UNSW

SCHOOL OF ELECTRICAL ENGINEERING & TELECOMMUNICATIONS

INTRODUCTORY LABORATORY SAFETY

MANUAL FOR EET STUDENTS

2024 Edition

Preface

This document will discuss best practices and laboratory safety rules to help users be aware of and follow the safety rules and lower the risks in laboratories. Laboratory safety is everyone's responsibility!

Students must read and understand this material, and pass the associated test, before being allowed to work in the electronics (or other) laboratories. It makes you aware of the potential hazards and risks that may be present in some laboratory work that you undertake during your course. Access to EET areas may be removed if you fail to comply with reasonable requirements communicated to you by our staff either verbally or in writing.

The School of Electrical Engineering & Telecommunications has an excellent safety record. We hope and expect you to play your part in preserving this.

Acknowledgements

This new edition of the student safety manual contains material derived mainly from the 2011 version. Thanks to those who worked on that Lydia Aristuti & Jacinta Xiujun Goh and former members of staff Trevor Blackburn & Kevan Daly, Prof E. Ambikairajah and Dr Iain Skinner.

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1 Introduction: engineering & safety

A major concern of the engineering profession is safety. It is integral to professional practice. You will find it embedded within Code of Ethics and Guidelines on Professional Conduct (AUGUST 2022):

"Practice engineering to foster the health, safety and well-being of the community and the environment."

Safety is a fundamental aspect of your practical work in Electrical Engineering (and any other engineering discipline). From your first day in the laboratory, understanding and practicing safety principles is crucial. Throughout your studies, you will revisit and build upon these safety concepts.

Safety is essentially about developing good habits—both in how you think and how you act. Start building these habits now. It's easier to establish good practices from the beginning than to break bad ones later.

As future engineers, you will likely take on leadership roles where the safety of others will be part of your responsibilities. Your education is designed to prepare you for these roles.

This manual does not cover everything you will learn about safety during your program. There are many hazards you may encounter, such as machinery, lasers, and hazardous substances, which are not fully detailed here. These topics will be covered in more depth as needed in your later studies.

Remember, safety is an ongoing learning process. Always stay curious, stay cautious, and never hesitate to ask questions if you're unsure about any safety procedures.

2 Principles of safety

Two fundamental components of safety are your knowledge and your attitude.

(i) Knowledge of Hazards:

- **Understand the Risks:** The first step in safety is knowing the dangers (or hazards) so that you can take appropriate precautions. This may require some research, and in some cases, a lot of research.
- **Proactive Learning:** Avoid the mindset of “What I don't know can't hurt me.” Your knowledge of hazards allows you to design systems with safety in mind and to implement appropriate controls.

(ii) Attitude Towards Safety:

- **Implementing Safety Measures:** Knowing the risks is not enough. Your decision to implement safety precautions reflects your attitude towards safety. It demonstrates what you prioritize. True safety comes from a genuine concern for your own safety and the safety of others.
- **Duty of Care:** From a professional ethics standpoint, this is your duty of care. Knowledge of safety is useless if it doesn’t influence your design choices. Remember people indirectly affected by your project and be concerned for safety beyond the initial implementation of a system.

Key Takeaway: “Think first. Act carefully.”

No one wants accidents to happen, but they do. Preventing accidents requires proactive efforts. However, it’s also crucial to be prepared for accidents should they happen. Accidents typically result from:

- **Human Error:** Mistakes made by individuals.
- **Human Ignorance:** Lack of knowledge or awareness.
- **Hardware Failure:** Physical breakdowns, such as metal fatigue.
- **Random External Events:** Unpredictable factors beyond control.

As an engineer, your duty is to minimize both the likelihood of system failures and the impact if a failure occurs.

Processes for Ensuring Safety

When fulfilling your safety responsibilities, several established and useful processes can guide you:

- **Risk Assessment:** Identify potential hazards, evaluate risks, and implement measures to mitigate them.
- **Safety Training:** Regularly participate in and promote safety training sessions to stay informed about best practices and new safety protocols.
- **Safety Inspections:** Conduct periodic safety inspections to ensure compliance with safety standards and to identify areas for improvement.
- **Incident Reporting:** Encourage prompt reporting of any safety incidents, hazards or near-misses to prevent future occurrences.
- **Maintenance:** Ensure regular maintenance and inspection of equipment to prevent hardware failures.

By integrating these processes into your routine, you can foster a culture of safety and ensure a secure environment for yourself and others.

2.1 Hazard management

Managing hazards effectively is crucial to maintaining a safe environment in the electronics laboratories. A hazard is anything that has the potential of causing harm or damage. Follow these steps to handle hazards:

(i) Identify the Hazard:

- Determine the source of potential danger (e.g., lasers, electricity, sulfuric acid, curious children). Knowing the hazard is the first step to mitigating it.

(ii) Assess the Risk of the Hazard (Refer to section 2.3):

- Evaluate the severity of all possible consequences and the likelihood of each occurring. This may require extensive research and can be time-consuming and uncertain, especially for unknown consequences.

(iii) Control the Hazard (Refer to section 2.2):

- Implement measures to reduce the risk associated with the hazard.

(iv) Monitor the Effectiveness of Controls:

- Safety measures can involve some experimentation. Collect data to see how well your controls are working.

(v) Periodically Review Hazard Management:

- New information and experiences can offer insights. Regularly reassess the hazard management strategies to ensure ongoing safety.

2.2 Hierarchy of hazard controls

Once a hazard is identified, it can be controlled in several ways, listed here in decreasing order of effectiveness:

(i) Eliminate the Hazard:

- The safest option is to completely remove the hazard. However, this might not be possible.

(ii) Substitute the Hazard:

- Replace the hazard with something less dangerous.

(iii) Redesign the System (Engineering Controls):

- Limit human contact with the hazard, for example, use guards, rails, or interlocks.
- Reduce the possibility of human error, for example, use automation.
- Design systems so that failures have minimal adverse outcomes.

(iv) Implement Relevant Procedures (Administrative Controls):

- These can include restricted access, emergency procedures, training, and warning signs. Regular monitoring and maintenance are also essential.

(v) Issue Personal Protective Equipment (PPE):

- Provide appropriate PPE, such as clothing, eye protection, and insulated tools.

2.3 Assessing risks

Risk assessment involves understanding the context, identifying hazards, and evaluating the potential consequences. Follow these steps:

(i) Identify the Context:

- Determine who is involved, where the activity will occur, and when it is scheduled. The level of risk can depend on these factors.

(ii) Identify Hazards:

- Note the existing control measures for each hazard associated with the activity.

(iii) Assess the Consequences and Likelihood:

- Identify possible adverse outcomes and estimate the likelihood of each occurring, given the existing controls.
- Sometimes probabilities are based on historical data, but for rare or extreme outcomes, this can be challenging.
- The risk of each hazard is the product of the probability and the severity of the outcome.

