled bottles under the COD bench. There should be NO MORE THAN TWO partially filled bottles there at any time.

d) Once a COD waste bottle is full, it must be removed to the acid bunding outside the boiler room on the lower level.

e) When 10 COD waste bottles have accumulated in the acid bunding, contact Laboratory Assistant to assist with removing and packaging them in the main laboratory.

COD waste is highly toxic and corrosive. Handle with extreme care.

8.24 DISPOSAL OF WASTE MATERIALS

Any safety equipment (gloves, face masks), paper towel, disposable containers or samples contaminated with hazardous biological agents must be autoclaved before disposal.

Liquids (including leftover sludge samples, wastewater and sanitation sample suspensions) must be poured into a large conical or round-bottomed flask. The neck of the flask must be packed with cotton wool and covered with aluminium foil before autoclaving. After autoclaving, samples may be flushed down the toilet.

Solids (including paper towel, gloves, face masks and disposable containers) must be packed into autoclave bags (these are specialised heat resistant plastic bags), tied closed and autoclaved. Once autoclaved, they may be disposed of with general refuse.

Damaged glass is not to be thrown into the general rubbish bin. Chemical residue must first be removed and the glass disposed of into the special “broken glassware” containers. When this container has reached it capacity it will be sealed and disposed of in the fitting manner.

Used “sharps” (blades, scalpels, needles, etc.) must be put into a special rigid-walled container marked for these items that are placed at several points in the laboratories. When these containers are three quarter full, they will be sealed and sent for incineration by the appropriate authority.

Under no circumstances may sharps be thrown into the general waste bins.

Gloves contaminated with hazardous chemical substances must be placed into a separate container and marked as such. This too is not to be disposed of into the general purpose waste bin.

It is not acceptable to throw used gloves, paper towel and face masks etc. into general refuse.

8.25 RADIOACTIVE MATERIAL

Only authorized personnel may open, move or in any way tamper with any source of radiation. These sources are recognizable by the radioactive hazard symbol (see “Hazard Signs”). If there is any doubt as to the correct procedure when dealing with any radioactive material consult the Supervisor or Laboratory Technicians. Correct protective clothing must be worn when dealing with radioactive material, and the source must be kept in its correct protective housing, clearly labelled.

8.26 BIOLOGICAL HAZARDS

The handling of items classified as *Hazardous Biological Agents* is governed by the Hazardous Biological Agents Act. Any sample that may contain or have been contaminated by material of faecal origin (including activated and anaerobic sludge) is classified as a hazardous biological agent. Gloves, laboratory coats, closed shoes, face masks and safety glasses should be used when working with hazardous biological agents.

People working with biological samples, and in particular sewage treatment projects, are potentially exposed to a number of pathogenic organisms (refer to Appendix D). Such people are under the threat of infections and the areas in which they work may be hazardous. If the amount of work done with such samples warrants it, the researcher should be provided with vaccinations against diseases such as Hepatitis B.

Eating, drinking or smoking is prohibited in these areas. Disinfect contaminated areas (hands etc.) after working with biological samples. The hands may have become contaminated with the organisms and accidental ingestion could lead to infection.

The working areas should be clearly demarcated, and the substances being examined (and potential dangers) should be visibly labelled. These areas should be well ventilated, and as clean as possible, regularly disinfected, and any spills wiped up as soon as they occur. Laboratory coats (regularly laundered) and gloves must be worn when dealing with biological samples (sewage in particular), and eye protection where splashing is possible. Hands should be disinfected after each contact with the samples/sample containers.

On completion, projects dealing with such waste materials should be dismantled by the person(s) involved as soon as possible and the waste material disposed of in a suitable manner. Waste material should be autoclaved to kill the organisms and disposed of in Bio-hazard bags via the waste disposal company (consult Laboratory Technicians). All equipment/containers should be autoclaved and/or disinfected before reuse.

8.27 REPORTING OF INCIDENTS/INJURIES AND PROTOCOL TO FOLLOW

ALL incidents/injuries must be reported to the relevant technicians on duty in your laboratory.

8.28 CHEMICAL SPILL ON THE SKIN IN A CONFINED AREA

- Immediately flush with cold water.

- If there is no visible burn, remove jewellery to make sure that all residual material is removed and wash the area with soap.
- If necessary, seek medical attention.
- If there is a delayed reaction (often noted the next day), seek medical attention.
- Provide the medical service personnel with the chemical name and any other helpful information. Supply the medical team with a MSDS.

BEWARE!
Some chemicals react with water, e.g. sodium metal, and highly toxic oily chemicals. Rather remove these with alcohol or a safe hydrocarbon solvent to prevent absorption through the skin. Large volumes of the solvent must be used for washing away the contamination. Always know how to wash off the chemical that you work with.

8.29 CHEMICALS IN THE EYES

- Flush the eyeball and inner eyelid with cold water for at least 15 minutes. You need to forcibly keep the eye open ensuring that the area behind the eyelid is properly washed.
- Remove contact lenses while washing the eye.
- Seek medical assistance.
- For caustic splash, continue washing of the eye during transportation.
- Provide the medical service personnel with the chemical name and any other helpful information. Supply the medical team with a MSDS.

