



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

School of Chemical & Energy Engineering
Faculty of Engineering

HANDBOOK

OF LABORATORY

SAFETY AND REGULATIONS

3rd Edition

ACKNOWLEDGEMENT

In conjunction with publishing the Handbook of Laboratory Safety and Regulations, the School of Chemical and Energy Engineering would like to express gratitude to the Faculty's Occupational Safety and Health Committee members as well as many others who were involved directly or indirectly in the completion of this handbook for their effort and perseverance.

FOREWORD

Assalamualaikum wbt.

I am extremely grateful to Allah for allowing us to properly complete yet another task in performing the responsibilities given.

The safety handbook has reached its fourth edition and has been improved, in line with aspiration of the School of Chemical and Energy Engineering (SCEE). This safety handbook is carefully designed to fulfill the safety, health and environment aspects for all laboratories as well as work place in the faculty. Special consideration concerning DOSH and DOE regulation has been made added. Significant amounts of time, energy, and effort were placed into publishing the updated version of this handbook. All of this was purely made with one noble intention, which is to foster and inculcate safety practices within the community of SCEE. Hence, let's make sure that the hard work does not go to waste by putting the handbook into practice.

I would also like to congratulate all those who were involved especially the Faculty's Occupational Safety and Health Committee members for their diligence in publishing the handbook.

In conclusion, I believe that good safety practices will produce academic education of excellent quality.

ASSOCIATE PROFESSOR DR. ZAINUL AKMAR ZAKARIA
ASSOCIATE CHAIR (FACILITY)
School of Chemical and Energy Engineering
Faculty of Engineering
Universiti Teknologi Malaysia
Johor Bahru, Johor.

AUTHORS

Editor-in-Chief:

Prof. Dr. Mat Uzir Wahit

Editors:

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Dr. Mahadhir Mohamad
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En. Nik Azmi Nik Mahmood
Pn. Zaimarhamah Zainuddin
Pn. Ardiyana Mohd Suhaimi

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CHAPTER 1

THE OCCUPATIONAL SAFETY AND HEALTH COMMITTEE

1.1 Introduction

The School of Chemical and Natural Resources Engineering's Laboratory Safety Supervision Committee was officially established in January 1992 with the objectives of examining, evaluating and enhancing the quality and level of safety of laboratory users at a departmental level. To fulfill the requirements of the Occupational Safety and Health Act 1994 which emphasizes on the aspects of employee safety and health, from 2005, the committee was renamed the Occupational Safety and Health Committee, School of Chemical and Natural Resources Engineering. This was until the 1 July 2018, when the faculty split and the School of Chemical and Energy Engineering was formed.

1.2 Occupational Safety and Health Committee

Section 30 of the Occupational Safety and Health Act 1994 has imposed that all employers of workplaces with 40 or more employees, or employers directed by the Director General of the Department of Occupational Safety and Health, to establish an Occupational Safety and Health Committee for the given workplace. The act also imposed the employer to consult the committee in making and implementing arrangements which will enable the employer and employees to co-operate effectively in promoting, developing and evaluating safety and health measures at the workplace.

1.3 Functions of the Occupational Safety and Health Committee

1. Manage matters related to the school's occupational environment, safety and health.
2. Ensure the school follows all that is written in national safety acts and regulations.
3. Ensure the level of safety in all areas within the school is in tip top condition.
4. Prepare safety handbooks for the school.
5. Conduct fire drill exercises.
6. Perform safety audits.
7. Recommend safety improving measures.

1.4 Objectives of the Occupational Safety and Health Committee

1. To enhance co-operation between the employer and employees in improving the safety and health at the workplace.
2. To establish a 2-way communication channel in transmitting occupational safety and health-related information.
3. To promote the interest and motivation of all among the management and the employees in occupational safety and health-related issues.
4. Assist in preparing, implementing, revising and improving safety and health policies.
5. Make recommendations on all necessary repairs and restorations relating to occupational safety and health.

1.5 Membership of the Occupational Safety and Health Committee at the Division/School Level

1. Chairperson
Chair / Associate Chair
2. Secretary
Deputy Registrar/ Academic Member (competent if possible)

3. Employer Representatives
4. Employee Representatives
 - Academic
 - Non-academic

1.6 Structure of the Occupational Safety and Health Committee

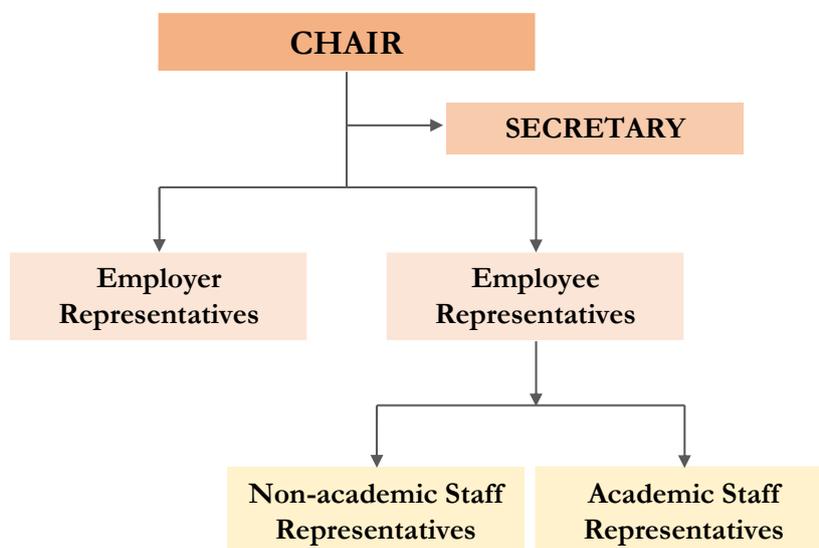


Figure 1.1: Organization Chart of the Occupational Safety and Health Committee School of Chemical and Energy Engineering.

1.7 Responsibilities of the Occupational Safety and Health Committee

From time to time, examine and evaluate the school's level of safety especially the chemistry laboratories and put forward recommendations for refining safety aspects to all staff, students and visitors.