(iv) Recognize Subjectivity in Risk Assessment:

- Risk assessments can never be entirely objective as they depend on the quality of the data and the measures chosen. Often, probabilities and severities are estimated in a way that supports a predetermined decision.

(v) Decision-Making:

- Deciding whether a given risk should be taken is subjective and depends on the overall risk, potential benefits, and who bears the risk. Those with the authority to make decisions should consult with those affected.

Note that in your courses, the risks of assigned experiments have been assessed by the staff. However, you will need to complete the risk assessment for any experiments you conduct as part of your final year thesis.

2.4 Reporting incidents, hazards, concerns and near misses

Maintaining a safe laboratory environment relies on prompt and accurate reporting of incidents, hazards, and near misses. Here’s how to report them effectively:

(i) What to Report:

- **Incidents:** Any event that results in injury, or damage to equipment.

- **Hazards:** Any potential source of harm or adverse health effect on a person or persons.
- **Concerns:** Any concerns you have regarding issues relating to health and safety
- **Near Misses:** Events that could have resulted in injury, or damage but did not, either by chance or timely intervention.

(ii) How to Report:

- **Immediately Inform Your Supervisor:** As soon as an incident, hazard, or near miss occurs, inform your lab supervisor or class demonstrator.
- **Report on Salus:** Report incidents or hazards on Salus, this will allow the university to track and follow up.

(iii) Importance of Reporting:

- **Prevent Future Incidents:** Reporting helps identify patterns and prevent future incidents.
- **Continuous Improvement:** Regular reporting and investigation contribute to continuous improvement of safety protocols.
- **Safety Culture:** Promotes a culture of safety and responsibility within the laboratory.

By following these procedures, you contribute to a safer laboratory environment for everyone.

Six step safety method (*after Cadick*)

1) THINK - BE AWARE
   - Persons must be aware of any potential hazards in the laboratory at all times.
   - Risks should be assessed before starting any experiment.
2) UNDERSTAND YOUR PROCEDURES
   - Be familiar with all safety procedures, as outlined by the relevant expert authority (in your case the School).
3) FOLLOW YOUR PROCEDURES
   - All safety procedures should be followed closely at all times.
4) USE APPROPRIATE SAFETY EQUIPMENT
   - Appropriate safety equipment must be used when there is a possibility of accidents, such as electric shock, arcs or electrical fires.
5) ASK IF YOU ARE UNSURE
   - Always ask questions or seek advice from laboratory staff, if you are unsure of what to do in any particular situation.
6) DO NOT ANSWER IF YOU DO NOT KNOW
   - Do not answer any safety-related questions if you are unsure of the answer.

3 Safety in the electronics laboratories

This section gives you a quick rundown of safety practices in the electronics labs. We'll dive deeper into electricity, a key hazard in our labs, in Section 4.

While in the electronics labs, you'll usually have a lab demonstrator supervising you. If you have any safety questions, ask your demonstrator or lab manager first. They're here to help and make sure you know how to work safely.

Remember, *you can't work alone in the labs until you've had the right training*. This rule makes sure you're ready to use the equipment and know all the safety rules.

If an incident occurs in the laboratory, call the workshop for assistance on 93855507, 93855508 or 93855509.

3.1 General laboratory precautions

The primary laboratory safety consideration is this:

NEVER do anything that poses a needless or excessive risk to anyone.

Don't put yourself or others at risk. This rule applies all the time, in every situation. We can't make a rule for everything, so it's important to understand this basic principle. For instance, we don't specifically say you can't use your teeth to strip wires, but doing so is reckless and puts you at risk.

Any student who fails to abide by safety requirements WILL BE REMOVED from the class.

For everyone's safety, we've posted the general lab rules in all labs.

These regulations MUST be followed by everyone at all times.

Some labs have additional rules that are specific to that space. Many of these rules are all about safety.

3.1.1 Personal conduct

Wear shoes that protect your feet from things that might fall or be left on the floor. Loose shoes can trip you up in an emergency. Students wearing unsafe footwear will be asked to leave the class.

See allowed footwear below.

The toes must be totally enclosed.
The sole must be firmly attached to the foot.

Don’t eat or drink in the labs to avoid spilling on the bench-tops and damaging electrical equipment. Leave all drinks at the lab entrance.

Keep bench-tops and aisles clear to avoid accidents and make sure everyone can move around easily. This includes keeping cables and leads off the floor. Store bags neatly under the benches or at the specified place for them.

Drugs, including alcohol and some medications, can affect your thinking and slow your reactions. Any student under the influence will be asked to leave the lab until they’re sober. If you’re on medication, talk to the lecturer about other arrangements.

Don’t work in the lab if you’re too tired to think clearly. This is especially important when projects are due. Your grades aren’t worth getting hurt. Remember, being awake for 18 hours is like having a blood alcohol content of 0.05%.

You can test the effects of fatigue here.

Safety glasses are provided in the laboratory and must be worn when soldering. It is also encouraged to wear safety glasses whenever you feel the need for additional eye protection. Certain electronic components, particularly electrolytic capacitors, can explode if connected incorrectly. To protect your eyes from potential damage, wear safety glasses. Remember, safety devices like these are only effective if used properly.

UNSW is a smoke free campus which includes all forms of cigarettes, cigars, e-cigarettes (vaping). This means ***no vaping or smoking is allowed in the building, especially laboratories,*** and on campus!

School of Electrical Engineering & Telecommunications

UNSW

Laboratory Regulations

1) All laboratory users must undergo induction, agree to comply with laboratory rules, and read any required safety manuals.
2) Bare feet or exposed, open footwear (e.g., sandals) are not permitted.
3) Food and drink are not to be consumed in laboratories at any time. Water bottles must be stored in the trays provided at the lab entrance.
4) The 240 V, 50 Hz mains power must only be used for purposes approved by the School. Only authorized personnel are permitted to alter power connections (60 V and above) or connect any equipment to mains power.
5) Tampering with or removing any laboratory equipment is strictly forbidden.
6) Students are expected to conduct themselves in a reserved manner at all times. Noise must be kept to a minimum, and mobile phones should be on silent.
7) All bags should be stored neatly under the benches or to a specified place. They shouldn't be put on the bench.
8) Students should clean and tidy their workstations after finishing. All leads should be returned to the cable rack, and equipment should be switched off before leaving the laboratory.
9) Faulty equipment should be reported to laboratory staff, who may not otherwise be aware of the problem.
10) Students are not permitted to install unauthorized software or alter network data connections, as this could pose a cybersecurity risk.

3.1.2 Electrical infrastructure and equipment

In our labs, we use two types of power outlets. Normally, we use earthed ones. Isolated, non-earthed outlets should only be used if your experiment needs them. Make sure to connect your equipment to the right outlet. If you're not sure, ask your lab staff or demonstrator.