8.30 SMOKE OR CHEMICAL FUME INHALATION

- Remove anyone overcome with smoke or chemical fumes out of the contaminated area to a fresh air area.
- If necessary, treat for shock.
- Seek medical help.
- Provide the medical service personnel with the chemical name and any other helpful information. Supply the medical team with a MSDS.
- Do not enter the area if it is life threatening, i.e. Oxygen depletion, explosive vapours, cyanide gas, hydrogen sulphide, nitrogen oxides, carbon monoxides.

8.31 BURNING CHEMICAL ON CLOTHING

- If your clothing catches alight, DO NOT run about as the air movement fans the flames and the fire rapidly burns upwards causing upper body and facial damage.
- Adopt the drop-and –roll technique immediately, keeping the burning side on the ground as much as possible.
- Douse with cold water.
- The contaminated clothing must be removed taking care not to cause further damage to the burned area.
- Cover the injured person with a blanket, woollen clothing, etc. to prevent shock.
- Seek medical help.
- Provide the medical service personnel with the chemical name and any other helpful information. Supply the medical team with a MSDS and the victim's clothing.

8.32 BURNS

- For burns, immerse in cold water as this is very effective.

- Keep the burned area in the water for at least 10 minutes.
- Do not apply any oily liquids as this only makes the medical team's job difficult.

8.33 CHEMICAL INGESTION

- Identify the chemical ingested.
- If the chemical is confined to the mouth, give administer large amounts of water as a mouth wash. DO NOT swallow the mouth wash.
- If the chemical has been swallowed, give about 250ml of water in an attempt to dilute it in the stomach.
- Administer antidote, if known and available.
- DO NOT induce vomiting as a first aid procedure.
- Call campus clinic or the ambulance services.
- Cover victim to prevent shock.
- Provide the medical service personnel with the chemical name and any other helpful information. Supply the medical team with a MSDS.

8.34 COMPRESSED GAS LEAKS

- If a gas leak is suspected, confirm by using a gas-leak detector or soapy water. DO NOT use a flame for detection.
- If the gas is not hazardous, tighten all valves and nuts. If this does not stop the problem, evacuate the area and seek assistance from the supervisor.
- In the case of hazardous gases or fumes, activate the emergency alarm and follow the emergency procedure.
- Seek medical help for any injured parties.

8.35 BLEEDING

Using a suitable pad, apply pressure to the wound until medical assistance arrives. There is no need for dressings and bandaging.

8.36 REPORTING MINOR INJURIES

- In the event of a minor injury call a technician/safety officer/supervisor
- The patient must report to the Campus Health Clinic and/or RMS.
- Thereafter, Campus Health Clinic treats or refers the patient for medical treatment or patient visits private Medical Practitioner

8.37 REPORTING SERIOUS INJURIES

- In the event of a serious injury call/notify a technician/safety officer/supervisor IMMEDIATELY to assist you
- If the patient is unable to move or is seriously injured, Call Campus Health Clinic and RMS
- RMS/Clinic treats and refers for follow up medical treatment
- A decision may be made to call an Ambulance
- An Accident Advice form will be completed by RMS ASAP.
- An IR number will be issued by RMS
- When calling for an ambulance you must have this IR number on hand as a reference.
- The ambulance will transport you to the nearest private hospital (Life Entabeni or Netcare St. Augustines Hospital) if you have personal medical insurance, or alternatively to the nearest government hospital for emergency treatment.

- A copy of the Accident Advice form must go to hospital / Medical practitioner/s so they are aware that this is an Injury on Duty (IOD) claim.

8.38 GASES AND LIQUIDS UNDER PRESSURE

Permanent gases, oxygen, nitrogen, air, argon, helium, hydrogen, methane, etc. are supplied in high pressure cylinders. Numerous other gases are supplied as liquids under pressure. These include, ammonia, butane, carbon dioxide, chlorine, hydrogen chloride, propane, and sulphur dioxide. The pressure is dependent on the characteristics of the substance. In addition, the gases can be toxic and flammable. Cylinders of flammable gases generally have valve outlets with left-hand threads, while non-flammable gases have right-hand threaded outlets.

8.39 STORAGE OF GAS CYLINDERS

Due to the large amount of energy associated with compressed gases, gas cylinders can be very dangerous. All cylinders must be stored in a vertical position at all times, except for cylinders designed to be horizontal, e.g. ammonia or chlorine. This is to keep any liquid present out of the valve, and to protect the sides of the cylinder from shocks. Cylinders must also be chained at any given time. If a cylinder of compressed gas falls over and the fitting snaps off, that cylinder will propel like a rocket and can go through concrete walls. The cylinders must always be stored and used in a cool well-ventilated area away from all ignition sources. Valve caps should always be kept in place to protect the valve from damage and accidental opening.

Cylinders containing noxious or toxic gases must be stored in a well-ventilated area, and ALL cylinders must be returned as soon as they become empty. These cylinders should be kept aside from full cylinders, be clearly marked and their valves closed.