1. Update and ensure that chemical waste storage and disposal practices are always in accordance with the latest acts and regulations.
2. Organize talks, demonstrations, exercises, workshops or other safety-related activities to make certain that personal safety measures and safe working habits are practiced at all times.
3. Keep records of matters relating to the school's safety such as the list of dangerous chemicals.
4. Investigate, report, record and take follow-up action on any accidents in the school.
5. Perform scheduled safety audits on school laboratories and submit a report on it.

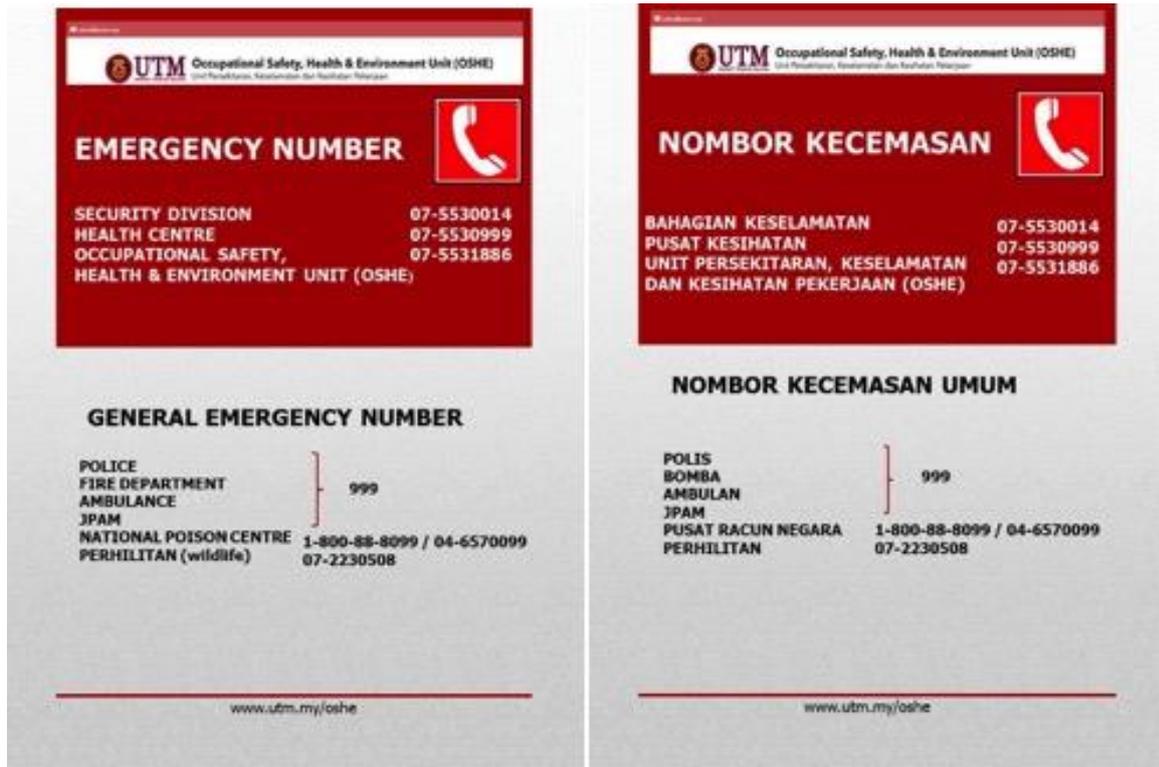


Figure 1.2: Emergency hotlines.

CHAPTER 2

GENERAL SAFETY AT THE WORKPLACE

2.1 Introduction

A person generally works for a period of 8 hours a day at the “workplace”. Therefore, the employer and every employee must give attention to safety at the workplace. Thus, a few rules must be followed and made a habit.

2.2 General Rules

1. Make sure the paths inside and outside the laboratory are not obstructed by equipment, furniture, electrical wires, etc.
2. Make sure that all equipment in the office are in working condition.
3. Follow the manufacturer’s equipment handling and maintenance rules.
4. Use screen filters to reduce UV radiation from computer monitors.
5. Work at a minimum distance of 50 cm from the computer screen.
6. Make sure the cabinet drawers are neatly closed after opening them.
7. Be careful when moving heavy objects like cupboards, tables, equipment and boxes as to avoid manual handling injuries. Use a trolley if necessary.
8. Clean any spillages immediately even if it’s just water.
9. Report broken furniture or equipment to the related department.
10. Use a ladder to obtain items from tall racks.
11. Make sure that nothing is obstructing the emergency exit.
12. Make sure the fire extinguishers are easily accessible.
13. Identify the location of the glass breaker for activating the fire alarm in case of a fire.
14. Rest for a while to relieve stress and recuperate.

2.3 Building Security

To prevent people from spying and stealing classified information by entering the office illegally, the following steps must be taken:

1. To have an entrance/exit with a reception counter,
2. Set up/strengthen windows and doors and equip with safety locks,
3. Strengthen the walls and the ceiling,
4. Install sound filters, intruder alarms, and other devices,
5. Set up a special area or room for guests,
6. Establish security guard services.

CHAPTER 3

CHEMICAL SAFETY

3.1 Introduction

Various chemicals are used in the laboratory and the handling know-how is of utmost importance. Negligence in handling chemicals may be hazardous to users. Therefore, the following safety measures must be understood and practiced. In addition, the rules and regulations of Chemical Protective Clothing (PCP), the Use and Standard of Exposure Chemical Hazardous to Health (USECHH 2000), and Classification, Labelling and Safety Data Sheet of Hazardous Chemicals (CLASS 2013) must be complied.

