University of Wollongong

Faculty of Engineering

Environmental Engineering Laboratory

Safety Induction Manual

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Mr N Gal

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OH&S Induction Acknowledgement

- I understand that there are University of Wollongong OH&S rules, Faculty of Engineering rules, Environmental Engineering laboratory rules and regulations that I must follow.
- I have been shown where materials safety data sheets are located and how to use them. I agree to consult the relevant MSDS before using any substance.
- I have read, and understand this document, consisting of the Laboratory Safety Manual for the Environmental Engineering laboratories in the Faculty of Engineering and the University of Wollongong's OH&S Laboratory Safety notes and understand I must abide by them.
- I will wear a laboratory coat, suitable footwear and safety glasses, as warranted.
- I will not work in the laboratories after hours without gaining appropriate approval [see After Hours Access, Section 5.8]. I will not work after hours unless, a second inducted person is present. When working after hours in the laboratory, I, and the person accompanying me, will sign on and off in the attendance book in the foyer of the Environmental Engineering Laboratories.
- I agree to seek instruction on any new procedure and practice. I agree to seek instruction in the safe use of all equipment and to follow the directions given to me by staff. I agree to report any unsafe items or practices.
- I understand the term 'duty of care' and understand I have legal responsibilities under the Occupational Health and Safety Act.
- A risk assessment must be completed before any thesis experiment is undertaken. Forms are available from the Environmental Engineering Technical Staff and must be filled in by the student and discussed with the Academic Supervisor. The Academic Supervisor must sign the form that is then returned to the Environmental Engineering Technical Staff. No laboratory work will be permitted without a completed risk assessment. I understand I must fill in this form before beginning my laboratory work.

OH&S Induction Acknowledgement

- Must be completed and signed before any work is carried out in the Environmental Engineering Laboratories
- After hours access will not be considered if this form is not complete

1. I've read, and understand this document. I agree to follow the guidelines set out in this document.
2. I have completed the required induction for this laboratory.
3. I agree to complete a risk assessment before any experiment is undertaken.

This form is to be signed by the student and the Academic Supervisor and handed to the Environmental Engineering Technical Staff before using the laboratory.

Student/Staff Name:…… Student/Staff Number…….

Student/Staff Signature…… Date:……..

Induction Date…….. Trainers Signature……..

Trainers Name……..

Academic Supervisors Name…… Date:……..

Academic Supervisors Signature……..

Student Contact Telephone Number:……. Student Contact Email……..

Copies: Lab/Workshop & Faculty Office

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1. Introduction

Occupational Health and Safety is an issue that is closely regulated by legislation in NSW under the Occupational Health and Safety Act 2000. The act obliges the University of Wollongong, through the Faculty of Engineering to:

1. Secure the health, safety and welfare of all persons in the Faculty
2. Protect all persons in the Faculty against risks to health
3. Promote an occupational environment for persons to work, which takes into account their particular physiological and psychological needs.

This legislation imposes a 'duty of care' on the employer and the employer's representatives to ensure the wellbeing of all those who come under the umbrella of the organisation. The Occupational Health and Safety Act gives the responsibility for safety to both employer and employee (the definition of 'employee' includes all students and visitors to the Faculty) to ensure that safe practice is followed at all times. This requires that the employee must co-operate with the employer to ensure that any reasonable requirements are observed and implemented in the interests of safety.

The specific means whereby the above aims are achieved include:

- Provision or maintenance of equipment and systems of work that are safe and cause no risk to health
- Ensuring the safe use, handling, storage and transport of equipment and substances
- Provision of information, instruction, training and supervision necessary to ensure the heath and safety of all persons in the Faculty
- Maintaining the places of work under the Faculty's control in a safe condition and provision of safe entries and exits.
- Making available adequate information about relevant tests and research concerning substances used at the place of work.

The Act also binds those persons who comprise the total of the Faculty (staff, students and visitors) to take reasonable care of the health and safety of others. **Therefore the obligation to provide a safe workplace is the responsibility of all the people in it.** Section 19 of the OH&S Act 2000 states that every employee (staff, students and visitors) shall 'take reasonable care for the health and safety of all persons who are at this place of work and who may be affected by their acts and omissions at work'. This act further requires all those present in the Faculty to co-operate with the Faculty's requirements that have been imposed in the interests of the health, safety and welfare of all those present in the workplace, be they staff, students or visitors.

In addition, Section 20 of the act requires that 'a person shall not intentionally or recklessly interfere with, or misuse anything provided in the interests of health, safety and welfare in pursuance of this act'. In other words, it is a violation of the law to interfere with or render inoperative any safety protection devices, first aid kits, notices, or any items supplied or installed by the Faculty in the interests of safety of any of the other people in it.

All staff and students who undertake work in the environmental engineering laboratories must take reasonable care of their own health and safety, and the health and safety of others by:

- Taking action to avoid, eliminate or minimise hazards of which they are aware;
- Complying with all occupational health and safety instructions, policies and procedures in the safety manual;
- Making proper use of all safety devices and personal protective equipment;
- Complying with the instructions given by emergency response personnel such as emergency wardens and first aiders;
- Not willfully placing at risk the health and safety of any other person;
- Seeking information or advice where necessary before carrying out new or unfamiliar work;
- Maintaining dress standards appropriate for the work being done. Appropriate protective clothing and footwear must be worn at all times;
- Only consuming food and drink in designated areas;
- Being familiar with emergency and evacuation procedures and the location of, and if appropriately trained, in the use of, emergency equipment;
- Reporting all incidents, hazards and 'near-miss' incidents using the online "SafetyNet" hazard and incident report form available through the OHS website (http://staff.uow.edu.au/ohs/index.html).

2. Responsibilities

The responsibility for implementation of these procedures rests with the Dean and Heads of School.

The Faculty of Engineering Workplace Advisory Committee will provide advice and feedback to the Dean and Heads on actions needed to comply with these procedures. This group will be able to seek advice from the Occupational Health and Safety Unit.

2.1 Dean and Heads of School

Heads of cost centres have overall responsibility for ensuring that occupational health and safety standards and practices are implemented and maintained in the teaching facilities, laboratories and studios by their respective supervisory staff.

To achieve compliance, the Dean and Heads of School should:

- Ensure that staff and students receive the appropriate information, instruction and training necessary for them to perform work safely.
- Ensure that all staff and students receive an induction that includes information pertaining to emergency response procedures and personnel.
- Ensure that local occupational health and safety procedures are developed, documented and issued to staff and students as appropriate.
- Ensure that facilities and equipment provided for staff and students are safe and suitable for the types of work to be carried out.