8.40 TRANSPORTATION OF GAS CYLINDERS

- Always read the label on a cylinder before transporting or connecting up a fresh cylinder. If the label is illegible or altogether missing, return to the supplier. It is unsafe to use a cylinder of unidentified contents.
- Cylinders must always be in an upright position and never on their side, except for cylinders designed to be horizontal, e.g. ammonia or chlorine. This is to keep any liquid present out of the valve, and to protect the sides of the cylinder from shocks.
- Ensure that cylinders are always chained to a stable object, whether in use, being stored or transported. A damaged valve on a cylinder means that the contents will exit with great force.
- Cylinders are not to be rolled or “walked”. Always use a proper trolley and ensure that the valve is protected with a valve cover during transportation. Do not transport a cylinder with the regulator still in place.

8.41 USING GAS CYLINDERS

- Firstly, secure the cylinder to a permanent fixture such as a laboratory bench or a wall with a cylinder support bracket.
- Then select a regulator that is recommended by the supplier as this is compatible with the gas content of the cylinder and DO NOT use grease on gauges or connections as this could cause an explosion especially with oxygen cylinders. At no time must you attempt to use a cylinder without a regulator in place.
- Always ensure that the valve socket is clean, dry and free of damage before fitting the regulator.
- If defects are detected, return the cylinder to the supplier. Any dust or liquid may be cleared out by use of a jet of compressed air.

Once the correct regulator has been installed, stand with the cylinder between yourself and the regulator, i.e. the cylinder valve outlet facing away. Open the valve slowly.

If a valve cannot be opened by hand, or the hand wheel supplied, the cylinder should be returned. Never hammer a cylinder valve.

Do not open acetylene or other flammable gas cylinder valves more than ½ turn of the spindle (at most, no more than ¾ of a turn). This reduces the risk of explosion and in the event of an emergency, allows for the cylinder valve to be closed quickly to cut-off the gas flow.

To withdraw gas from a high pressure cylinder follow the procedure outlined below:

- Close off the regulator valve
- Open the cylinder valve until pressure is shown, then an extra quarter turn
- Adjust the regulator to the required pressure (or flow rate)

To shut-down the gas system:

- Turn off the gas cylinder valve
- Bleed the regulator and gas lines
- Turn off the regulator

Do not close off the regulator without shutting down the gas cylinder valve as this leaves the regulator under pressure.

If a cylinder of hazardous gas develops a leak, evacuate and seal off the area. Ensure all sources of ignition have been removed if the gas is flammable. Contact the fire department.

Beware of all the precautions when using liquefied gases or cryogenic liquids.

8.42 GAS REGULATORS

The primary function of a gas regulator is to reduce high pressure gas in a cylinder or process to a lower usable level as it passes from the cylinder to a piece of equipment. It is not a flow control device and is only used to control delivery pressure.

As there are various hazards associated with the use of gases, take proper precautions to assure safety in high pressure gas control. When unsure of an operation, seek the advice of an expert.

Never use a regulator for a gas that it is not intended for. Only use the type of regulator appropriate for the gas in the cylinder, as interchanging these could lead to mixing reactive gases under pressure. Regulators should not be modified except by authorized personnel.

8.43 HAZARDOUS GASES

As mentioned previously all compressed gases are hazardous. Refer to Appendix B (Table B.1) for some common gases and their associated hazards (reference to additional sources is still necessary).

8.44 SAFETY EQUIPMENT IN CHEMICAL AND BIOLOGICAL LABORATORIES

The importance of personal protective equipment cannot be over emphasised. No persons must be allowed entry into a laboratory without the necessary personal protective gear.

8.45 CLOTHING

When you are working with chemicals, it is necessary to minimise skin exposure. The use of laboratory coats or overalls is essential as they offer a good first line of defence. In the event of contamination they are easily removed. Laboratory coats and overalls must not be worn or taken to any place/area where food is consumed or stored. Laboratory coats and overalls need to be cleaned periodically.

No person is allowed entry into a laboratory without a laboratory coat or an overall.

Proper safety shoes must be worn in laboratories and engineering workshops. **The use of sandals, open-toed, open-back, high-heeled, takkies or perforated shoes are not permitted in the laboratory.** Any person found wearing any shoe other than approved acid resistant, steel-capped safety shoes will be ejected from the laboratory.

Safety goggles should be worn at all times in the laboratory. It offers protection when glass apparatus is evacuated or taken above atmospheric pressure. It is essential when chemicals are being poured, heated or when other reactions are taking place.

Half- and full-face visors are also available and it is a better choice when transferring liquids. Prescription spectacles are not safety goggles. Specific safety goggles are available to users of spectacles. These goggles wrap around the pair of prescription glasses.

Users of contact lens need to be extra cautious around harmful liquids and vapours.

Ear plugs must be worn in areas where there is ultra-sound machinery or high noise levels.

Your hands are one of the most frequently used parts of your body and need to be well looked after. They are the easiest, most direct route of transferring chemicals into your body. Gloves are an effective barrier against such problems. A wide range of gloves are available for the large variety of chemicals that need to be handled.

The user therefore needs to carefully match the type of glove required to the chemical to be used. Please consult the laboratory technicians or relevant sources for further information to selecting a suitable glove. Also, do remember that certain individuals have displayed allergic reactions to natural rubber latex gloves. Make sure that you are not sensitive to this or any other personal protective equipment. Also, always wash your hands with soap and water after removing your gloves.