3.2 Safety Precautions in Handling Chemicals

1. Users must obtain the original Safety Data Sheet (SDS) of the chemicals from the manufacturer and the chemical registry must be up-to-date.
2. Personal Protective Equipment (PPE) must be used in accordance to the SDS. Heat-resistant gloves and/or tongs must be used when handling hot glassware.
3. The SDS must be referred during the preparation of each chemical. Chemicals which are toxic, odoriferous, volatile or harmful by inhalation must be handled in a fume hood with the exhaust fan on and the sash lowered.
4. Every chemical-containing bottle must be closed right after acquiring the required amounts.
5. Use a bottle carrier to transport Winchester bottles.
6. The SDS must be referred to in case of any chemical spillages; the mess must be cleaned up immediately following the designated procedure. **Please refer Chapter 10 (First Aid at the Workplace).**
7. Hands must be thoroughly washed after handling chemicals.
8. There are various types of chemicals in the laboratory, therefore the following safety precautions must be given attention, followed according to the chemical type and with reference to the SDS.
9. Highly Flammable Solids
 - a. Sodium, potassium and lithium metals must be kept fully immersed in oil.
 - b. Yellow phosphorus must be kept fully immersed in water and avoid drying.
 - c. Strong oxidizing agents (Please refer Appendix 1) must be stored separately and at a safe distance from strong reducing agents.
10. Highly Flammable Liquids
Highly flammable liquids (Please refer Appendix 2) must be placed at a safe distance from any fire or electricity source as evaporation from them may cause an explosion or start a fire. Liquid-containing containers must be stored at easily-accessed levels and must be placed in a plastic tray. Do not place them on the floor.
11. Corrosive Materials
 - a. Avoid direct skin contact with corrosive material (Please refer Appendix 3). If contact is made, wash immediately with large amounts of water and refer to the SDS. Corrosive material must be handled in the fume hood. Wear PPE as recommended in the SDS.
 - b. When diluting acid, do it carefully and make sure to pour the acid into the water and not water into acid. The process must be conducted on a tray prepared in the fume hood.
 - c. Do not wear contact lenses when handling corrosive materials.

12. **Poisonous Materials**

Use a pipette to draw poisonous materials (Please refer Appendix 4). Wash immediately any areas that were in contact with poisonous materials.

13. **Corrosive Materials**

Incompatible chemicals (Please refer Appendix 5) should not be transported in the same carrier.

3.3 Storage

1. Storage areas must be available to authorized personnel only.
2. All chemical bottles must be clearly labeled and their concentration specified.
3. Storage racks must have heightened edges to avoid bottles from sliding to a fall.
4. Adequate containment for spills and accidental releases shall be provided.
5. Easily evaporated liquids and other hazardous chemicals (such as large volume of concentrated acids) must be kept at a separate special location.
6. Poisonous materials must be kept in locked cupboard and their use must be recorded.
7. Do not keep excessive highly flammable materials in the laboratory.
8. Avoid stored chemicals from sunlight as some chemicals are photosensitive.
9. Periodic inspections must be conducted to identify any sign of chemical leakage, expired chemicals, damaged and fallen labels, as well as rusted and broken bottle caps.
10. Large or heavy bottles and containers must be stored on shelves at waist level or lower.
11. Do not use fume hood as a storage cabinet.

3.4 Disposal

1. Out-of-date and unwanted chemicals should be disposed of regularly.
2. Chemical waste disposal from the laboratory to the department's temporary storage should be done as recommended by the SDS.
3. Chemical waste must be collected in original or another suitable container.
4. The containers must be clearly labeled to indicate their contents and associated hazards.
5. The containers must be properly stored until they are ready for disposal.

3.5 Chemical Health Risk Assessment (CHRA)

1. It is highly recommended that all laboratories to conduct CHRA in order to assess the risks arising from the use, handling, storage or transportation of chemicals hazardous to the health of users as required by USECHH 2000.
2. The purpose of conducting CHRA is to ensure appropriate decisions are taken to protect the health of users who may be exposed to chemical hazardous.
3. The assessment should be conducted in accordance to Manual for the Assessment of the Health Risks arising from the use of Hazardous Chemicals in the Workplace: Second Edition that was published by the DOSH (<http://www.dosh.gov.my/index.php/en/osh-info-2/chemical-issues-sp-265/341-chemical-health-risk-assessment-chra>).
4. Sample of CHRA could be obtained at www.fcee.utm.my.

CHAPTER 4

COMPRESSED GAS SAFETY

4.1 Introduction

Compressed gases are widely used in laboratories and can expose users to both chemical and physical hazards. Therefore, the cylinders must be handled, stored, and used safely. In addition, usage of flammable gases (such as compressed natural gas, and liquefied petroleum gas) must be in compliance with the Gas Supply Act 1993 and the Gas Supply Regulations 1997, as well as codes of practice MS930:2017, Installation of Fuel Gas Piping Systems and Appliances, and MS830:2013, Storage, Handling and Transportation of Liquefied Petroleum Gases (LPG). Special care must be taken for handling flammable gases since they are dangerous as they may explode and can cause physical damage.

4.2 General Guidelines

1. Ensure gas cylinders are properly labeled / tagged when received. Do not accept cylinders that are not labeled / tagged. Do not add, remove, alter or change the identification tag on the compressed gas cylinders.
2. Never use cylinders not compatible with the gas' given pressure and type.
3. The cylinder valve should be closed at all times except when in use.
4. Never use cylinder storage space for anything other than for storing gas cylinders.
5. Never change, customize, knock, or repair the gas regulator at the valve or cylinder.
6. Minimize the number of gas cylinders used at workplace
7. Gas cylinders should not be placed in hallways, near elevators, or near exits. Gas cylinders must not obstruct exit routes, electrical panels, or emergency equipment.
8. Gas cylinders must be kept vertically and tied tightly in place with chains or iron cages or other suitable method to avoid tumbling down.
9. Tighten the valves and make sure the valve safety lid (if present) is replaced before returning empty cylinders.

4.3 Handling

1. Wear proper PPE when handling gas cylinders such as eye protection, safety shoes, and work gloves.
2. Never drag or slide the cylinders, use a gas cylinder trolley or approved lifting device to transport them instead. Never lift cylinders by the valve cap.
3. The valve and any other equipment of the cylinder must be free of lubricants such as oil or grease.
4. The pipe connector, regulator, and other equipment must be tightly closed to avoid leakage. Make sure the hose is in good condition.
5. Never light a fire to find the source of a leakage. Instead, use a leak detector or soap solution.
6. Make sure the gas pressure regulator is compatible with the gas. Never use the regulator or other equipment from one type of gas on another.
7. Remove all wrappings around the cylinder before use to ensure the label is clearly visible.
8. Open valves slowly when using compressed gas. When opening the valve regulator, point the hose nozzle far away from the user. Never knock the valve when opening or closing the valve.
9. Avoid exposing cylinders to temperatures over 50 °C. Never allow a fire or heat source to make contact with the gas-containing cylinder compartment.
10. Keep the cylinders away from electrical current.