- Ensure that adequate financial provisions are made for occupational health and safety equipment and materials and the maintenance of occupational health and safety standards.
- Ensure that hazard identification and risk assessment procedures are developed, documented and maintained for the use, handling, storage, transport and disposal of equipment, materials and substances and that appropriate risk controls are implemented and maintained.

2.2 Supervisors and Subject Coordinators of Honours and Postgraduate Students

As honours and postgraduate research is a major aspect of work undertaken in laboratories, it is essential that adequate supervision is provided to maintain safety. Supervisors and subject coordinators are to:

- Actively practice and develop in their students proper attitudes towards occupational health and safety matters.
- Control the risk associated with the work that they supervise using a documented risk management process.
- Ensure that safe work practices are developed and maintained at all times.
- Arrange for their staff and students to be instructed in safe and healthy work procedures, and ensure that they are fully informed about particular hazards, and how to eliminate, avoid or minimise them.
- Ensure that good housekeeping standards are developed and maintained in the areas under their control.
- Ensure that staff and students under their control use safety equipment provided in a correct manner.
- Ensure that all students understand the disciplinary procedures that will be invoked for non-compliance with occupational health and safety instructions, policies and procedures.
- Ensure that all incidents, hazards and ‘near-miss’ incidents that occur are reported using the online "SafetyNet" hazard and incident report form available through the OHS website (http://staff.uow.edu.au/ohs/index.html).

2.3 Staff and Students

All staff and students who undertake work in the laboratories must take reasonable care of their own health and safety and the health and safety of others by:

- Taking action to eliminate, avoid or minimise hazards of which they are aware.
- Comply with all occupational health and safety instructions, policies and procedures including Departmental safety manuals
- Making proper use of all safety devices and personal protective equipment.
- Complying with instructions given by emergency response personnel such as emergency wardens and first aiders.
- Not willfully placing at risk the health and safety of any other person.

- Seeking information or advice where necessary before carrying out new or unfamiliar work.
- Maintaining dress standards appropriate for the work being done.
- Appropriate protective clothing and footwear must be worn at all times.
- Only consuming or storing food and drink in designated areas.
- Being familiar with emergency and evacuation procedures and the location of, and if appropriately trained, the use of, emergency equipment.
- Reporting all incidents, hazards and 'near-miss' incidents using the online "SafetyNet" hazard and incident report form available through the OHS website (http://staff.uow.edu.au/ohs/index.html).

3. General Information

3.1 Emergency Telephone Numbers

University telephones require the prefix '0' to be dialed for an external connection.

Emergency Services – Police, Fire Brigade, Ambulance	(0) 000
Wollongong Hospital	(0) 4222 5000
NRMA Road Service	(0) 132 132

3.2 Location of Emergency Telephones

Emergency telephones are located:

Outside the Southern front door of Building 8
In the main foyer of Building 4
In the corridor adjacent to the high bay laboratory in Building 4
In front of Building 1

3.3 Location of First Aid Boxes

First aid boxes are available in each laboratory and in the corridor of the Environmental laboratory complex. First aid boxes are also available in Building 4.

3.4 Security and Patrol Staff

Campus Security – all hours	Extension: 4555
Campus Security – Shift Leader's mobile	Extension: 6555
Campus Security – Mobile	Ph: 0407 287 750
Campus Security – Emergency Only Dial #1 from any campus security telephone	Extension: 4900

http://www.uow.edu.au/about/security/index.html

3.5 First Aid Officers

Dr. Faisal Ibney Hai Extension: 3177 Room: 8.125

If you require first aid, please see the Technical Staff. Please report any accidents or incidents to the staff and ensure an accident/incident report form is complete.

3.6 Building Wardens – Top Floor Building 8

Dr. Faisal Ibney Hai Extension: 3177 Room: 8.125

If you are asked to leave the building by the building wardens or another member of staff, you must do so immediately. The assembly area for the environmental engineering is assembly point B, refer to map on page 11.

3.7 After Hours Contact (For Emergency Only)

Please contact Security Extension: 4900

3.8 Occupational Health and Safety

Wayne Ireland [Faculty OHS Officer] Extension: 4724

OHS Unit Extension: 3931

http://staff.uow.edu.au/ohs/index.html

3.9 Building Maintenance

Buildings and Grounds Call Centre (Office Hours only)	Extension: 3217
Security	Extension: 4555
Security (Emergency Only)	Extension: 4900

4. Emergency Procedures

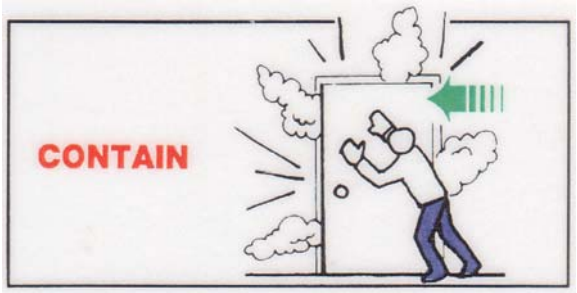
4.1 Standard Fire Orders

Actions to be considered on discovering a fire

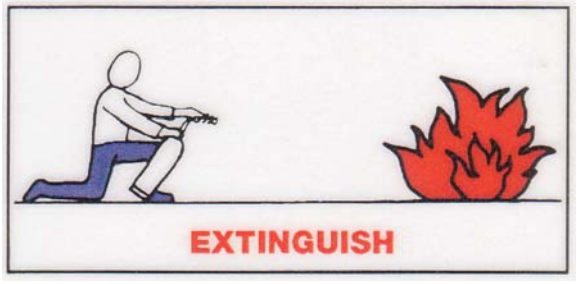
R **Rescue - Any person/s in immediate danger**

A **Alarm – Raise the alarm. Contact the emergency services on 0 000. Contact University Security on Extension: 4900. Activate Break Glass Alarm**

C **Contain – Close doors to contain the fire.**



E **Extinguish – Attempt to extinguish the fire only if you are trained and it is safe to do so.**