8.46 RESPIRATORS

Respirators are used in an environment where there is insufficient oxygen to protect against harmful dusts, fogs, smokes, mists, gases, vapours and sprays. Simple respirators, e.g. dust masks, are often used when dust is being produced. A filter cartridge/canister type respirator is required in an area wherein low concentration toxic vapour is present. The filter cartridge used will depend on the vapour being emitted. These cartridges have a shelf life. If possible, the filter cartridge type respirator should be used solely by a single individual. The respirator must be a) inspected before and after each use, b) cleaned and disinfected after each use

8.47 ROUTINE INSPECTION OF RESPIRATOR

- Rubber face piece should be checked for :
  - » Dirt
  - » Cracks, tears or holes
  - » Distortion from improper storage
  - » Cracked, scratched or loose fitting lens
  - » Damaged or absent mounting clips
- Head straps should be checked for:
  - » Breaks or tears
  - » Loss of elasticity
  - » Broken or malfunctioning buckles or attachments
  - » Excessively worn serrations of the head straps which might allow the face piece to slip
- Valves
  - » Detergent residue, dust or dirt on the valve seat
  - » Cracks, tears or distortion in the valve
  - » Missing or defective valve cover
- Filter Elements
  - » Proper type of filter for the job and contaminants
  - » Approved design

- » Missing or worn gaskets
- » Worn threads
- » Cracks or dents in the housing
- » Spent, dirty, used

8.48 CLEANING THE RESPIRATOR

- Using a brush wash with a detergent, or a detergent/disinfectant combination.
- Rinse in clean water, or rinse once with a disinfectant and once with clean water. The clean water rinse is very important as it removes traces of detergent or disinfectant from the mask. If these traces are not removed, they can cause skin irritation and/or damage to the respirator
- Hang to dry in a manner which prevents the face piece from distortion.

Should you require a respirator for use in the School, please contact the Chief Technician or Laboratory Technician in the mechanical workshop.

8.49 FIRE PREVENTION

Know the emergency plan for your work area.

- You have a personal responsibility in the prevention and control of fires. Familiarize yourself with the location of fire equipment in the area where you work and the proper method of turning in a fire alarm. If you are to use portable fire protection equipment (such as fire extinguishers), you must be trained in the use of portable fire protection equipment and updated as necessary.
- Obey all rules, regulations and signs for fire safety such as those controlling smoking, open flames and other sources of ignition and those controlling the storage, handing and use of flammable liquids or other hazardous materials.

Practice good housekeeping and fire prevention.

- Flammable liquid shall be handled and stored in approved safety containers equipped with flame arrestors and spring actuated caps.
- Do not store acids and bases or oxidizers and reducers in the same cabinets due to the possibility of extremely volatile reaction between the two.
- Store all poisons separately.
- Keep hand operated fire equipment such as extinguishers, hoses, etc., fully accessible, mounted and unobstructed at all times.
- If you use a fire extinguisher or any other fire equipment, notify your supervisor at once so that it can be immediately replaced and serviced.
- If your clothing catches fire, smoother the flame by rolling on the floor or ground. Never run, as this could cause the flames to spread.
- Do not clean clothing with gasoline, solvents or other flammable gasses or liquid. A spark may ignite your clothing.
- Do not use oil or grease on any oxygen equipment such as cylinders. Oxygen under pressure unites with oil and grease with explosive violence.

8.50 PROTECTIVE SHIELDS

Vessels which operate at high temperature or high pressures must also have shields/guards erected around them to protect any person working in the area. This particularly applies to glass distillation apparatus where explosives or dangerous chemicals are being processed or explosive mixtures may arise.

Face shields are also available in the School for work on small scale reactions which may be explosive. Contact the Laboratory Technicians.

9. REGULATIONS GOVERNING THE USE OF COMPUTER FACILITIES

The following regulations apply to all computer facilities at the University of KwaZulu Natal. It is the responsibility of the computer user to know and understands. A user is defined as a student, staff member or any other person making use of the university's computer facilities.

These regulations are intended to safeguard the university's computer resources for your continued benefit. Breach of these regulations will be construed as a breach of the rules of the university. Parties involved may be subject to student or staff disciplinary procedures, pre prosecution under South African law.

a) The actions of users must be in compliance with South African law and the rules of the university.
b) The rights and privacy of other users must be respected.
c) People using any university computer facility place themselves under the authority of the facility supervisor.
d) System security must be observed. Users may not attempt to bypass or undermine the security.
e) Users must treat all computer facilities and equipment with due care and consideration.
f) Users must respect any misuse of computer facilities or equipment to the facility supervisor.
g) No smoking, eating, drinking or playing of computer games is allowed in computer laboratories.
h) Users may not make use of university computer facilities to access or copy any computer games, pornography or viruses.
i) People using these facilities may not create a disturbance or interfere with other users.
j) People using these facilities may not create a disturbance or interfere with other user.
k) Users are required to produce proof of identity at the request of the facility supervisor or a university official. A University of KwaZulu Natal student or staff card or written authorization to use the facility is required.
l) Users must use their own access identification and password. These may not be shared or distributed.
m) Users must exit and sign off from computer systems correctly.
n) University computer facilities may only be used for official purposes.
o) Private work may not be undertaken without the permission of the facility supervisor.
p) Users must register a chargeable account if university computer facilities are to be used for commercial use or monetary gain.
q) Users may only access those facilities, which they have been specifically authorised to use. Users may not access or attempt to access any other facilities, equipment systems or data.
r) Copyright and licensing requirements and intellectual property rights must be respected. Users may not copy, software or other fires from university computer systems without due permission. Other users' files may not be accessed or altered in any way.
s) Users are responsible for resources under their control. Any file found on a disk in a person's possession will be assumed to be owned by that person unless the contrary can be proven on a balance of probabilities.
t) Only official university software may be used on the university computers. Permission must be obtained from the facility if any non-standard or unofficial software is to be loaded, developed or executed.
u) No software may be loaded, developed or executed on university computers that attempt to access or alter the network timeserver or other equipment.
v) Users may not intervene or tamper with computer equipment, software configurations and any other data files other than their own.