Only authorized personnel can change power connections (above 60 V) or connect equipment directly to mains power. Wiring of the 240 V plug or any internal wiring of equipment must not be interfered with.

The 240 V, 50 Hz mains power should only be used for School approved purposes. If you're working on something not related to a school course, you must get approval from the laboratory staff first. In all cases, *work may only be done under appropriate supervision*.

Laboratory equipment, e.g. oscilloscopes, is designed to be safe if used in compliance with the manufacturer's operational guide. However, there is added risk if the equipment is modified to accommodate a particular experiment, e.g. if the earth in an oscilloscope is removed to prevent an earth loop during measurement. Tampering with any laboratory equipment may cause the malfunction of equipment or personal injury.

Faulty laboratory equipment might pose danger to laboratory users if operated unknowingly. It may result in personal injury or malfunction of other equipment. Faulty equipment should be reported immediately to laboratory staff, who may not otherwise be aware of the problem. Faulty equipment must be clearly tagged and taken out of service for repair. ***Do not remove or ignore such tags.*** They are there for everyone's protection, the next user's as much as your own.

3.1.3 Insulated tools

Insulated tools are standard hand tools with a covering of electrical insulation such that only a minimum amount of metallic surface is exposed, e.g. a screwdriver with a plastic-coated blade. They are used to prevent shock or arc when the user is in contact with or near an energized conductor. Generally, buy the best tools you can afford. You want them to last your professional lifetime.

3.2 Soldering

There will be times when you need to solder. When you do, you need to solder safely. You can only solder after completing the practical soldering training. There are 4 associated hazards: electricity, heat, toxins, and fumes. When you solder, proceed as follows.

(i) Always leave the soldering iron in the guard when not in use; never touch the iron's tip; wait until the solder has cooled and set before touching the components. When you are finished, turn it off.
(ii) Goggles or safety glasses must be worn, as a precaution against hot solder flicking or splattering.
(iii) Use provided fume extractors where possible these will such up and filter the toxic fumes. Keep the area ventilated.
(iv) Only solder within the designated spaces in the electronics laboratories.
(v) Wash your hands thoroughly after soldering.
(vi) Wipe down the bench after use.

On the wall near the soldering stations, you will find a document, a ***safe work procedure**,* entitled *Soldering*. It contains the relevant safety information. There are other such safe work procedures on the walls of other laboratories, too. These describe the activities done therein. The laboratory regulations are a safe work procedure.

Soldering Safety Video

EET SOLDERING SAFETY

You MUST wear Safety glasses. If you can’t find them ask a staff member.

DO NOT EAT, DRINK, BITE YOUR NAILS OR RUB YOUR EYES WHILE SOLDERING

DO NOT touch the soldering iron, and keep it away from flammable material

TURN ON ventilation OR extraction fan BEFORE you start soldering. DO NOT BREATHE IN THE FUMES.

WIPE the bench work area BEFORE you start AND AFTER you finish soldering.

Place any soldering waste or wet wipes in the white bucket provided, NOT in the normal bin.

WASH YOUR HANDS DIRECTLY AFTER YOU FINISH SOLDERING

3.3 Use of lab equipment

Lab equipment and tools in the laboratory should be used only for their intended purpose. Likewise appropriate equipment and tools need to be used for all tasks. For example, oscilloscope probes should only be used to measure signals and for stripping isolation of wires, wire strippers should be used.

3.3.1 DC Power Supplies

1. Initial Inspection

   - Check the power supply for damage or wear before using it. Make sure the power cords and connections are secure.

2. Operation

   - Double-check the voltage and current settings to match your circuit's requirements. Wrong settings can damage both the power supply and your components
   - Always connect the power supply leads to your circuit before turning the power supply on.

3. Shutting Down
   - Turn off the power supply and let capacitors discharge before disconnecting the leads.
   - Safely store the leads on the racks provided.

3.3.2 Oscilloscopes

1. Pre-Use Checks
   - Inspect the oscilloscope for any visible damage. Ensure that the probes and cables are in good condition.
2. Connecting Probes
   - Use the proper probes for the signals you are measuring. Always connect the ground clip of the probe to a common ground in your circuit.
   - Ensure probes are properly compensated to prevent signal distortion.
3. Safe Operation
   - Be aware of the input voltage limits of the oscilloscope to prevent damage to the device.
   - Start with the oscilloscope set to a high voltage range and then adjust down to avoid overloading the inputs.
   - Always connect the ground of the probe lead to the ground of circuit, failure to do

this can seriously damage the oscilloscope

4. Interpreting Data
    - Understand the functions of the oscilloscope controls, such as time base, trigger settings, and vertical/horizontal adjustments, to accurately capture and analyze signals.
5. After Use
    - Turn off the oscilloscope and safely store the probes on the racks provided.
    - Clean the screen and control if necessary to maintain visibility and functionality.

3.3.3 Multimeters

1. Inspection
    - Check the multimeter for any signs of damage, especially on the probes and connection leads.
2. Selecting the Mode
    - Always select the correct measurement mode (voltage, current, resistance, etc.) before connecting the multimeter to the circuit. Always ensure that the leads are connected to the correct current measure range otherwise you will blow up fuses. Never try to measure voltage with the multimeter leads connected to measure current!
    - Start with the highest range and work your way down to prevent overloading the meter.
3. Safe Measurement
    - When measuring voltage, connect the probes in parallel with the component or section of the circuit.
    - For current measurements, connect the multimeter in series with the circuit.
    - Never measure resistance in a live circuit to avoid damaging the meter and the circuit.
    - Ensure a secure and stable connection to avoid false readings or accidental short circuits.
4. Storage
    - Turn off the multimeter after use and return the leads to the storage racks.

3.3.4 Signal Generators

1. Initial Setup
    - Inspect the signal generator and its cables for any visible damage.
    - Ensure the generator is properly grounded to prevent electrical noise and interference.
2. Configuring Signals
    - Set the desired frequency, amplitude, and waveform type before connecting to

your circuit.
- Use appropriate output attenuation to match the requirements of your circuit and prevent overloading.

3. Connection
    - Connect the signal generator output to your circuit with properly rated cables and connectors.
    - Use the 50-ohm or high-impedance setting as required by your measurement setup.
4. Operation
    - Start with low amplitude and gradually increase to the required level while observing the circuit's response.
    - Monitor the output on an oscilloscope to ensure the signal is as expected and free from distortion.
    - Don't connect the signal generator directly to a DC supply. This will damage the output circuitry, always use a current limiting resistor!
5. Turn Off and Store
    - Disconnect the signal generator from your circuit before turning it off.
    - Return cables to the storage racks and switch off the device.

By adhering to these guidelines, you will ensure the safe and effective use of electrical measurement equipment, protecting both yourself and the lab resources.