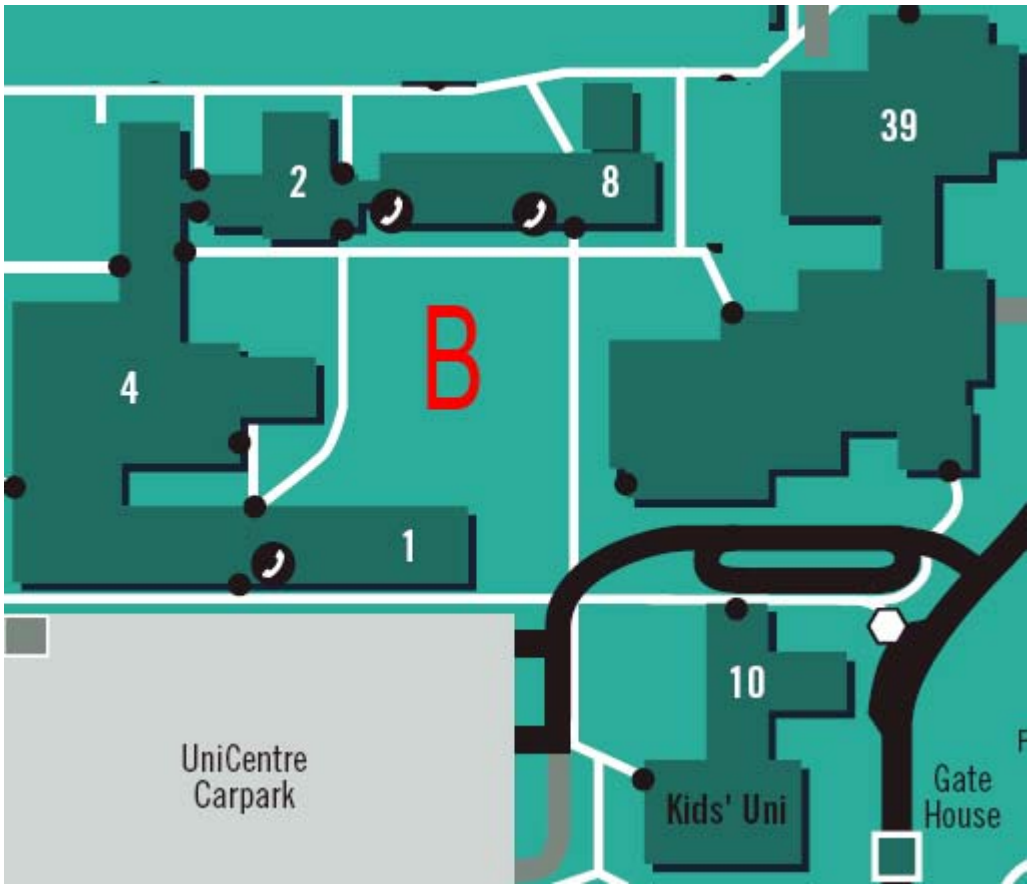


4.2 Emergency Evacuation Procedures

http://staff.uow.edu.au/ohs/Emergencies/emaps/index.html

If you hear a continuous alarm bell or are requested, by a Building Warden, or a member of staff, to evacuate the building you must:

- **Leave the building immediately by the nearest exit;**
- **Proceed to the assembly area indicated in the map below;**
- **Remain in the assembly area until advised the emergency is over;**
- **Do not re-enter the building until advised it is safe to do so by the building warden or by security staff.**



The Assembly area for the Environmental Engineering laboratories is Assembly Area B

5. Laboratory Rules

5.1 Attire

Every person working in the Environmental Engineering laboratories must ensure that they are correctly attired before undertaking laboratory work.

It is mandatory that all students working in the Environmental Engineering laboratories wear laboratory coats, suitable non-slip enclosed footwear and safety glasses at all times. Long hair should be tied back.

Contact lenses are not recommended in chemical laboratories. The use of nylon- based clothing is advised against. When fieldwork is involved, clothing suitable to the location must be worn.

5.2 Behaviour

Apply commonsense in the laboratories, avoid reckless behaviour and never indulge in practical jokes or unauthorised experiments. Indulging in 'horseplay' and practical jokes in the laboratories is strictly prohibited.

Running is also prohibited and care should be taken when opening and closing doors and entering or leaving the laboratory.

Smoking is not permitted in any University building or vehicle.

Eating and drinking are not permitted in the laboratory. Do not store food or drink in a refrigerator, which is used to store laboratory materials.

Persons under the influence of, or affected by alcohol or other substances, both legal and illegal are prohibited from working in the laboratory.

Pipetting by mouth is hazardous and illegal. Pipetting of liquids is only allowed when rubber pipette bulbs, red or green pipettors or an automatic pipette is used.

Fume cupboards must be used to extract any particulate matter, gases or vapours, which may be toxic, flammable, corrosive or noxious. The sash of the fume cupboard is to remain lowered at all times except when manipulating the contents of the cupboard. This ensures efficient fume extraction.

5.3 Housekeeping

Work areas should be kept well organised and good housekeeping practice should always be followed when using chemical laboratories to reduce the risks of spillage and other accidents.

Benches should be kept clean and free of equipment not in use. Both benches and equipment

should be thoroughly cleaned after use.

Properly wipe off any spilled chemical while using the balance and thereby keep the balance and the desk clean and safe for other users.

The dishwasher in 8.127 is simple to operate and the appropriate trays should be used for glassware. Clean glassware should be put back into the correct cupboard. Pipettes do not go in the dishwasher and must be washed by hand. Immediately wash the used glassware without leaving them in the sink.

The interior of fume cupboards should be kept clean and clear.

Appropriately clean the Bio-clean bench in room 8.126, after performing microbiological work.

Aisles, exits, and all emergency equipment must be easily accessed and kept free of obstruction.

Disposal of wastes should be in the appropriate containers. This is dealt with in more depth on page 31. Hazmat pillows and vermiculite are available in each laboratory. These should be used with staff supervision.

Overnight experiments must carry a notice which shows: name of responsible person, name of academic supervisor, date, emergency contact numbers, special instructions if required e.g. **DO NOT TURN OFF – EXPERIMENT IN PROGRESS**.

5.4 Instruction

It is the responsibility of students to ensure they have been fully instructed in, and understand the use of equipment before operating it. No equipment of any type may be operated unless the person is authorized to do so. Authorisation is obtained by participation in a process of induction, which means obtaining instruction from the appropriate technical or academic staff in its use. This also applies to the safe use of substances.

Assume all substances are hazardous unless there is definite information to the contrary. Each of the laboratories has a copy of the material safety data sheets (MSDS) relevant to all of the chemicals used in the laboratory. These sheets **must** be consulted **before** carrying out any laboratory work involving the use of chemicals. The MSDS gives details of the characteristics of the chemicals, any hazards associated with their use, including toxicity, known carcinogenic behaviour, disposal restrictions, spillage clean-up procedures, personal protective equipment required, and any other relevant safety instructions.

5.5 Use of Equipment

It is the responsibility of students to ensure they have been fully instructed in, and understand the use of equipment before operating it. No equipment of any type may be operated unless the person is authorized to do so. Never undertake any work unless the potential hazards of

the operation are known as precisely as possible and the appropriate safety precautions are adopted.