Acknowledgements

This Safety Guide combines information from safety documentation previously compiled by each discipline in the School of Engineering. Major contributors are Mr D Narayansamy (Mech Eng, ret.), Mr D Naidoo (Chem Eng) and Ms Fiona Higginson (School) who initially drafted the combined document.

References

- *The Occupational Health and Safety Act (85/1993)*
- *Laboratory Safety Manual*, Chemical Engineering Department, University of Natal, Durban, South Africa, 1995.
- Crisp, P. *Safety in the School of Chemical Engineering and Industrial Chemistry, University of New South Wales for Persons Carrying out Supervised Research,* 1st Ed, School of Chemical Engineering and Industrial Chemistry, University of New South Wales, Australia, March 1996.
- *Laboratory Safety Manual*, Chemical Engineering Department, University of Delaware, Delaware, USA, 2004.
- *Safety in Chemical Laboratories and in the Use of Chemicals,* 4th Ed, Imperial College of Science and Technology, London, UK, April 1977.
- http://www.ehs.ucdavis.edu/sftynet/chem/sn-42.html - accessed 1/6/98
- http://web.princeton.edu/sites/ehs/labsafetymanual/appe.htm - accessed December 2007
- http://web.chem-eng.utoronto.ca/index.php?option=com_docman&task=down&bid=8 - accessed December 2007
- http://www.cheme.washington.edu/PDFs/health_safety_plan_2005.pdf - accessed December 2007
- Wikipedia (Static Electricity)
- Princeton University, USA
- United Arab Emirates University, UAE

Editorial Comment:

This is the very first edition of the School of Engineering's Safety Guide. Refinements in close liaison with and official endorsement by the Safety, Health and Environment (S.H.E.) department of UKZN Howard College Campus will be effected in the subsequent edition.

Should you see any errors or inaccuracies in this document, please do not hesitate to report it to Roland Koch, Technical Manager for the School of Engineering.

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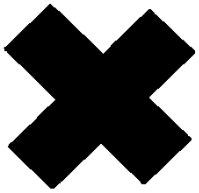
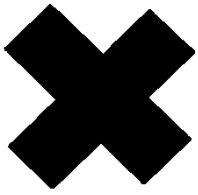
Thursday 12 September 2013

APPENDIX A

SOME COMMON HAZARD SIGNS (CHEMICAL)

SYMBOL	TYPE OF HAZARD	PRECAUTIONS
	E Explosive	Avoid impact, knocks, friction, sparks, fire and heat. When it is absolutely unavoidable to work with potentially explosive substances, keep the quantities used to a minimum, use a safe screen and store in a designated enclosure away from the area of work.
	O Oxidising	Avoid all contact with flammable substances. Risk of ignition. The substance promotes fires and impedes firefighting. This group of organic peroxides, and chemicals and preparations that come in contact with inflammable substances can inflame them or will become explosive when they are mixed with flammable substances.
	Xn Harmful	Avoid contact with the human body, including the inhalation of vapours. Injury to health is possible with improper use. With some substances carcinogenic, teratogenic or mutagenic action cannot be fully excluded, as well as possible sensitization.
 i	i Irritant	Avoid contact with eyes and skin, do not inhale vapours. Significant damage to eyes or inflammation of the skin lasting at least 24 hours after a defined exposure or significant irritation of the respiratory tract.

	C Corrosive	Take special measures to protect the eyes, skin and clothes. Do not inhale vapours.
	Radioactive	Only authorized personnel may open, move or in any way tamper with any source of radiation. Correct protective clothing must be worn when dealing with radioactive material, and the source must be kept in its correct protective housing, clearly labelled.
	Biohazard	Only authorized personnel may enter and work in these demarcated areas. Correct protective clothing must be worn when dealing with biohazardous materials.
	F Flammable F+ Highly Flammable	Keep away from naked flames, sparks and sources of heat.

	T Toxic T+ Very Toxic	All contact with the human body must be avoided as sever or even lethal damage to the health cannot be excluded. Particular attention is drawn to the carcinogenic, teratogenic or mutagenic risks associated with certain substances. A few guidelines when working with toxic chemicals are (i) Prevent inhalation of vapours and dusts (ii) Prevent contact with food (iii) Prevent skin contact (iv) No eating, drinking or smoking in the laboratory or store (v) Never pipette by using your mouth (vi) Store dangerous drugs in a locked cupboard and keep a register of the stock and its usage (vii) Medical advice must be sought at the first signs of illnesses (viii) Wash hands thoroughly (even if gloves were worn) before leaving the laboratory (ix) Keep protective clothing clean

APPENDIX B

Table B.1 lists some common gases and some of their associated hazardous (reference to additional sources is still necessary).