3.4 Electrical Components

3.4.1 Electrolytic Capacitors

Electrolytic capacitors are often used in electronic circuits because they have high capacitance values. But they can be dangerous if not handled properly. They're polarized, which means they have specific positive and negative terminals. Connecting them wrong can make them fail violently, possibly exploding and releasing harmful chemicals and fragments. They can also store a lot of energy even after a circuit is turned off, which can cause an electric shock. To stay safe, always check the polarity markings and install them correctly. Before working on a circuit with electrolytic capacitors, discharge them safely using a resistor across the terminals. If possible, consider using ceramic capacitors instead to reduce the risk of catastrophic failure. It is recommended to wear goggle while connecting an electrolytic capacitor to the circuit and before connecting a power source to the circuit.

3.4.2 Component Heating

Components that dissipate power, such as resistors, transistors and integrated circuits (IC), can generate significant heat during operation, potentially causing burns if touched. Even seemingly harmless components can become very hot due to power dissipation. Avoid contact with these components during and immediately after use, as they may remain hot for some time.

3.5 After Using the Laboratory

Always tidy up your working bench after the end of all works, turn the power of all equipment off, put all the leads back to their designated places and return all the reusable components to the demonstrator after your use that you were asked to give back instead of throwing them into the rubbish bin.

4 Electricity: hazards & precautions

The most severe consequence of an accident with electricity is electrocution, which is the extreme form of electric shock that can lead to death. There are, though, other things that can happen. This section briefly surveys the consequences of electric shock, how it occurs and some standard ways to reduce its chance of happening. It concludes with consideration of other consequences of electrical faults in systems.

4.1 Physiological effects of electric current

Electric shock is the physical stimulation that occurs when electric circuit passes through the body. The impact of electric shock on the body depends on the amount of current, the parts of the body the current passes through, and the person's overall health. Depending on the current path through the body and the magnitude and duration of current transmitted, electric shock may have these effects on the human body.

Damage and burns to tissue: Electric current can result in severe tissue damage through burning. It is mostly deep burns, as it occurs from the inside of the body where the growth centers are destroyed. If vital internal organs are involved, the burns can be fatal.

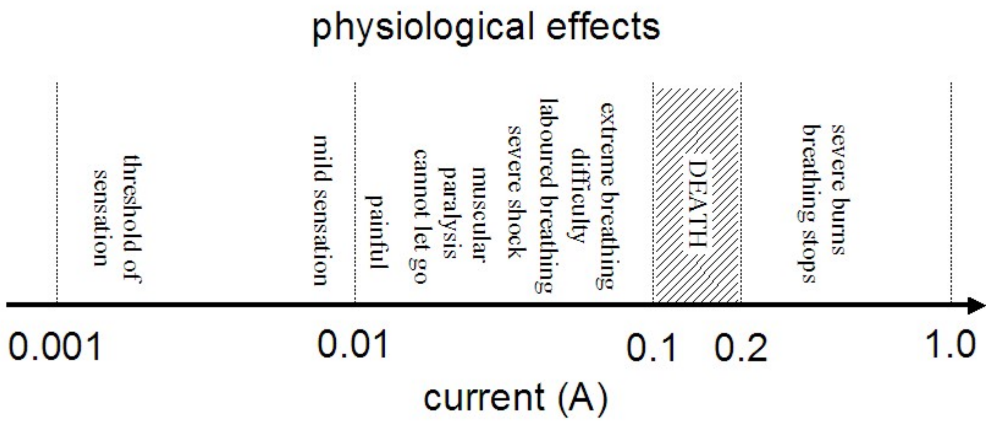
Involuntary Muscular Contraction: At low currents, muscular contractions may occur, potentially causing the "no-let-go" effect, where the hand cannot release a live conductor. Respiratory muscles may also be affected, leading to breathing difficulti**es.**

Ventricular Fibrillation: The heart muscles are the last to be affected, and if impacted, irregular heartbeats or ventricular fibrillation may occur, potentially leading to death.

"It's the current that kills."

This isn't widely understood. Even though the mains voltage supply poses a definite hazard, quite low voltages can be equally dangerous if the resistance of the body between contact points is low enough. This resistance depends on contact area, skin moisture, etc. While any current over 10 mA can cause a painful to severe shock, currents between 100 and 200 mA are lethal. Currents above 200 mA, while causing severe burns and unconsciousness, don't usually cause death if the victim gets immediate attention. However, such high currents can cause permanent damage.

How physiological effects depend upon current is indicated in the Figure below. This is only ***approximate*** and ***varies with the individual***. Several points should be noted.



i) There is very little difference between 'mild' and 'painful' sensations, 8 to 12 mA. The *threshold of perception* is the minimum value of current that can be sensed when flowing through a person. Some factors that affect the threshold of perception are contact area, conditions of contact (dry, wet, pressure, temperature), and the physiological characteristics of the individual. For AC, the accepted value is about 0.5 mA, independent of the duration of flow; for DC, the nominal value of this threshold is 2 mA.

ii) The so-called 'let go' current is a slightly higher value. The *threshold of let go* is the maximum value of current at which a person holding electrodes can ***voluntarily let go of them***. It depends on contact area, shape & size of electrodes, and physiological characteristics of the individual concerned. For AC, this averages around 16 mA for men and 10 mA for women. There's no definable value for DC below 300 mA. Above 300 mA, let go is only possible after several seconds or minutes of shock duration. Only making and breaking sensation is felt, and it leads to painful muscle contraction. 20mA (mains frequency) can cause paralysis of the respiratory muscle. [Fish and Geddes, "Conduction of Electrical Current to and Through the Human Body: A Review", 2009]

iii) Currents above the let-go threshold, up to about 80 mA, will cause severe pain and laboured breathing. If the person is still conscious, recovery is almost certain immediately after exposure is removed. If exposure is allowed to continue, however, collapse, unconsciousness, or even death by asphyxia, may ensue. Recovery from the unconscious state, with symptoms resembling those of normal shock, is comparatively certain with resuscitation, although it could take several hours.

iv) The biggest danger is ventricular fibrillation which leads to death in a few minutes because the heart fails to maintain blood supply to the brain. The threshold of ventricular fibrillation is the minimum value of current that causes heart to beat with an irregular rhythm which can lead to a heart attack. It depends on physiological factors such as anatomy of the body, state of cardiac function, as well as electrical factors, e.g. contact area, duration and pathway of current flow and type of current.

For AC, above 500 mA, fibrillation may occur for shock duration below 0.1 s. It may also occur for current magnitude of several amps, if the shock falls inside the vulnerable period of the cardiac cycle. Reversible cardiac arrest may result when shocks last longer than one cardiac cycle.

The threshold of fibrillation for DC is several times higher than AC for shock duration longer than the cardiac cycle. If the shock duration is shorter than 200ms, the threshold of fibrillation for DC is approximately the same as for AC (rms value).