Any defect found during operation of equipment must be reported to the environmental engineering technical staff, preferably in the form of a written notification. Equipment must not be used for purposes other than that for which it was designed. If personal protective equipment is required for the operation of the equipment, it must be used.

5.6 Risk Assessments

Risk assessments must be completed before any thesis experiments are undertaken. No laboratory work will be permitted without a completed risk assessment. There will be NO exemptions. Forms are available from the environmental engineering laboratory staff. Chemical risk analysis may also be necessary. This can be determined from the relevant MSDS. If the material is classified as hazardous, a chemical risk assessment will be required. The risk assessment forms must be completed by the student and discussed with, and approved by the academic supervisor. The academic supervisor must sign the form that is then returned to the environmental engineering laboratory staff. A copy of the completed risk assessment form is also forwarded to the Faculty of Engineering WAC (Workplace Advisory Committee). If the WAC determines the activity to be hazardous, they may call in an expert from the University of Wollongong or a private company for advice. In this case, no work can be undertaken until a full investigation has taken place and the recommendations adopted and acted upon.

5.7 After Hours and Working Alone Policy

The Faculty of Engineering has established rules that ensure the safety of staff and students who work on University property outside normal working hours or alone.
After hours work may be classified according to risk:

Category 1	**Category 2**	**Category 3**
Work that can be done at any time as it poses minimal risk.	Work which should only be done between 6.30am and midnight on weekdays and between 8.00am to 10pm on weekends	Work that should not be carried out under any circumstances after 5.30pm or before 8.00am on any day.
You may work alone	**You must not work alone**	**You must not work alone**
General Office Work: reading, writing, use of instrumentation which is considered to pose no risk	Any laboratory work that **does not** involve toxic, radioactive, corrosive, explosive, biohazardous or flammable substances.	Laboratory work i**nvolving** toxic, radioactive, corrosive, explosive, biohazardous or flammable substances.

5.8 After Hours Access

Normal working hours are weekdays 8.00am – 5.30pm. The laboratories are open from 8.00am – 4.00pm. Students requiring after hours access to laboratories and equipment use will be required to follow the **GUIDELINES FOR AFTER HOURS ACCESS AND EQUIPMENT USE IN CME LABORATORIES.** The guidelines are:

i) As it is not feasible for any trained technical or research staff to provide 24/7 supervision in the labs to CME research students to strictly maintain the OHS requirements, it is understood that after hours access to work in the laboratories (after 4.00pm) is more a pre-approved privilege rather than a right. All after hours access authority forms will need to be completed, approved and signed by the relevant parties (including the Dean for Medium & High Risk Equipment) before a student is permitted after hours access.

ii) Working alone after hours is STRICTLY prohibited. Any accompanied person including a spouse will need to be inducted beforehand. Children should not be brought into Labs at any time.

iii) Students who have been properly trained and deemed competent by the technical staff are permitted to work after hours on the condition that they will have another inducted person(s) present in the vicinity.

(iv) After hours work authority is based on the EQUIPMENT to be used rather than the access to a particular LABORATORY. Therefore, a student may be authorised to use one particular piece of equipment in a given laboratory, but not others unless permission for its use is obtained separately upon training.

(v) Given the extent of training undertaken by the student and the required competency attained, after hours work requests will be considered on a case by case basis by the technical staff and/or laboratory area supervisor, and approved in accordance with the risk factor (low, medium, high and extreme).

(vi) In the case of equipment rated as EXTREME risk, after hours work is discouraged, unless a special approval is obtained from the Dean through recommendation by the Head of School. In this case, it is highly desirable that security be informed in advance indicating the laboratory room number and the time.

(vii) For undergraduate thesis/project students, the bulk of laboratory work would need to be undertaken during weekdays (8am to 4pm), unless he/she is working together with an authorised Research Student or Research Associate after hours.

(viii) It is mandatory for all students working after hours to fill in the laboratory log-book.

(ix) Any other conditions may be stipulated by the laboratory manager from time to time, depending on equipment operational and maintenance requirements and the students will be notified accordingly.

(x) Students failing to comply with these guidelines or general laboratory rules may have their after hours access privileges suspended or cancelled.

5.9 Working Alone

Working alone refers to situations where people may be exposed to risks because:

- The area they are working in is remote from others or isolated from the assistance of others because the nature, time or location of their work; or
- It involves the operation or maintenance of equipment, or the handling of a hazardous substance; or
- The work is dangerous for a person to perform alone.

1. Staff and students may work alone in office environments; however they must have completed the After Hours access permission forms.
2. Staff and students must not work alone in laboratories where chemical substances are handled or housed or where radioactive isotopes are handled i.e. the Environmental Engineering laboratories.
3. Working alone off campus – fieldwork involves performing research, teaching or instruction outdoors, at a location off campus. Prior to undertaking fieldwork, possible hazards must be identified and appropriate risk management strategies employed. Students should not undertake fieldwork without the permission of their supervisor. Fieldwork should not be carried out alone; students and staff should be accompanied by their supervisor, another staff member or appropriate adult. Students must ensure that a University employee knows when and where they are undertaking fieldwork and what time they are expected back. They must have some means of communication. A more detailed set of rules for fieldtrips is covered in the fieldwork section of this manual.
4. Emergency assistance – a means of communication to gain assistance in an emergency is available. The telephones in the environmental engineering laboratories can be used to contact the emergency services. If this is necessary, security should also be informed and can meet the emergency vehicle at the front gate.

5.10 Safety Equipment

Eyewash and **safety shower** facilities are available in the environmental engineering laboratories. Eyewash facilities are available in each laboratory and a full-drench safety shower is available in the corridor. Students should familiarise themselves with the location of these. In the event of a chemical splash in the eye, the eye must be irrigated for at least 15 minutes and medical attention sought.

Latex gloves are available in each laboratory and should be used when handling any chemical. They are single use and disposable. If nitrile or other gloves are required (this can be ascertained from the MSDS) they are available from the laboratory staff.

Safety information and emergency procedures are prominently displayed in each laboratory. Students should familiarise themselves with the emergency procedures.

Each laboratory is also equipped with a **fire blanket and fire extinguisher**. These are provided to extinguish minor fires only. If there is any risk from the fire the building should be evacuated. Before using a fire extinguisher, read the instructions to ensure that it is appropriate to the type of fire.

Dry Powder Extinguisher – Colour coded red with a white band. For use, on electrical and flammable liquids fire.