4.4 Storage

1. Empty cylinders must be placed separately from the gas-containing ones.
2. The storage room must be dry and with good ventilation. It must be at a safe distance from a fire source or flammable materials.
3. Separate highly flammable gases like acetylene, hydrogen, LPG, and CNG from other gases.

4.5 Precautions for Flammable Gases

1. Flammable gases shall be stored in well-ventilated areas away from electrical appliances, oxidizers, open flames, sparks, and other heat and ignition sources.
2. Pressure regulator must be removed when experimental process is not in progress or the laboratory is unattended.
3. Immediately shut off gas supply if gas leak is suspected.
4. Never turn electric switches on or off if gas leak is suspected.
5. Never store flammable materials (such as paper, cloth, or broom) near gas appliances.
6. If the pilot light is out, immediately shut off gas supply and wait for five minutes to let gas disperse before relight the pilot light.
7. Always observe for sign of gas leaks through smell, sound, and sight (dirt spraying into the air, or continual bubbling in water).

CHAPTER 5

RADIOACTIVE MATERIAL SAFETY

5.1 Introduction

Radiation from radionuclides and other radiation generator used in teaching and research at UTM can present hazards to mankind and the environment. They must be handled with extreme, care utilizing specialized equipment and following rules and regulation.

The purpose of this procedure is to outline the basic approach to a radiological incident that will ensure that the safety and health of staff, students, general public, and the environment are protected. This is in line with requirements as stated in Atomic Energy Licensing Act 1986 (Act 304) and its subsidiary.

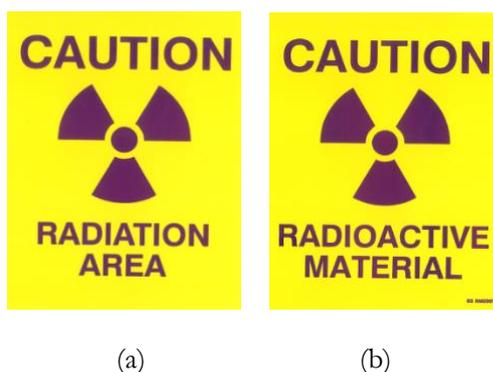


Figure 5.1: Showing (a) normal representation of radiation working area, and (b) radioactive substances.

5.2 Rules for handling and use of radioactive material

1. An appropriate PPE such as lab coat, protective gloves and closed-toe shoes must be worn when working with radiation and radioactive material.
2. A personal dosimeter must be worn when working with radioactive material.
3. Operating staff must send the personal dosimeter for checking to ensure annual dose limit is not exceeded.
4. Radioactive sources should be used only when there is a justified benefit.
5. Radioactive sources should be handled in ways that minimize both staff and student exposures.
6. Use a radioactive source that emits the smallest practicable dose rate.
7. Ensure that adequate shielding of the source is in place.
8. Keeping all parts of the body at the greatest practicable distance from the source. In particular no source shall be held in the hand or manipulated directly by hand if the work can be carried out by another means.
9. Remote-handling devices should be used for gamma-emitters and hard beta-emitters and for all sources not in protective containers.
10. Restriction of the period of exposure to the minimum practicable.

11. Closed/sealed sources must be kept securely, normally within a locked cupboard within a locked room. Access to keys and codes must be restricted.
12. Closed/sealed sources must be strictly accounted for to ensure that their location is known.
13. Sealed sources should be carefully checked periodically to make sure they remain in a safe condition.
14. Any suspected loss of, or damage to a source must be reported immediately to the Radiation Protection Officer.
15. Regular leak testing must be carried out. A suitable interval for most sources is once every two years but circumstances might require alternative frequencies to be adopted.
16. Records of all radioactive sources should be properly kept, showing what they are, when they were bought, when and by whom they have been used, and eventually, how they were disposed of.
17. The laboratory should have a suitable radioactivity detector in good working order.
18. Do not eat, drink and store food in any laboratory area.

5.3 Accident and Emergency

1. In the event of a spill, restrict access to contaminated area, avoid the spread of contamination and report immediately to staff on duty or to the Radiation Protection Officer.
2. Do not wear potentially contaminated gloves when handling monitors or where their use may spread contamination, e.g. handles of doors and refrigerators.
3. Suspected Lost or stolen radioactive material must be reported immediately to Radiation Protection Officer.
4. In case of injury, medical treatment takes priority over contamination concerns.

5.4 Disposal of radioactive / radiation contaminated material

1. It is a legal requirement that radioactive waste may be accumulated and disposed of only in accordance with the authorization of AELB.
2. Generation of radioactive waste should be kept to the minimum practicable.
3. Radioactive waste inventory (activity, exposure rate, source and location, chemical and physical properties) if any, must be properly recorded.
4. All radiation workers should be familiar with the restrictions imposed on the period of accumulation of waste and on disposal routes and quantities
5. All waste measuring less than twice background (VLLW) may be disposed as non-radioactive material.

CHAPTER 6

ELECTRICAL EQUIPMENT SAFETY

6.1 Introduction

Electricity can be dangerous or even fatal if laboratory users do not follow the correct rules of usage.