Gas	Boiling Point (ºC)	Explosive range (% by volume in air)	Specific Gravity	Permissible Exposure Limit (PPM)	Flammable? (Y/N)	Other Hazards
Acetylene	-84.0	2-82	0.91	2500	Y	Asphyxiant, explosive compounds
Ammonia	-33.3	15-28	0.6	50	Y	Tissue burns, respiratory irritant
Arsine	-62.5	Explo	2.66	0.05	Y	Deadly poison, fire/explo hazard
Boron Trifluoride	-100	-	2.3	1	N	Irritant, highly toxic
1,3-Butadiene	-4.5	2-11.5	1.9	100	Y	Irritant, suspected carcinogen
Carbon Dioxide	-78.5s	-	1.53	5000	N	Asphyxiant
Carbon Monoxide	-191.1	12.5-74	0.97	50	Y	Highly toxic, chemical asphyxiant
Chlorine	-34.5	-	2.49	1	N	Toxic, explosive compounds
Ethylene	-103.9	2.7-36	0.98	-	Y	Simple asphyxiant
Ethylene Oxide	10.7	3-100	1.52	1	Y	Strong irritant, toxic, carcinogen
Formaldehyde	-19.4	7-73	1.01	3	Y	Irritant, toxic, allergen, carcinogen
Hydrogen	-252.8	4.1-74.2	0.07	-	Y	Asphyxiant, invisible flame
Hydrogen Chloride	-84.8	-	1.27	5	N	Irritant. Toxic, corrosive
Hydrogen Sulphide	-60	4.3-46	1.19	20	Y	Irritant, highly toxic
Methane	-161.4	5-15	0.52	-	Y	Simple asphyxiant
Methyl Chloride	-23.7	8.1-17	1.78	100	Y	Irritant, toxic
Nitric Oxide	-152	-	1.0	25	N	Strong oxidizer, toxic, narcotic
Nitrous Dioxide	-21	-	2.83	5	N	Toxic, strong irritant
Oxygen	-183	-	1.11	-	N	Oxidising, promotes combustion
Ozone	-112	-	1.65	0.1	N	Strong oxidiser, unstable
Propane	-42.11	2.3-9.5	1.6	1000	Y	(non-irritating, odourless)
Propene	-47.7	2-11	1.5	-	Y	Simple asphyxiant, reactive
Sulphur Dioxide	-10.05	-	2.26	5	N	Strong irritant, corrosive
Vinyl Chloride	-13.9	4-33	2.15	1	Y	Dangerous irritant, carcinogen

APPENDIX C

TOXIC AND/OR NOXIOUS CHEMICALS

1. Irritants – These may affect any part of the respiratory system. Examples include:

Ammonia	Halogen acids	Sulphuric Acid
Formic Acid	Acetic Acid	Acetic anhydride
Sulphur halides	Sulphuryl chlorides	Thionyl halides
Sulhur dioxide	Chlorine	Bromine
Arsenic compounds	Phosphorous chlorides	Ozone
Nitrogen oxides	Phosgene	Acrolein
Dimethyl sulphate	Active-halogen organics	Hydrogen sulphide
Boron hydrides		

2. Asphyxiants – These interfere with the supply of the oxygen to the body tissue. Examples include:

Any gas other than oxygen	Hydrogen sulphide
Carbon monoxide	Volatile cyanides

3. Systematic Poisons – These are absorbed through the respiratory system, enter the blood stream and affect a site other than the point of contact. Examples include:

Benzene	Toluene	Styrene	Butane
Alcohols	Aldehydes	Ketones	Ketene
Ethers	Esters	Halogenated hydrocarbons	
Aromatic amines	Cycloparaffins	Organic nitro-compounds	
Carbon disulphide	Boron hydride	Mercury and its compounds	
Arsenic and its compounds		Selenium and its compounds	
Selenium and its compounds		Antimony and its compounds	
Lead and its compounds		Metal carbonyls	
Phosphorous			

APPENDIX D

BIOLOGICAL INFECTIONS

Typhoid

Typhoid is spread by the faecal-oral route, and workers with sewage may be exposed to infection. The incubation period varies from one to two weeks after contact with the organism. The disease entails high temperatures, abdominal pain, blood stained diarrhoea and “marked debility”. Mild infections do occur when the disease is not as severe. Some people (2-5%) when recovered from the disease harbour the organism and become carriers. The organisms when excreted in faeces and in urine may infect others.

Cholera

Cholera is also transmitted by the faecal-oral route and is a serious acute intestinal disease, characterized by diarrhoea, vomiting, rapid dehydration, acidosis and circulatory collapse. It can be fatal within a few hours of the onset, and the incubation period varies from a few hours to five days. The disease is contagious while the organisms are present in the faeces, which is until a few days after recovery. Again, a few recovered people can serve as carriers for a longer period.

Polio

Polio is usually spread by direct contact with pharyngeal secretions from an infected person, but it is possible to contract it from work with sewage as the organisms are present in faeces. Most people have been immunized against polio, and this prevents infection.