Carbon Dioxide Extinguisher [CO2] – Colour coded red with a black band. For use on electrical and flammable liquids fire – it should be noted that this extinguisher can be safely used on all types of fires, however when the gas dissipates, re-ignition may occur.

Safety carriers are available for carrying chemicals in glass or plastic containers with a capacity of 2 litres or greater. Never carry mutually reactive substances at the same time. If you need a carrier, see the laboratory staff.

Bottle-top dispensers for acids are accessible in each laboratory. The operating instructions are situated above them. Students should familiarise themselves with their use and always decant acid using them.

5.11 Personal Protective Clothing and Equipment [PPCE]

Personal protective equipment such as eye protection, gloves, ear protection and dust masks can be obtained from the environmental engineering staff. As a general rule, students will be expected to provide their own laboratory coat and safety glasses. A small supply of these is available for emergencies. Gloves are single use, disposable and available in each laboratory. Ear protection and dust masks will be issued on request.

Personal protective clothing and equipment specified in the material safety data sheets must be used at all times.

5.12 Reporting incidents, accidents, injuries and near misses

All events that fall into the above categories should be reported to a member of the environmental engineering staff and using the online "SafetyNet" hazard and incident report form available through the OH&S website (http://staff.uow.edu.au/ohs/index.html). This is extremely important, as the University will not cover injuries that are not documented. Forms can be obtained from the environmental engineering staff or are available on the University OH&S website. Any injury that requires first aid must be documented. Students will suffer no penalty for reporting of accidents, incidents and near misses.

5.13 Sample Storage

Storage of samples should be minimized. However, if it is necessary to store samples for future use the following rules apply:

1. Samples must be stored in appropriate containers to prevent spillage

2. Samples **must not** be stored in volumetric glassware
3. It is an offence to store samples in food or drink containers and samples stored in these will be removed and discarded
4. Approval to store any hazardous material should be sought from the environmental engineering technical staff. Samples of hazardous material should be clearly labeled to this effect and comply with the dangerous goods and hazardous substance legislation. This information is contained in the relevant MSDS. The following information **must** be written clearly on the sample container – the name of the substance; the UN number (if any); the dangerous goods class (if any); the potential hazards and the relevant risk and safety phrases. An additional label with the name of the student, academic supervisor and date of storage and disposal is also required.
5. Non-hazardous samples should be labeled with the labels issued by the environmental engineering technical staff.
6. Storage of samples must comply with the Australian Dangerous Goods Code and as such, hazardous samples must be segregated into their respective classes.
7. Flammable liquids must be stored in an approved flammable liquid storage facility. Please see the environmental engineering technical staff.
8. Incorrectly labeled samples will be discarded by the laboratory staff.

5.14 Glassware

Glassware has particular hazards. The largest single cause of injury in the laboratory is broken glassware. To avoid this care should be taken when breaking tubing to length to ensure glass cannot enter an eye, and cuts to the hands are avoided. All glass tubing and rod should have the ends flame polished and broken or chipped glassware should not be used.

It is particularly important that broken glassware is disposed of in the green glass bin in 8.128. This material must **not** be disposed of in garbage bins or wastepaper baskets due to the hazard posed to cleaning staff.

5.15 Manual Handling

Lifting and carrying excessive weights is hazardous and can cause injury, often not immediately present. To avoid this:

1. Employ correct methods of lifting, do not over-reach and ensure stable footing at all times.
2. If heavy lifting, or pushing and pulling is involved, seek help from staff.
3. If working at heights is necessary, ensure that a second person is present, take particular care with footing and ensure that supports are strong and reliable.

5.16 Using Gas Cylinders

Compressed, liquefied or dissolved gases are categorised as Class 2 dangerous goods and subcategorized as:
Class 2.1 Flammable gases identified by a red dangerous goods diamond (e.g. Butane)

Class 2.2 Non-flammable and non-toxic gases identified by a green dangerous goods diamond (e.g. Helium)

Class 2.3 Poisonous gases identified by a white dangerous goods diamond (e.g. Ammonia)

In instances where the gas presents multiple hazards additional diamonds indicates the subsidiary risks. For example, Chlorine Class 2.3 (toxicity) and Class 5.a (oxidising agent).

5.16.1 Moving Cylinders

The majority of accidents involving gas cylinders occur while moving them from one location to another. The following control measures should be used to reduce the potential for an accident:

- The use of purpose-built trolleys or other suitable devices for gas cylinder transportation.
- Securing the gas cylinder's valve, disconnecting and removing associated distribution equipment.
- Shutting the cylinder's valve, disconnecting and removing associated distribution equipment.
- A requirement that only properly trained personnel are permitted to move cylinders.
- Laboratory procedures preventing the manual movement of larger gas cylinders.

5.16.2 Storage of Gas Cylinders

The guidelines for the storage of gas cylinders are detailed in AS 4332 The Storage and Handling of Gases in Cylinders. For more information please refer to the AS 4332.

The following table outlines the quantities described as 'minor storage' of gases in cylinders.

Class of Gas	Maximum aggregate water capacity, L
2.1	500
2.2	2000
2.2, with class 5.1 Subsidiary risk	1000
2.3	50

Where gases of mixed classes are kept in minor storage, the aggregate quantity of all gases shall not exceed 2000 litres and the quantity of each subclass shall not exceed that given in the table above.

The following precautions shall be observed for minor storage and handling of gas cylinders:

- Gas cylinders are to be kept away from artificial sources of heat, i.e. radiators, boilers or steam pipes; and kept clear.
- Gas cylinders shall be provided with adequate ventilation at all times.
- Classes of gas cylinders shall be segregated within the store, but need not be separated.
- Outdoor storage of Class 2 cylinders shall be separated from other dangerous goods by 3 metres. They shall not be less than 1m from any door, window, air vent or duct.

- All gas cylinders are to be secured in the upright position by chain or other means to prevent falling

Indoor storage of gas cylinders should be avoided wherever possible. However where it is not reasonable to have an outdoor cylinder and reticulation system, the keeping of gas cylinders shall incorporate a risk management approach. Specific precautions, to be included in a risk assessment; would be:

- The total capacity of gas in cylinders allowed for any particular indoor location shall include cylinders in use, spare cylinders not in use, and used cylinders awaiting removal.
- The total capacity of the gases kept shall not exceed one minor storage quantity per 200 m^2 of floor area. Where the floor area exceeds 200m2 any arrangement which results in an excessive concentration of cylinders shall be avoided.
- Indoor minor stores of gases in cylinders shall be separated from other minor stores of gases or other dangerous goods stores by a minimum distance of 5 m.
- Except for Class 2.2 gases having no subsidiary risks, there shall be no minor storage in basements.
- Where cylinders are kept inside a building or a confined area, e.g. a vehicle tray/trailer a shipping container, that building or area shall be adequately ventilated by natural air movement or equivalent.