Ventricular fibrillation can occur for currents between 100 and 200 mA (average) applied for a short time (order of 1 s or longer), and even for lower currents if applied for a longer time (5-10 s). Exposure to even small currents for extended periods might eventually cause fibrillation, but this is not certain. Chances of recovery are poor, since defibrillation procedures must be administered within a few minutes, i.e. application of a larger shock to clamp the heart, and then respiration support, if necessary.

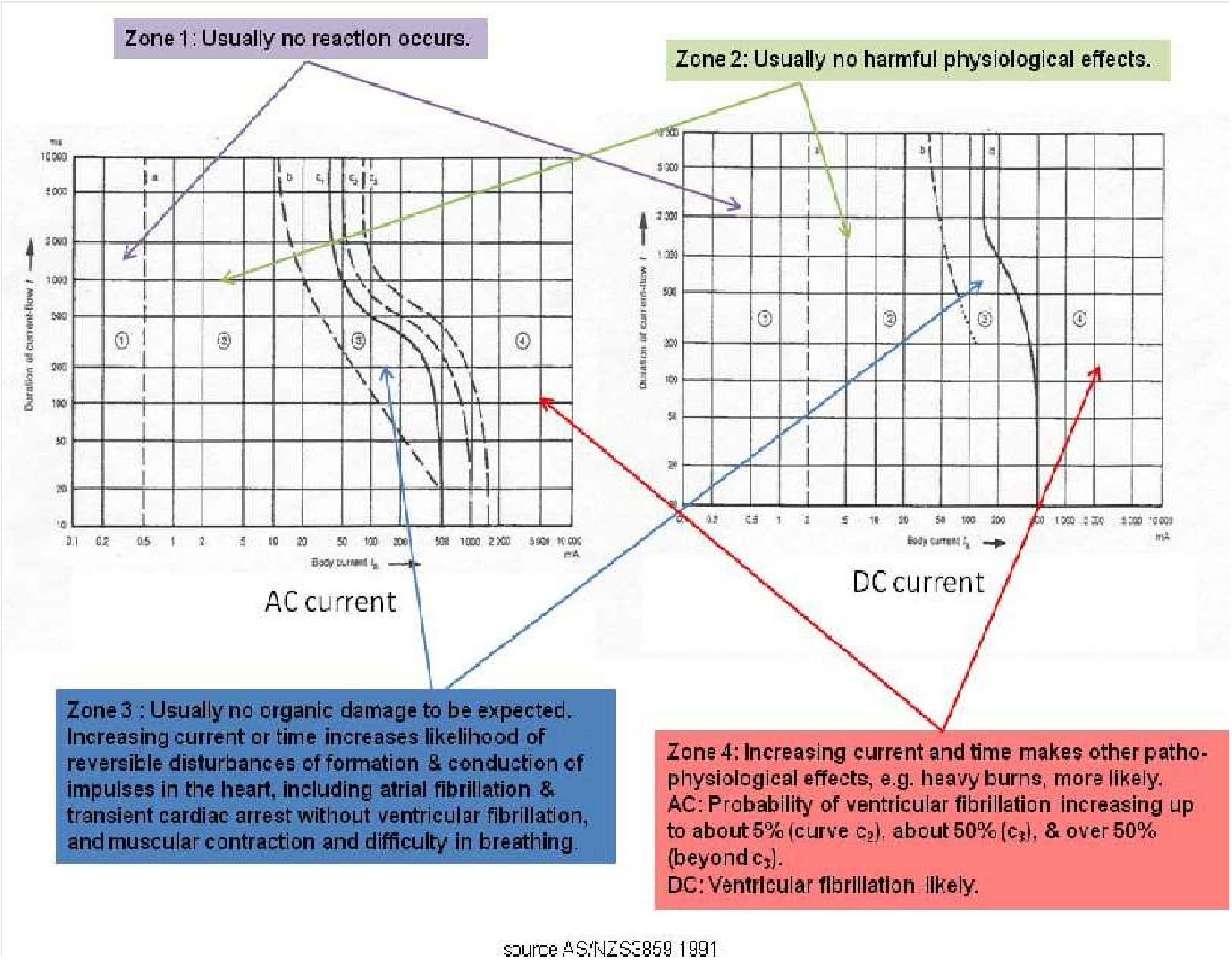
When the flow of DC current is below 300 mA, a warm sensation is felt in the extremities. If there is transverse current up to 300 mA flowing through the body for several minutes, as time and current increases, this might cause reversible cardiac dysrhythmia, current marks, burns, dizziness, and unconsciousness. Unconsciousness occurs frequently when the current is above 300 mA.

(i) For high currents, say over 200 mA, the muscular contraction of the heart may be severe enough to clamp it (the basis of defibrillation), thereby preventing fibrillation, and the chance of recovery is good.

(ii) Very high currents (say above 250 mA) may cause
  - complete respiratory inhibition due to damage to the nerve center controlling breathing, resuscitation likely to be unsuccessful.
  - irreversible and eventually fatal damage to nervous system.
  - serious burns and delayed death due to damaged organs; and/or
  - deep burns and sufficient body temperature rise to cause immediate death.

Very high current shocks are rare and probably only occur at high voltages or from lightning strikes.

Curiously, the person who receives a potentially lethal shock would probably be better off getting a high dose (say 250 mA), thereby preventing fibrillation. If lucky, the person would be thrown clear and only need resuscitation.



Most serious accidents that occur in the home or in industry involve a current path through the chest (say hand to foot, or hand to hand) and the current magnitude anything up to that causing fibrillation.

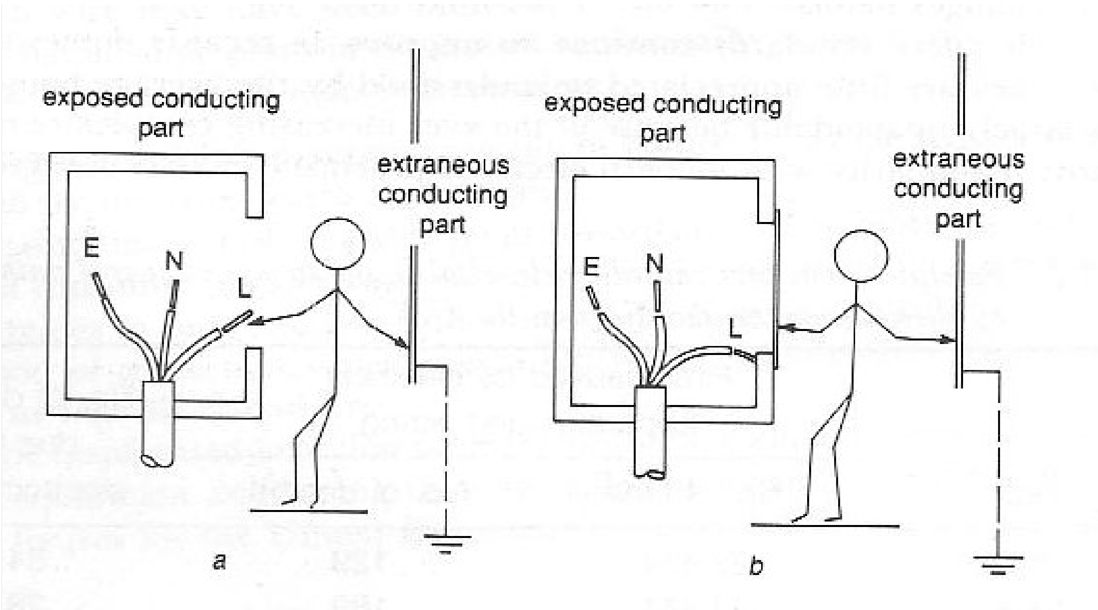
Finally, the following, relevant information may be of interest.