Hepatitis A and B and HIV-AIDS

The infection by the Hepatitis B virus is a significant risk amongst sewage workers. The incubation period is twenty to sixty days, and the infectious period is seven days before and after the onset of jaundice. The symptoms prior to becoming jaundiced are feelings of tiredness, lethargy and a loss of appetite. The liver may also enlarge. After the onset of jaundice, abdominal pain may occur. Mortality is not high.

Hepatitis B and HIV-AIDS are transmitted sexually, and by inoculation with infected blood and body fluids it is highly unlikely that these organisms would survive in the medium of sewage, but may be contracted when dealing with blood.

Amoebic Dysentery

This is one example of a parasitic infection which can be contracted from sewage and which can produce diarrhoeal diseases. The infection may be asymptomatic, mild, acute or chronic. The organisms can spread to cause abscesses of the liver, lungs or brain which can be fatal. Incubation periods range from five days to a number of months, (usually three to four weeks). The disease is contagious for as long as the organism is present in the faeces which may be a period of years.

Round worm and Tape worm

These are two of a number of worms which can affect the intestine. This results in the person feeling unwell, and is associated with allergic conditions.

APPENDIX E

Chemical Incompatibility List

Substance	Incompatible With
Acetic Acid	Chromium (Vi) Oxide, Nitric Acid, Alcohols, Ethylene Glycol, Perchloric Acid, Peroxides, Permanganates
Acetone	Chlorine, Bromine, Copper, Fluorine, Silver, Mercury
Acetylene	Bromine, Chlorine, Fluorine, Copper, Silver, Mercury
Active Charcoal	Calcium Hypochlorite, Oxidising Agents
Alkali Metals	Water, Carbon Tetrachloride & Other Halogenated Alkanes, Carbon Dioxide, Halogens
Aluminium Alkyls	Water
Ammonia, Anhydrous	Mercury, Chlorine, Calcium Hypochlorite, Iodine, Bromine, Hydrofluoric Acid
Ammonia, Laboratory Gas	Mercury (E.G. In Manometers), Chlorine, Calcium, Calcium Hypochlorite, Iodine, Bromine, Hydrogen Fluoride
Ammonium Nitrate	Acids, Metal Powders, Flammable Liquids, Chlorates, Nitrates, Sulphur, Finely Divided Organic Substances Or Other Combustible Substances
Aniline	Nitric Acid, Hydrogen Peroxide
Azides	Acids
Bromine	Acetylene, Ammonia, Butadiene, Butane, Methane, Propane, Hydrogen, Petroleum Ether, Benzene, Metal Powders
Chlorates	Ammonium Salts, Acids, Metal Powders, Sulphur, Finely Divided Organic Substances Or Other Flammable Substances
Chlorine	Acetylene, Ammonia, Butadiene, Butane, Methane, Propane, Hydrogen, Petroleum Ether, Benzene, Metal Powders
Chlorine Dioxide	Ammonia, Methane, Phosphine, Hydrogen Sulphide
Chlorites	Sodium Sulphite, Sodium Hydrogen Sulphite
Chromium (Vi) Oxide	Acetic Acid, Naphthaline, Camphor, Glycerol, Petroleum Ether, Alcohols, Flammable Liquids
Copper	Acetylene, Hydrogen Peroxide
Cyanides	Acids
Cumene Hydroxide	Acids, Organic And Inorganic
Flammable Liquids	Ammonium Nitrate, Chromic Acid, Hydrogen Peroxide, Nitric Acid, Sodium Peroxide, Halogens
Fluorine	Store Separately
Hydrocarbons	Fluorine, Chlorine, Bromine. Chromium (Vi) Oxide, Sodium Peroxide
Hydrocyanic Acid	Nitric Acid, Alkali
Hydrogen Fluoride	Ammonia (Laboratory Gas Or Solution)
Hydrogen Peroxide	Copper, Chromium, Iron, Metals And Metal Salts, Alcohol, Acetone, Organic Substances (Solid Or Liquid)
Hydrogen Sulphide	Fuming Nitric Acid, Oxidising Gases
Iodine	Acetylene, Ammonia (Laboratory Gas Or Solution)
Mercury	Acetylene, Ammonia
Nitric Acid (Conc)	Acetic Acid, Aniline, Chromium (Vi) Oxide, Hydrogen Cyanide, Hydrogen Sulphide, Flammable Liquids & Gases

Nitrites	Acids
Oxalic Acid	Silver, Mercury
Perchloric Acid	Acetic Anhydride, Bismuth & Its Alloys, Alcohols, Paper, Wood
Peroxides, Organic	Acids (Organic Or Mineral), Avoid Friction, Store Cold.
Phosphorous	Sulphur, Compounds Containing Oxygen, E.G. Chlorates
Potassium	Water, Carbon Tetrachloride & Other Halogenated Alkanes, Carbon Dioxide, Halogens
Potassium Perchlorate	Ammonium Salts, Acids, Metal Powders, Sulphur, Finely Divided Organic Substances Or Other Flammable Substances
Potassium Permanganate	Glycerol, Ethylene Glycol, Benzaldehyde, Sulphuric Acid
Silver	Acetylene, Oxalic Acid, Tartaric Acid, Ammonium Compounds
Sodium	Water, Carbon Tetrachloride & Other Halogenated Alkanes, Carbon Dioxide, Halogens
Sodium Nitrate	Ammonium Nitrate And Other Ammonium Salts.
Sodium Peroxide	Methanol, Ethanol, Glacial Acetic Acid, Acetic Anhydride, Benzaldehyde, Carbon Disulphide, Glycerol, Ethylene Glycol, Ethyl Acetate, Methyl Acetate, Furfural
Sulphides	Acids
Sulphuric Acid	Potassium Chlorate, Potassium Perchlorate, Potassium Permanganate