5.17 Safe Handling of Cryogenic Fluids

Cryogenic fluids are defined as fluids having a boiling point below -150°C at atmospheric pressure [eg: liquid nitrogen]. Cold contact burns, frost bite, suffocation, lung disorder and general body cooling can result from exposure to cryogenic fluids. In addition, liquid oxygen and hydrogen present a fire hazard. It should also be noted that liquid nitrogen although not flammable in itself is sufficiently cold to condense oxygen out of the atmosphere which can then present a hazard. The following procedures should be followed when handling cryogenic fluids.

5.17.1 Personal Protection

In all cases, eye and hand protection should always be worn. The need for additional safety protection, outlined below, will depend upon the operation being carried out and the quantity of liquid involved.

- A full face shield (see AS 1336) when transferring liquid, immersing objects or any other time when splashing may occur,
- Use fit, clean dry insulated gloves when carrying cryogenic fluids in containers
- Use appropriate safety clothing that minimises the formation of traps capable of holding liquid near the skin
- Use enclosed footwear.
- Never travel in an elevator with cryogenic liquids.

5.17.2 Transfer techniques

The following techniques can be used when transferring cryogenic fluids to secondary containers:

- Pressurisation (conventional method) using pressure creating by heat leak into the storage container, by a heat source with the container, or by pressurisation with a gas corresponding to the liquid product.
- Submersible electrically operated pump for the transfer of liquid nitrogen, though precautions will be required to prevent condensate entering and freezing in the pump especially when changing containers. This method is not recommended for liquid oxygen transfers.
- The use of transfer tubes approved by the supplier of cryogenic container.
- Pouring using a filling funnel with the top of the funnel partly covered to reduce splashing.

5.17.3 Proprietary Equipment

Proprietary equipment, such as cryostats and liquefiers, should always be operated and maintained in accordance with the manufacturer's instructions. Regular maintenance and inspections should be arranged.

5.17.4 Working at Reduced Pressure

If the pressure on a cryogenic liquid is reduced below atmospheric, the following additional precautions should be taken:

- Check that the system is vacuum-tight to prevent moist air being drawn in and forming ice plugs.
- Provide a protective screen when working with glass dear flasks.
- Carefully control initial pumping speed to avoid pressure oscillation and liquid entertainment.
- Prevent violent boiling of superheated liquid by inserting boiling centres, compatible with the liquid in use, inside the dear flask. This precaution is especially necessary when working with nitrogen in a glass system.

When the backing pump is used to pump evolved gas into a valved recovery system, provide a pressure-relief valve on the exhaust side of the pump, to protect against pump operation with recovery valves shut.

5.18 Fieldwork Guidelines

Staff and students should be aware that the field is a workplace of the University of Wollongong and that they are expected to maintain appropriate standards of workplace behaviour. Fieldwork is like any experimental work, before it is undertaken, a complete risk analysis must be completed and submitted to the WAC. Before undertaking any major fieldwork, first aid training should be considered.

1. Fieldwork involves performing research, teaching or instruction outdoors, at a location off campus. Prior to undertaking fieldwork, possible hazards must be identified and appropriate risk management strategies employed. Postgraduate students should not undertake fieldwork without the permission of their supervisor. Fieldwork should not be carried out alone; students and staff should be accompanied by their supervisor,

2. another staff member or appropriate adult. Undergraduate students must be supervised by their academic supervisor, at all times. Students must ensure that a University employee knows when and where they are undertaking fieldwork and what time they are expected back. They must have some means of communication.

3. Communication – the persons undertaking the fieldwork must be able to contact someone who can provide or send assistance.

4. Risk Analysis – prior identification of the hazards involved in the field trip should be addressed in the risk analysis. Control and minimisation of these hazards should also be considered.

The University of Wollongong has a comprehensive field work policy which must be adhered to. Please refer to http://staff.uow.edu.au/ohs/workingsafely/fieldwork/index.html. All relevant paperwork must be completed and authorised before any field work is undertaken. These forms are available through the University of Wollongong's web page. These forms include the field activity participant acknowledgement, field activity plan and field activity risk assessment form.

6. Chemical Aspects

6.1 Storage

Chemical storage is governed by the Australian Dangerous Goods codes, and the NSW Hazardous Substance Regulation.

Students do not have access to the chemical store but should be aware that these regulations apply in the laboratory work area. To comply, a few simple rules should be followed:

1. Never store mutually reactive substances together. The easiest way to ensure this happens is to segregate each dangerous goods class. Appropriate storage containers should be used. Be aware that there is often a primary and a secondary dangerous goods class.
2. Keep only the minimum required quantities of hazardous substances in the laboratory work area.

6.2 Gas Cylinders – Dangerous Goods Class 2 – Compressed and liquefied gases.

Gas cylinders represent a potential hazard due to the high pressure involved and also because of their contents.

Never use compressed gas without appropriate knowledge of the nature of the gas and the hazards associated with it

All cylinders should be secured in an upright position so it is impossible for them to fall. (If the tap is damaged on a high-pressure cylinder the escaping gases and cylinder can cause

violent damage to people and property.) It is illegal to store gas cylinders in a laboratory – gas bottles must be connected to an instrument.

Cylinder keys (if used) must be in place when the gas is being used to allow the cylinder to be turned off at any time. Appropriate measures are required if the gas is toxic or flammable, and oil and grease must never be used in fittings, pipe work connections and regulators.

High-pressure oxygen must never be allowed to come into contact with oxidisable materials.
.
Acetylene must be used with particular care due to the extreme hazard associated with 'burn back' which can happen if equipment is improperly used.

Always close the cylinder valve when the gas supply is not required. If possible, vent the pipes.

Gas cylinders are heavy and should not be moved without suitable trolleys or assistance. Only properly trained personnel are permitted to move, connect or disconnect gas cylinders.

6.3 Flammable Liquids – Dangerous Goods Class 3

This includes solvents and glues. Always ensure adequate ventilation by working in a fume cupboard when volatile substances are being used. Wear gloves and eye protection particularly when using glues.

Naked flames and other sources of ignition must not be used in any laboratory where flammable liquids and solids are used.

Flammable liquids must be stored in an approved flammable liquid storage facility.

When heating flammable liquids, use only steam or water baths or heating mantles. Extreme care must be exercised to ensure there is no source of ignition.