- Risks of shock are worst at power line frequencies, quickly losing effect above 1 kHz or below 10 Hz.
- Figures on body resistance are interesting. The volume resistance between the ears is 100 Ω and hand to foot about 500 Ω. However, the skin resistance is much higher, from 1 kΩ for wet skin up to 5 kΩ for normal skin. It would be idiotic to work near mains voltage with wet hands, as the 100 - 250 mA region is worst.
- 110 V systems are as dangerous as 240 V systems.

4.2 Causes of electric shock

4.2.1 Exposed live conductors

An exposed conductive part is ***any*** metalwork surrounding electrical equipment. An electric shock can be received from live metallic casing. This occurs when there is a partial elevation of voltage during the passage of an electrical fault current to earth or a full elevation when the casing is not earthed. A shock can also be received from exposed energized metallic parts (e.g. wiring) which normally carry a live voltage.



Direct contact (a) and indirect contact (b) with live wiring (from Greenwald)

Electric shocks can occur even without the presence of a fault current. Some examples follow.

- Direct contact by touching the live and neutral or two phases of an energized supply. (This is a highly unlikely incident.)
- Direct contact with a live conductor when any part of the body is connected to earth.
- Indirect contact with an unearthed casing comprising an earth fault.

4.2.2 Improperly earthed equipment

The purpose of earthing equipment is to ensure that all exposed metal (i.e. conducting) surfaces are maintained at substantially earth potential, even during a fault condition when substantial current flows to earth. If the equipment is properly earthed, the circuit's over-current protection device will trip in the case of a low-resistance internal fault to an exposed metal surface. This will remove the hazard. In case of a fault with high internal resistance, equipment earthing will keep the exposed metal surfaces at or near-earth potential.

With improperly earthed equipment, both low- and high-resistance faults will energize the exposed metal parts to significant voltage levels, thereby causing the potential for serious electric shock if persons are in contact with the metal parts.

4.2.3 Electric currents and water

Electric shocks might occur when an individual is in water and electric currents are present. This is due to the energized conductor being exposed to the water. While water is not a good electrical conductor, it does conduct some current. Its danger is that it can spread over large surface areas of the body and lower contact resistance with the skin. It can also cover insulating surfaces and make them live. The factors which will determine the current flow in such cases are

(i) Shape and size of the conductor – water contact surface
(ii) Shape and size of any insulating object covered with water
(iii) Conductivity of the water
(iv) Resistance in the current path to earth

When water is present, its relatively poor conductivity may mean that there exists a reasonably high resistance to earth. This can limit the current magnitude and thus any circuit over-current protection ***may not operate***.

4.3 Building safety into circuits

The following are examples of standard engineering controls of electrical hazards.

(i) **Fuses and circuit-breakers:**

- A fuse or a circuit breaker protects a circuit from failure of the insulation of an unearthed conductor. It trips when the fault current exceeds the trip setting limit, and disconnects the power, thereby minimizing the hazard. Fuses and circuit breakers are over-current devices and ***do not protect against electric shock***. Their tripping current is almost always orders of magnitude greater than the current levels that can cause electrocution. They ***only protect equipment***.

(ii) **Residual current devices** (aka safety switches):

- A residual current device (RCD) incorporates a means for detecting a residual (or earth leakage) current, with a way to isolate the circuit if the residual current exceeds the trip level (normally 30 mA).

- It monitors the balance between the load current and the return current from the load and has a miniature core balance relay to detect earth leakage and an integrated circuit-breaker that also protects against overloading, short-circuit and earth leakage currents.
- RCDs do not prevent electric shock. Instead, they respond very rapidly to earth leakage currents through the body and are designed to trip the supply before fibrillation has time to establish.
- RCDs cannot provide universal protection. They only work if the current flows to earth through the body. ***The RCD will not provide protection, if a person is connected between the active and neutral***, with no earth leakage current.

(iii) **Protective earthing:**

- The purpose of a protective earthing conductor is to make sure that any leakage current from the live parts within the equipment flows harmlessly, via a low resistance path, to earth. The resistance to earth from protective earthed parts in equipment must be low enough to allow sufficient fault current to flow to earth This ensures that the over-current protection device in the final sub-circuit or fixed wiring opens quickly during insulation failure.

(iv) **Double insulation:**

- All live circuits must be insulated from earth and all earthed external connections. The purpose of double insulation is to minimize the possibility of an earth fault loop. It means that there are two, physically separate insulations. Functional insulation is necessary for the proper operation of equipment, whereas the protecting insulation protects against electric shock when the functional insulation fails to work. Double-insulated equipment is not earthed because of the two levels of protection provided by the insulation. However, electrocutions may still occur with double insulation, especially ***if the equipment is used near water*** or if there are plug or flexible cord faults.

(v) **Extra-Low Voltage Operation:**

- Extra-low voltages are those under 50 V AC or 120 V ripple-free DC (AS/NZS 3000: 2000). In general, extra-low voltages are considered relatively safe for direct contact. However, if the condition of the room changes, such as high humidity or a wet environment, contact resistance is decreased and this increases the probability of an electric shock, even at extra-low voltages.

4.4 Electricity and fire

Electrical fires can occur due to overcurrent, insulation failures, or arcing:

- **Overcurrent:** Overloading circuits can lead to component failures, causing sparks or heat buildup. Faulty insulation or dust accumulation can make the risk of fires worse.
- **Arcing:** High voltages across open circuits can cause arcs, igniting nearby combustible materials like insulation or plastic casing. Lightning strikes are a notorious example of arcing causing bushfires.

When dealing with electrical fires, safety protocols should be followed:

- **Disconnect Power:** Priority should be given to disconnecting power to mitigate the electrical hazard.
  - ➢ If power cannot be disconnected, consider using CO_2 or foam extinguishers to starve the fire of oxygen. Avoid using water, as it can spread the electrical hazard. All labs have CO_2-extinguishers, marked in black.