6.2 General Safety Measures

1. Make sure that all electrical equipment (both handheld and fixed) are in good condition. Periodic examinations of electrical equipment (based on frequency of use) must be conducted and logged.
2. Any electrical equipment assembly, addition, or repair work must be conducted by qualified personnel only.
3. Old insulators and insulators with cracks must be reported and replaced immediately.
4. Use cable/conductors with suitable size and insulators to withstand the voltage, current and temperature.
5. Avoid adding circuits to equipment.
6. Make sure the power supply to the equipment is disconnected before maintenance, repairs or modification work.
7. Place a **“UNDER MAINTENANCE”** warning sign on equipment under maintenance to avoid others from turning them on.
8. Make sure replacement fuses are in accordance to the specifications given by the manufacturer. Never change it without reason as it may threaten the safety of other equipment and users.
9. Handle electrical equipment with dry hands.
10. Pull any plugs showing signs of over-heating or internal-arching from its socket. Such may be due to a loose connection, an unsuitable conductor or a short circuit.
11. Broken electrical equipment must be labeled **“BROKEN”** and reported immediately.

CHAPTER 7

FIRE SAFETY

7.1 Introduction

A fire is an accident that occurs frequently and must be controlled before it spreads and becomes more dangerous. Laboratory fires may be due to a short circuit, gas explosion, or highly flammable chemicals.

7.2 Fire Preventive Measures

1. Gas cylinders, gas pipes as well as Bunsen burner tubes must be regularly examined. Soap solutions must be used for testing gas leakages.
2. Avoid storing large amounts of highly flammable materials in the laboratory. Limit according to daily requirements only.
3. Laboratory users must plan their work in advance. Most laboratory fires are caused by negligence and failure to follow the procedures of a given experiment.
4. The switches, connectors, and connection to the electrical equipment must be examined from time to time to avoid the risk of short circuiting, over-heating or internal arcing.
5. Laboratory users must practice hygienic laboratory culture, i.e. tidy the tables and empty the rubbish bins every day.
6. Laboratory users must be proficient at using fire extinguishers.
7. Make sure laboratory space is free of flammable evaporations. Otherwise, open all the windows to ventilate the air.

CHAPTER 8

GENERAL PROTOCOL FOR EMERGENCY RESPONSE

8.1 Introduction

Emergency protocols are necessary steps taken in cases of accidents like chemical spillage, fire, etc. All forms of accidents must be immediately reported to the school's Occupational Safety and Health Committee.

8.2 Chemical Spillage

General protocol for small spillages

1. Provide aid to people spilled with chemicals.
2. Notify the other laboratory users nearby.
3. Deploy the spillage control kit to prevent spillages from spreading.
4. Get unrelated people to leave the area.
5. Clean up the mess with a suitable method.
6. Never forget to wear your PPE.
7. Start the fume hood.

General protocol for large spillages

1. Activate the emergency system.
2. Save the victims if possible.
3. Empty the area and call the fire department.

8.3 General Protocol in the event of a Fire

Small fire

1. Notify the staff and the head officer on duty.
2. Extinguish the fire with a fire extinguisher in the laboratory.

Large fire

1. Start the fire alarm.
2. Contact the fire department.
3. Leave the building and gather at the designated area through the path given in the evacuation route guide posted on the building.
4. Cut off the laboratory's gas and power supply if possible.
5. Never risk returning to the scene without approval of the fire department.

8.4 General Protocol in case of an Electrical Shock

1. Cut the power supply immediately if possible.
2. If cutting the power supply is not possible, free the victim using a piece of dry wood.
3. Provide first aid.

8.5 First Aid

1. A complete first aid kit must be available and checked at all times; the contents must be refilled once they are used up.
2. The complete first aid kit must be placed somewhere easily spotted in the laboratory or the preparation room.

3. All accident victims suspected of complications must be sent to a clinic or hospital for further treatment.
4. Acid or alkali-caused blisters must be washed with a lot of water followed by a neutralizer.
5. If the clothes are on fire, put the victim down and wrap him/her with a fire-proof blanket.
6. Eyes must be washed immediately with flowing water if in contact with acid or alkali.

**Flow Chart of the Incident and Disaster Management System
(Command Center)**

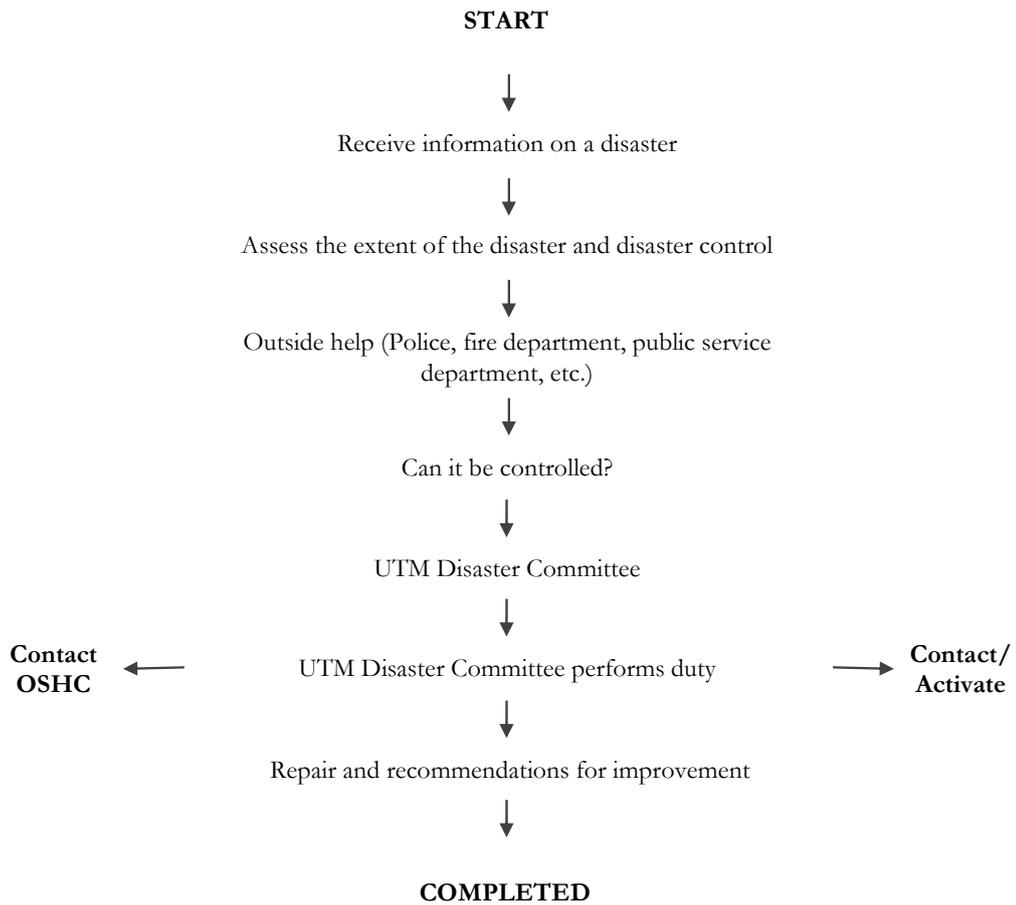


Figure 8.1: Flow chart of the Incident and Disaster Management System (Command Centre).