Many solvents are also carcinogenic i.e. cancer causing. Where possible less hazardous substances should be substituted for these. If this is not possible, some health monitoring may be required. Students should discuss this with their supervisors. Extreme care must be taken when using these substances – gloves and eye protection are required and a fume cupboard must be used.

6.4 Corrosives – Dangerous Goods Class 8

As a general rule, acids and alkalis are classified as corrosives. Other chemicals such as ferric chloride are also corrosive. Always check the label for the dangerous goods class. Acids and alkalis would be the most commonly used laboratory reagents.

When handling corrosives, gloves and eye protection must be worn. Alkalis, particularly sodium hydroxide are extremely dangerous to the eye and extreme care must be taken when using this substance.

Bottle-top dispensers for acids are accessible in each laboratory. The operating instructions are situated above them. Students should familiarise themselves with their use and always decant acid using them. As a general rule for acids, add acid to water NEVER water to acid. Acetic acid and nitric acid must be kept away from each other.

Safety carriers are available for carrying chemicals in glass or plastic containers with a capacity of 2 litres or greater. Never carry mutually reactive substances at the same time. If you need a carrier, see the laboratory staff.

6.5 Oxidisers – Dangerous Goods Class 5

In general, oxidizing chemicals present no risk to people. The reason they are segregated is that they will add fuel to any fire that may occur. Some oxidizers have a secondary dangerous goods class and this must also be taken into account.

6.6 Toxics – Dangerous Goods Class 6

As the name implies, Class 6 chemicals are toxic to people. Their toxicity varies from chemical to chemical but care should be taken when using any Class 6 chemical. It is mandatory to consult the relevant MSDS and use the personal protective equipment and administrative controls recommended.

6.7 Spills

Chemical spills must be cleaned up immediately. Inform staff if the spilled material is of a hazardous nature, which can be ascertained from the appropriate MSDS available in the laboratory. Specific information on spills clean-up methods should be obtained from the MSDS.

Prior to commencing the clean up ensure you are wearing the appropriate personal protective equipment.

It should be noted that even small spills of volatile materials in a confined space could generate significant concentrations of fumes and respiratory protection may be needed.

Hazmat pillows and vermiculite is available in each laboratory. These should be used with staff supervision.

As a guide to spill clean up the following steps should be taken:

1. Containment – contain the spill by bunding around it.
2. Absorption – as a general rule:
    - Organics – use vermiculite as the absorbent
    - Acids or alkalis – first neutralise then absorb with paper towel, cloth or mop
    - Mercury – cover with sulphur then remove with a dustpan and broom before placing in a sealed container.

3. At the completion of the spill, clean up. All absorbent or contaminated material should be placed in sealed containers, labeled and disposed of as contaminated waste.

If chemicals are spilled on the skin wash skin immediately regardless of the substance involved.

7. Biohazard Aspects

Environmental engineering laboratory work frequently involves working with materials that are biologically contaminated. Before any work involving these materials is started, students must be fully vaccinated for both Hepatitis A and Hepatitis B. A Tetanus booster is also recommended. The academic supervisor will require proof of this before any work commences.

These materials must be handled carefully to avoid health problems. Latex gloves are available for use in the laboratories and should be worn at all times. Laboratory coats and eye protection must also be worn. For materials that may generate aerosols, a dust mask should also be worn.

All containers, implements and apparatus that have been contaminated with biologically active materials must be disinfected after use. Benches and workspaces should also be disinfected. This can be done using a weak solution of bleach.

Clothes, boots etc should be washed carefully after each exposure to contaminated material. It is advised that contaminated clothing be washed separately from other clothes and a bacteriological agent such as a nappy wash be added.

In the event of a spill, the following steps should be taken:

1. Containment – contain the spill by bunding around it.
2. Absorption – absorb the spill into some absorbent material. Vermiculite is available in the laboratories. If it is a small spill, paper towel can be used.
3. Disinfection – the area contaminated by the spill should be decontaminated using a weak solution of bleach.
3. At the completion of the spill clean up, all absorbent or contaminated material should be placed in sealed containers, labeled and disposed of as contaminated waste.

Hand washing is an important means of preventing the spread of infectious contaminants. Students should wash their hands after removing gloves and before leaving the laboratory. After thorough washing, students should dry their hands with disposable paper towels. Eating, drinking, smoking, handling contact lenses, and applying cosmetics should not be done in laboratories, nor should any other activities that might involve hand-to-mouth or hand-to-eye contact

8. Radiation

8.1 General

In the environmental engineering laboratories, radioactive substances are sometimes used. The instrument laboratory 8.129 has a section set aside for radioactive work. Whenever radioisotopes are being used, the laboratory is a radiation laboratory and no other work can be performed in it.

Particular care must be taken when using radioisotopes. Radiation interacts with the cells of the body. If enough cells are affected, they can disrupt the function of the whole body. Radiation exposure can cause nausea, reduced blood cell count, hair loss, cataracts, various cancers and death. It is critical to protect or shield users from radiation exposure. Generally, low activity substances that emit only weak radiation are used in the laboratory. The least active isotope should always be used. The same hazard management strategy is still used regardless of the substance.

Radioisotopes can be divided into four radiotoxicity groups according the relative hazard. The radiotoxicity should always be determined before any work is commenced and the appropriate handling directions followed.

8.2 Types of radiation

Ionising radiation occurs in several forms:

- Alpha (α) particles – these are large particles with very little penetrating power. They cannot penetrate the skin so external contact with alpha radiation is not hazardous. Their weakness makes ingesting or inhaling these substances extremely hazardous.
- Beta (β) particles – are smaller in size than alpha particles and have a range of energies. Shielding for beta particles can be made of thin aluminium, Perspex, glass or water. Beta particles may penetrate the skin and are normally considered to be a moderate internal radiation hazard; however some isotopes emit energetic beta particles that are an extreme hazard.
- Gamma (Υ) radiation is often produced with beta radiation. They are more penetrating and if the source is large enough, can present a serious radiation hazard.
- X-rays are similar to gamma radiation and are extremely penetrating. There are no x-ray sources in the environmental engineering laboratories.

8.3 Activity

Activity is a measure of how radioactive a material is. The old unit for this was the Curie (Ci). The SI unit for this is the Becquerel (Bq). 1 Becquerel is equivalent to one disintegration per second. (dps).

$1Bq = \sim 27 \times 10^{-12}$ Ci

8.4 The NSW Radiation Control Act (1990)

This legislation governs the use of radioisotopes in NSW. Generally, working with radioisotopes requires a licence. Only appropriately licenced persons may use radioactive substances without supervision. A strict '**no working alone**' policy operates in the radiation laboratory.