4.5 Working on live equipment

All voltages are potentially hazardous since contact with any live parts might allow substantial amounts of current to pass through the heart. This can be fatal.

Work on live equipment is only permitted if there is no alternative.
Supervision is compulsory.

The standard precautions [AS/NZS2243.7: 1991] to take when working with live equipment are these.

- Never work alone on live equipment.
- Use only tools and test probes with insulated handles.
- Work one-handed, keeping the other hand in your pocket to prevent constructing a hand-to-hand path (which would necessarily go through your heart!).
- Use earth-leakage core-balance protection. This is mandatory.
- Avoid contact with any earthed metal in the vicinity of the equipment.
- Stand on an insulating mat and wear insulated gloves.

- Use prominent warning signs and barriers if equipment with exposed live terminals is energized.
- If components must be touched, e.g. when a motor is being checked for overheating, use the back of the hand so that involuntary muscle contraction does not prevent withdrawal should the casing be alive.

5 In an emergency

In the event of **any emergency**, including fire, ambulance and police requirements,

Stay calm and contact UNSW Security on extension 56666

from any phone in the University, or use *University Help Points*, or free call 1800 626 003.

Carefully ***describe*** the emergency:

1. L*ocation* (G17 Electrical Engineering Building (if in the school)),
2. ***type*** of emergency,
3. your name & contact details, and
4. ***severity*** of the situation.
5. ***Also notify y***our supervisor, other students, staff, etc.

If you discover a FIRE or similar emergency,

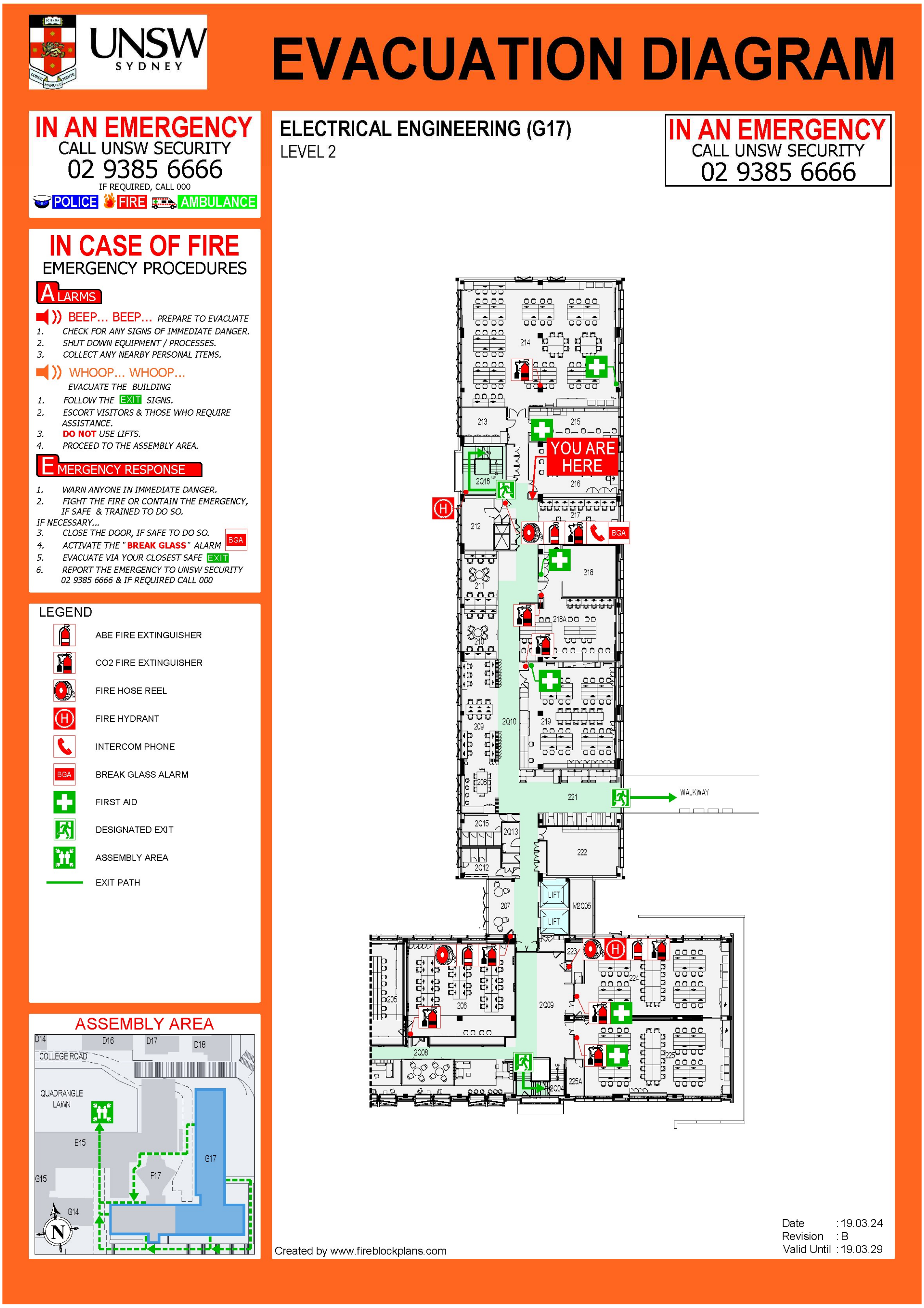
i. ***Activate the fire alarm*** by breaking the glass alarm if the automatic fire alarms haven't triggered. To activate the fire alarm, break the glass and push the switch. Fire alarms are in cabinets with warden intercom points (WIP).
ii. Close doors that may limit the spread of the emergency, but *only if it is safe to do so*.
iii. Notify UNSW Security on extension 56666.
iv. Tackle the situation, but ***only if trained in appropriate emergency procedures***. All laboratories in the Electrical Engineering Building are equipped with CO_2-extinguishers. CO_2-extinguishers and fire hose reels are also located in the corridor foyer areas on every level