APPENDIX F

HAZARDOUS WASTE

Responsible Individual: _____
Lab Group: _____
Accumulation Start Date: _____

Contents (**no abbreviations**)	Approx. %

Signature: _____

APPENDIX G

EMERGENCY NUMBERS

When dialling external telephone numbers, REMEMBER to precede the telephone number by the area code 031

EMERGENCY	SPEED DIAL	DIRECT DIALING
Campus Security *Risk Management Services (24 Hrs)* *In case of fire, theft, robbery, bomb threat, unrest, etc.* *Traffic Control – Shepstone Building*	Emergency Line 3777	x 2540 x 2542 x 2818 x 1427
Police *Umbilo Police Station* *Flying Squad* *Durban City Police*	*85107 *85108 *85109	205 3383 10111 306 4422
Ambulance Services ***NPA*** *NB: NPA ambulance dispatched from nearest Provincial Hospital & patient will only be taken to nearest Provincial Hospital for appropriate treatment.* ***MRI*** *(Criti-care)* ***NETCARE*** *Ambulance Services* *NB: Net Care dispatched from St. Augustines – patient may designate hospital to which they wish to be taken when making the call.*	*85100 *85114	10177 083 1999 0800 333 444
Campus Health Clinic*:* *Consulting Hours (weekdays only):* *07h00 - 15h00*		x 3285
Fire Department *24 hours*	*85105	361 0000
Poison Unit *St. Augustines Hospital*	*85114	0800 333 444
Student Counselling: *Office Hours:* *After Hours: Ms L Collins* *Dr R Naidoo*		x 2668/9 208 4062 or 902 2158 or 083 501 2557

APPENDIX H

SCHOOL OF ENGINEERING

SAFETY REPRESENTATIVES, FIRST AIDERS AND FIRE & EVACUATION MARSHALS

SEPTEMBER 2013 *(List subject to alteration)*

Agricultural Engineering (Ukulinga Farm, Pietermaritzburg)

Safety Representative/s:	Mr A Hill (x6816)
First Aider/s:	Mr A Hill
Fire Warden/s:	Mr A Hill
Evacuation Warden/s:	Mr A Hill

Civil Engineering, Surveying & Construction

Safety Representative/s:	Mr L Govender (x6816), Ms F Ali (x3362)
First Aider/s:	Mr L Govender, Ms F Ali, Mr B Dumisa, Mr S Mpungose (x1071)
Fire Warden/s:	Ms F Ali, Mr B Dumisa, Mr S Mpungose
Evacuation Warden/s:	Mr L Govender

Chemical Engineering *(see additional info below)*

Safety Representative/s:	Mr S Addieah (x1126), Ms N Hadebe (x1125)
First Aider/s:	Mr S Deeraj (x1125), Ms N Hadebe (x3384), Mr A Khanyile
Fire Warden/s:	Mr S Addieah, Mr S Deeraj
Evacuation Warden/s:	Mr S Addieah, Ms N Hadebe

Electrical, Electronic & Computer Engineering (NORTH)

Safety Representative/s:	Mr D Moodley (x2735), Mr D Moodley (x2735)
First Aider/s:	Mr D Moodley
Fire Warden/s:	Mr D Moodley
Evacuation Warden/s:	Mr D Moodley

Electrical, Electronic & Computer Engineering (SOUTH)

Safety Representative/s:	Mr A Lester (x2724), Mr U Roopnund (x7306)
First Aider/s:	Mr A Stengel (x2723), Mr G Loubser (x2723), Mr U Roopnund
Fire Warden/s:	Mr D Govender (x2723)
Evacuation Warden/s:	Mr A Lester, Mr U Roopnund

Mechanical Engineering

Safety Representative/s:	Mr S Govender (x1232), Mr H Sunpersadh (x7167)
First Aider/s:	Mr Y Reddy (x1221), Mr S Mahabeer (x1221), Mr D Singh (x1221)
Fire Warden/s:	Mr S Govender,
Evacuation Warden/s:	Mr S Savy (x3219), Mr S Govender

School of Engineering / UNITE

Safety Representative/s:	Ms M David (x2072)
First Aider/s:	Ms M David
Fire Warden/s:	Ms M David
Evacuation Warden/s:	Ms M David

CHEMICAL ENGINEERING SPECIALISED TEAMS

Safety Team: Mr D Naidoo (Chair) Dr S Kiambi (Deputy Chair), Mr M Ntunka, Dr C Narasigadu, Mr S Addieah, Mr A Khanyile, Mr L Mkize, Mr S Naidoo, Mr P Nayager, Ms M Reddy

HAZOP Team: Prof M Carsky, Dr D Lokhat, Dr P Naidoo, Mr D Naidoo, Mr S Addieah, Mr S Deeraj, Ms N Hadebe.