It is possible to get exemptions on a licence; so unlicenced persons can use radioisotopes. The act states "A person may work under supervision if they have been issued with an approval exempting that person from the requirement to hold a Radiation Control Act (1990) licence". Supervision in this sense is defined by the Radiation Regulation (2003) as "supervision by a qualified supervisor who is present at all times during, and is observing and directing, the use by the person being supervised of radioactive substances." Hence, work with radioactive substances presents several problems, not only of hazards but scheduling the instrument laboratory and staff time.

8.5 General Handling Procedures for Radioisotopes

The radiation laboratory has the following equipment designated for radioisotope work:

1. Disposable latex gloves – always double glove when using radioisotopes
2. Radioactive waste receptacles, which are clearly marked
3. Pipettes designated for radiation work only
4. Decon 90 in solutions for general decontamination and personal contamination work
5. Stainless steel spillage trays which should be lined with benchkote.

Personnel working with radioisotopes will wear a full-length button-up laboratory coat and covered shoes. These articles will not leave the radiation laboratory to minimise possible contamination. Any volatile substances must only be used in the fume cupboard.

Radioisotopes should be appropriately stored after use in a spillage tray lined with absorbent paper. Wipe tests of the area used should also be performed and counted in a scintillation counter. Contamination tests should also be performed on soles of shoes and the floor.

Always wash hands thoroughly after using radioisotopes.

8.6 Radioactive Spills

For small spillages:
On the person:

1. Inform the licence holder.
2. Remove contaminated clothing and place in contaminated waste.
3. Wash the area with copious amounts of water or Decon at personal strength followed by copious amounts of water.

In the laboratory:

1. Inform the licence holder and allow them to assess the situation.
2. Wear appropriate personal protective equipment

3. Absorb the liquid spill with absorbent material, either vermiculite or paper towel. This must go to the solid radioactive waste disposal. If the spill is of a solid, carefully wipe it up with a tissue moistened with solvent or a decontamination liquid.
4. Decontaminate the area with Decon.
5. Perform wipe tests to ensure decontamination is complete.
6. Report the spill to the University's Radiation Safety Officer (x3914) and the Faculty Radiation officer.

For Larger spills:

1. Contain the spill using bunding.
2. Evacuate the area if there is a significant radiological hazard to people.
3. Inform the Building Warden and ensure that the area is isolated until it can be fully assessed.
4. Contact the University's Radiation Safety Officer (x3914) for further instruction.

More information on radiation safety can be found at:
http://staff.uow.edu.au/ohs/workingsafely/radiation/index.html.

9. Waste Disposal

9.1 Liquid Waste

1. Always ask staff about the correct method of waste disposal.
2. Aqueous acidic and alkali wastes can be disposed of down the sink with adequate dilution. If possible neutralisation of one with the other is recommended.
3. Metallic wastes may have to be collected depending on the nature and concentration of the metal. Metal waste can be disposed of into appropriately labeled 5 litre plastic containers available from staff. These containers will be periodically collected and delivered to the University's waste store to be collected by private contractor.
4. No organic waste should ever be disposed of in the sink. Organic wastes should be divided into halogenic and non-halogenic wastes and disposed of in appropriately labeled 5 litre plastic containers available from staff. These containers will be periodically collected and delivered to the University's waste store to be collected by private contractor.
5. Radioactive liquid waste should be collected for disposal in appropriately labeled 5 litre plastic containers available under the fume hood in 8.129. This will be taken to the University's radioactive waste store for disposal.

9.2 Solid Waste

1. Solid waste such as soils can be disposed of in the laboratory garbage bins. Common sense should be used to judge when a bin is too heavy. Remember, the cleaners have to empty these bins and heavy bins can cause injury. Large quantities should be disposed of in the skip in the compound of Building 4. These instructions apply to clean waste only – no hazardous, infectious, radioactive or bio-hazardous material may be disposed of in this way.

2. Radioactive solid waste should be collected in the appropriate radioactive bin (clearly labeled) in 8.129. This should then be double-bagged and appropriately labeled. This will then be taken to the University's radioactive waste store and disposed of.
3. Disposal of used media from microbiological experiments is into the bin in 8.127. This material is autoclaved to render it sterile and then removed in the normal solid waste collection.

9.3 Sharps/broken glass disposal

It is particularly important that broken glassware is disposed of in the green glass bin in 8.128. This material must **not** be disposed of in garbage bins or wastepaper baskets due to the hazard posed to cleaning staff.

Glassware and sharps require different containers. Sharps must be disposed of in approved sharps containers. There is a sharps disposal container in 8.127.

10. Program Review

As part of a continuous improvement system, this manual shall be reviewed on a regular basis [usually annually], or upon recommendation of the Faculty of Engineering Workplace Advisory Committee [WAC].

11. Related Documents

Australian Dangerous Goods Code
Australian Government Press

Australian Hazardous Substances Regulation (1998)
Australian Government Press

Australian Standard AS2243:1:1997
Safety In Laboratories Part 1: General
Standards Australia

Australian Standard AS2243:2:1997
Safety In Laboratories Part 2: Chemical Aspects
Standards Australia

Australian Standard AS2243:3:2002
Safety in Laboratories Part 3 Microbiological Aspects
Standards Australia

Australian Standard AS2243:4:1998
Safety in Laboratories Part 4: Ionising Radiation
Standards Australia

Australian Standard AS2243:8:2001
Safety in Laboratories Part 8: Fume Cupboards
Standards Australia

Australian Standard AS2243:10:1993
Safety in Laboratories: Storage of Chemicals
Standards Australia

NSW Occupational Health and Safety Act (2001)
NSW Government Press

NSW Radiation Control Act (1990)
NSW Government Press

University of Wollongong Policy: Clothing and Protective Equipment Guidelines

University of Wollongong Policy: Emergency Management Procedures

University of Wollongong Policy: Field Activity Guidelines and Procedures

University of Wollongong Policy: Laboratory Safety Guidelines

University of Wollongong Policy: Radiation Safety Guidelines

University of Wollongong Policy: Working with Hazardous Substances Guidelines

12. Final Assessment Page

It is a requirement of the environmental engineering laboratories that users clean up their work area, dispose of unwanted samples and chemicals and return any equipment or literature borrowed during the course of their work. This page must be signed by the environmental engineering technical staff and submitted to the relevant Academic supervisor.

Student Name……..

Date……..

1. Has the user cleaned up all work areas including benches, cupboards and storage areas?

YES/NO

2. Has the user removed or disposed of appropriately all samples, both solid and liquid?

YES/NO

3. Has the user returned all literature/equipment borrowed?

YES/NO

Signed:……

Date:……