CHAPTER 9

CHEMICAL WASTE DISPOSAL MANAGEMENT

9.1 Introduction

These procedures attempt to aid the school's laboratory users to manage and handle chemical wastes created by the laboratory more systematically and better organized. They are the safety measures when collecting chemical wastes from laboratories to the school's temporary collection site before being delivered to the University's Waste Collection Center.

9.2 General Rules

1. Chemical wastes must be collected in bottles or containers labeled with the word "sisa" (meaning "waste"). Use containers that can withstand any chemical reactions and are suitable to the chemical waste.
2. Make sure the container's label contains the chemical waste's name, quantity and location/laboratory of origin. These labels are obtainable from the Laboratory Management Room.
3. If a used container is utilized, it must be cleaned before putting in chemical waste. The container's original labels must be lifted or covered completely and replaced with the label "SISA" (meaning "waste") to avoid confusing other users.
4. Never mix chemical wastes which may not be compatible with each other as it may cause an explosion (Please refer Appendix 5).
5. Avoid storing chemical waste for too long in the laboratory. The most effective method is to prepare no more than 2 containers in the laboratory. Once full, send to collection site. Never use the fume hood to store waste bottles and containers.
6. Never dispose flammable, water-insoluble, water-reactive and toxic waste in the sink.
7. Acidic, alkaline or salt waste may be disposed into the sink by first diluting in large amounts of water first. Never dispose organic material into the sink.
8. Dispose waste into waste containers according to their category.
9. It is prohibited from discarding/releasing/disposing volatile waste by allowing it to evaporate in the fume hood.
10. Radioactive waste, organic peroxide waste, polychlorinated biphenyls, explosive materials etc, must have specific handling and managing supervision as well as consultation from handling experts.
11. Make sure all waste containers are shut tight.
12. Fill the waste containers to a maximum of 70-80% full only.

9.3 Categories of Laboratory Waste

Waste created by the laboratory may be categorized as:

1. Liquid wastes
2. Solid wastes
3. Used bottles
4. Glass shards
5. Metals

Waste containers should be prepared in the laboratory to simplify managing and handling chemical wastes. Pre-existing containers in the laboratory may be used as follows:

Container	Type of Waste
2.5 L / 4 L Winchester Bottle, 20 L / 25 L Carbuoy	Liquids
Plastic bags	Used bottles
18 L Empty can, Large-opening plastic containers	Broken/shattered shards of glass or glass equipment
Thick plastic with fastener	Broken solids including broken, expired, and contaminated bottles of materials.

9.4 Waste Collection

1. Laboratory staff must deliver waste bottles/containers to the N10 storage center.
2. Laboratory staff must log all waste deliveries at the collection center.

CHAPTER 10

LABORATORY RULES

10.1 Introduction

These rules are created to provide safety measures that must be followed and practiced by laboratory users. They help execute working procedures safely in the laboratory. These rules involve general and special guidelines for the students.

10.2 General Rules

1. Follow all safety measures in the laboratory at all times.
2. Unauthorized personnel are prohibited from entering the laboratory except with authorization.
3. Laboratory users must always wear appropriately in the laboratory. When running laboratory work, wear laboratory coats and enclosed shoes.
4. Use safety protection gear suited for the situation or task at hand.
5. Laboratory users must always be careful when using and handling chemicals.
6. It is prohibited from bringing and keeping food and drinks into the laboratory especially into the fridge.
7. Every corner, laboratory floor and preparation room must be free of obstructions that might hinder movement.
8. Do not use the fume hood to store chemicals or laboratory equipment.
9. Users must thoroughly wash their hands before leaving the laboratory.
10. Make sure the electricity, water and gas are turned off when not in use.
11. The preparation room is not to be used for recreational purposes.
12. Apparatus that have been used should be cleaned before being returned to their original location.
13. Chemical containers that have been used should be stored at a suitable rack.
14. Any practical classes in progress cannot be left unsupervised.
15. Laboratory users who intend to conduct laboratory work outside working hours require a written approval from the School's Occupational Safety and Health Committee.

10.3 Safety Rules for Students

1. Slippers, sandals, and open-toed shoes may not be worn when conducting practical work in the laboratory.
2. Laboratory coats must be tidily worn throughout the practical session.
3. Long hair must be tidily tied up especially for female students.
4. Never leave an ongoing experiment without notifying others in the laboratory. If forced to leave anyway, ask the laboratory staff or other users in the laboratory to keep an eye on the experiment.
5. Apparatus in the laboratory must be used correctly and carefully.
6. Report any accidents in the laboratory to the supervisor or laboratory staff immediately.
7. Do not work alone in the laboratory especially if it involves dangerous materials or experiments.
8. The preparation room is a restricted area and students are prohibited from entering without permission.
9. Apparatus and chemicals may only be used under the directions or guidance of lecturers or laboratory staff on duty.

10. Experiments must not be conducted without the knowledge or permission of the lecturer or laboratory staff.
11. Report every accident and broken apparatus including glass to the laboratory staff immediately.
12. Students are prohibited from playing, running, fooling around, or making noise in the laboratory.
13. Students are prohibited from playing with the equipment and facilities in the laboratory.
14. Laboratory tables must be cleaned and the chairs must be tidily arranged after each practical session.
15. Never use paper to light a Bunsen burner. Instead, use a lighter or a match, and make sure the match's glowing flame is completely put out before disposal.
16. Students are prohibited from disposing used matches, filter paper, solid waste or chemical waste into the sink.
17. Bag packs should be placed on the racks prepared outside or inside the laboratory.
18. Students should use appropriate techniques to conduct experiments and give attention to all safety measures given with each experiment.

CHAPTER 11

KEY MANAGEMENT

11.1 Introduction

Management of laboratory and instrument room keys requires supervision and movement control to avoid any misuse. Good key management will improve laboratory security.

11.2 Key Access Control

1. The laboratory/instrument room key control room is situated at the general office and UTM Security Office.
2. Keys must be returned on the same day they were retrieved. Permission from the school's Occupational Safety and Health Committee is required for use after hours.
3. Personal duplication of keys is strictly **prohibited**.

11.3 Retrieving Keys

1. Log each key retrieval event with the number of keys retrieved, the laboratory/instrument room that the keys open, and the retriever's signature.
2. Only the school's laboratory staff may retrieve keys for laboratories or instrument rooms.
3. Non-school staff or students who wish to retrieve keys must obtain permission from the school's Occupational Safety and Health Committee or any staff on duty by stating their reasons. Aside from that, supervision of the given laboratory/instrument room's staff is required.

11.4 Returning Keys

1. The keys to the laboratories, instrument rooms, or any other spaces must be returned to the Laboratory Management Office on the same day of retrieval after using them by the end of office hours.
2. Log the keys' return and sign at the submission verification area in the log.
3. Keys returned after office hours on the same day must be inserted into the key box prepared. The staff on duty must log the keys' return on the following day.

11.5 Responsibilities of the School Security Officer (Key)

1. Responsible for everything related to the keys under his/her care including safety keys (file room keys, cabinet keys, safe keys, etc.);
2. Organize, update and audit a key registry that contains the list of keys in use;
3. Make sure the associates entrusted with security keys fully care for the keys' safety;
4. Make sure that all keys including duplicates are labeled with the name and location of where the keys are used. Keys may be labeled with only codes if required;
5. Make sure that all keys including duplicates are kept at a locked safety box in the room of the associate responsible for them;
6. Start a key movement registry and record movement of keys with details including the name, time, and signature of the key retriever;
7. Make sure a duplicate is never made without authorization;
8. Make sure that the safe is properly maintained. Change the safe's combination annually or whenever the associates knowing the combination change/leave or when in suspicion that safe's combination has leaked.
9. Make sure that every leaving associate surrenders all keys in his/her care.

10. The loss of keys must be reported immediately to the school's Safety Officer or the Head of Department. The school's Safety Officer or the Head of Department will investigate and submit a report to the Centralized Security Office.

CHAPTER 12

RULES OF USING LABORATORIES AND INSTRUMENT ROOMS AFTER OFFICE HOURS

These rules in effect are in accordance with the “**SAFETY DIRECTOR’S ORDERS; BILL 2/92**” – Use of laboratories/instrument rooms after office hours.

1. Any department staff, research officer, research assistant, or student using laboratories or instrument rooms after office hours to conduct experiments, research or related matters must first gain approval of the school’s Occupational Safety and Health Committee.
2. Students are not allowed to carry out practical alone after office hours without the supervision of a related lecturer or laboratory staff.
3. Users granted approval must inform the Security Station his/her laboratory or instrument room’s location.
4. Users must also inform the Security Station upon completion of his/her task. Make sure the equipment is safe and the door is locked.
5. Students are only allowed to work till 6 pm on weekdays. For weekends and public holidays, a separate approval is required. Approval is dependent on work being conducted etc.

APPENDICES

Appendix 1: List of Strong Oxidizing and Reducing Agents

Strong Oxidizing Agents

1. Fluorine
2. Ozone
3. Chlorine
4. Persulphates
5. Peroxides
6. Peroxy acid
7. Perchlorates
8. Dichromates
9. Chromates
10. Permanganate
11. Hypochlorites
12. Nitrates
13. Nitrites
14. Nitrous oxide
15. Liquid oxygen
16. Liquid air
17. Chlorosulfonic acid
18. Nitromethane
19. Hypochlorites
20. Chlorates

Strong Reducing Agents

1. Sodium
2. Lithium
3. Potassium
4. Butadiene
5. Acetylides
6. Finely divided metals
7. Hydrazine
8. Hydrides
9. Hydrogen
10. Aniline

Appendix 2: List of Highly Flammable Materials

Organic

1. Acetaldehyde
2. Acetone
3. Acetonitrile
4. Benzene
5. Carbon disulphide
6. Chlorobenzene
7. Cyclohexane
8. Cyclohexene
9. Diethyl ether
10. Ethanol
11. Ethyl acetate
12. n-Hexane
13. Methanol
14. Methyl ethyl ketone
15. Pentane
16. Petroleum ether
17. Propanol
18. Pyridine
19. Tetrahydrofuran
20. Toluene

Inorganic & Organometallic

1. Sodium & Alkali metals
2. Metals in the form of fine powder, Raney nickel, aluminum, magnesium & zinc
3. Metal hydrides & metal alkyl (aluminum hydride & trimethyl aluminum)
4. Yellow phosphorous

Appendix 3: List of Corrosive Materials**Inorganic acids**

1. Chlorosulfonic acid
2. Chromic acid
3. Hydrochloric acid
4. Nitric acid
5. Hydrofluoric acid
6. Sulfuric acid

Organic acid

1. Acetic acid
2. Butyric acid
3. Chloroacetic acid
4. Formic acid

Other inorganic substances

1. Bromine
2. Phosphorus trichloride
3. Silicon tetrachloride
4. Sulfur chlorine
5. Thionyl chloride
6. Peroxides

Caustic solutions

1. Ammonia
2. Sodium hydroxide
3. Potassium hydroxide

Organic solvent

1. Dichloroethylene
2. Ethylene chlorohydrin
3. Perchloroethylene
4. Butanone
5. Gasoline

Other organic substance

1. Acetic anhydride
2. Liquid Phenol
3. Triethanolamine
4. 2-Aminoethanol

Appendix 4: List of Poisonous Materials

Solids

- | | |
|------------------------|------------------------------|
| 1. Arsenic compounds | 11. Oxalic acids |
| 2. Barium compounds | 12. Phenols |
| 3. Beryllium compounds | 13. Phosphorus yellow |
| 4. Cadmium compounds | 14. Phosphorus pentachloride |
| 5. Chromate salts | 15. Picric acid |
| 6. Cyanide salts | 16. Selenium compounds |
| 7. Fluoride salts | 17. Silver nitrate |
| 8. Iodine | 18. Sodium |
| 9. Lead compounds | 19. Sodium hydroxide |
| 10. Mercuric compounds | 20. Sodium hypochlorite |

Liquids

- | | |
|-------------------------|----------------------------|
| 1. Aniline | 11. Hydrochloric acid |
| 2. Carbon disulphide | 12. Hydrofluoric acid |
| 3. Carbon tetrachloride | 13. Hydrogen peroxide |
| 4. Chloroform | 14. Mercury |
| 5. Chromic acids | 15. Nitric acid |
| 6. p-Dioxane | 16. Perchloric acid |
| 7. Ethylene glycol | 17. Phosphorus trichloride |
| 8. Formic acid | 18. Sulfuric acid |
| 9. Hydrazine | 19. Tetrachloroethylene |
| 10. Hydrobromic acid | 20. Tetrachloroethane |

Gases

- | | |
|--------------------|----------------------|
| 1. Carbon monoxide | 6. Formaldehyde |
| 2. Chlorine | 7. Hydrogen bromide |
| 3. Cyanogen | 8. Hydrogen chloride |
| 4. Diborane | 9. Hydrogen cyanide |
| 5. Fluorine | 10. Nitrogen Dioxide |

Appendix 5: List of Incompatible Materials

Chemical	Incompatibility
Acetic acid	Chromic acid, nitric acid, perchloric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl- containing compounds such as ethylene glycol and perchloric acid
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline	Water, carbon tetrachlorine or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic materials	Any reducing agent
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, finely divided organic or combustible materials
Chromic acid and trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, chromium, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane or other petroleum gases, hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic and inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Everything
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid	Ammonia
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gasses, copper, brass, any heavy metal
Nitrites	Acids

Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oil, grease, hydrogen, flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides (organic)	Acids, avoid friction, store cold
Phosphorus (white)	Alcohols, strong bases, water
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium peroxide	Ethanol and methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (and similar compounds of light metals such as sodium & lithium)
Tellurides	Reducing agents

Appendix 6: Accident Report Form

<http://www.utm.my/oshe/borang-laporan-kemalangan-kejadian-berbahaya-online/>

The screenshot shows a web browser displaying the online accident report form for UTM OSHE. The browser's address bar shows the URL: www.utm.my/oshe/borang-laporan-kemalangan-kejadian-berbahaya-online/. The page header includes the UTM logo and the text "Occupational Safety, Health & Environment Unit (OSHE) Unit Persekitaran, Keselamatan dan Kesihatan Pekerjaan". A navigation menu contains links for Home, About Us, OSH Info, Biosafety, Radiation safety, Training Module, Publications, Form, and Activities. The main content area is titled "Borang Laporan Kemalangan / Kejadian Berbahaya" and contains the following form fields:

- Nama/Name ***: A text input field.
- No. Kad Pengenalan/Identification Card No. ***: A text input field.
- Status**: A group of radio buttons with options: Pelajar/Student, Staf, Pelawat/Visitor, and Kontraktor/Contractor.
- Bahagian/Position & Kursus/Course**: A text input field.
- Alamat Fakulti/Bahagian/Unit/Pejabat/Kolej (Faculty / Section / Unit / Office / College Address)**: A large text input field.
- No. Telefon (Pejabat)/Telephone No (Office)**: A text input field.

Appendix 7: Using the Laboratory After Office Hours Form

Borang Kes.01/99
Pindaan / 07

FAKULTI KEJURUTERAAN KIMIA DAN KEJURUTERAAN SUMBER AIR
UNIVERSITI TEKNOLOGI MALAYSIA

BORANG PENGGUNAAN MAKMAL SELEPAS WAKTU PEJABAT
(Hendaklah diisi dalam 4 salinan)

MAKMAL : _____

Nama Pelajar : _____ No. Matrik : _____ Tarikh : _____

Tarikh: Dari _____ Hingga _____

Masa : Dari _____ Hingga _____

Bangunan/Aras/No. Bilik : _____

Arahan Keselamatan

- Pelajar dikehendaki mematuhi kesemua peraturan keselamatan makmal seperti terdapat dalam Buku Panduan Keselamatan Fakulti.
- Sila lapor diri kepada pengawal keselamatan bertugas di fakulti.

Sokongan Penyelia/Ketua Penyelidik

Nama Penyelia : _____ Tandatangan _____ Ya Tidak

Nama Ketua Penyelidik : _____ Tandatangan _____ Ya Tidak
(Jika berkenaan)

Untuk Kegunaan Pejabat

Permohonan diluluskan / tidak diluluskan _____

Catatan :

Nama Juruteknik Bertugas (Jika perlu) : _____

Nama : _____ Tandatangan : _____ Tarikh : _____
(Pengurus Makmal)

Cop Rasmi : _____

Catatan :

- Borang yang lengkap hendaklah dihantar kepada Kerani Kanan di pejabat am fakulti untuk tindakan lanjut.
- Borang hendaklah dihantar 1 minggu sebelum tarikh penggunaan makmal.
- Tempoh tempahan maksimum yang dibenarkan hanya 1 minggu.
- Sila tulis nama dalam buku log di makmal berkenaan setiap kali mengguna makmal.
- Jika berlaku kecemasan sila hubungi pengawal keselamatan bertugas (24 jam) di talian 30014 atau 30002.

Salinan : Fail Keselamatan Fakulti
Pegawai Keselamatan
Ketua Kumpulan Penyelidik
Penyelia



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

School of Chemical & Energy Engineering
Faculty of Engineering