Cabinet where break glass fire alarm is located

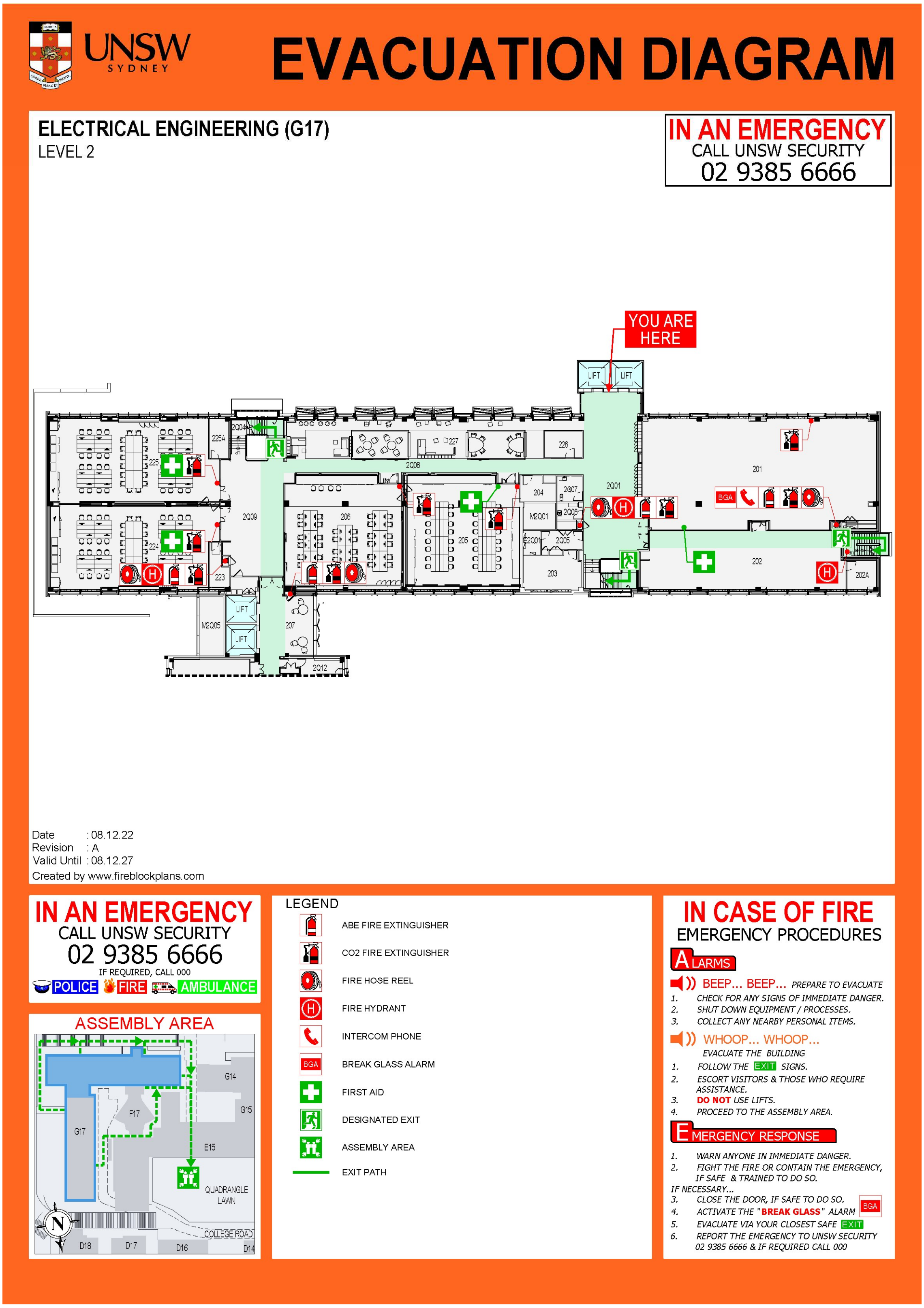
Break glass fire alarm

Be careful. FIRE SPREADS VERY FAST! You don't get much time.

Building Evacuation Diagram North Wing



Building Evacuation Diagram West Wing



In the case of **any ELECTRICAL emergency**, e.g. electrocution or fire, ***disconnect the power***. Each of the electronics laboratories has a wall-mounted, red, emergency stop-button that shuts down all electrical power.

The building also contains asphyxiant (oxygen depriving gases) while these aren't present in the electronic teaching labs they are in the building. If you see the Lab Gas Strobe active, you should **not** enter the room! Vacate the area and inform the laboratory manager.

Laboratory emergency shutdown button

Laboratory gas alarm

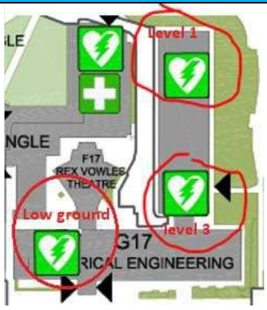
Electrical Engineering Building (Building No: G17)

Emergency Control Organisation

UNSW Emergency Number 9385 6666

Role	Name	Location	Phone
Chief Warden	Zhenyu Liu	Room G15	93855508
Deputy Chief Warden	Roy Zeng	Room G15	93855507
First Aid Officer Level Low Ground	Zoe George	Room LG07	93482295
First Aid Officer Level Low Ground	Samantha Chao	Room LG30	93480711
First Aid Officer Level Ground	Kamballoore K Unnirajan (Unni)	Room G13	93854005
First Aid Officer Level 1	Gabriel Graterol Nisi	Room 120	
First Aid Officer Level 2	Olivia Huang	Room 103	93854001
First Aid Officer Level 2	Jolanta Witkowska	Room 105	93854009
First Aid Officer Level 3	Phil Allen	Room 318/347	93854003
First Aid Officer Level 4	Lucy Chen	Room G15	93855509

Emergency Assembly Area: Quadrangle Lawn

<table>
<tr><th colspan="4">LOCATION OF FIRST AID KITS</th></tr>
<tr><td colspan="2">LG Level: west wing, Nura Gili Office</td><td colspan="2">Ground: G12, G13, G14, G15, G16, G19</td></tr>
<tr><td colspan="2">Level 1: 103,109,111,113,115,116, 119,120</td><td colspan="2">Level 2: 201,205,214,216, 218A, 219, 224,225</td></tr>
<tr><td colspan="2">Level 3: 324,329,332, 337,338, kitchen (near room 320)</td><td colspan="2">Level 4: 401,426,429,429A, 433,436, kitchen (near room 422)</td></tr>
<tr><td colspan="2">Level 5 (Roof): near lift</td><td colspan="2"></td></tr>
<tr><th colspan="4">LOCATION OF AUTOMATIC EMERGENCY DEFBRIBILLATOR (AED)</th></tr>
<tr><td>
</td><td>
</td><td>Nura Gili West Wing (low ground), outside room 113, 323</td><td>
</td></tr>
</table>

Automatic Emergency Defibrillators (AEDs)

Automatic Emergency Defibrillators (AEDs) are portable, life-saving devices designed to treat individuals experiencing sudden cardiac arrest. These devices analyse the heart's rhythm and, if necessary, deliver an electrical shock to help re-establish an effective heartbeat. AEDs are user-friendly, featuring clear voice prompts and visual instructions, which guide even untrained bystanders through the defibrillation process. This accessibility makes AEDs crucial tools in emergency situations, significantly increasing the survival rates of cardiac arrest victims when used promptly. These are located throughout the school. It's important to know the location of these as one of the major risks of electric shocks is cardiac arrests.

5.1 Evacuation

What should you do if the alarm sounds while you are in the Electrical Engineering Building?

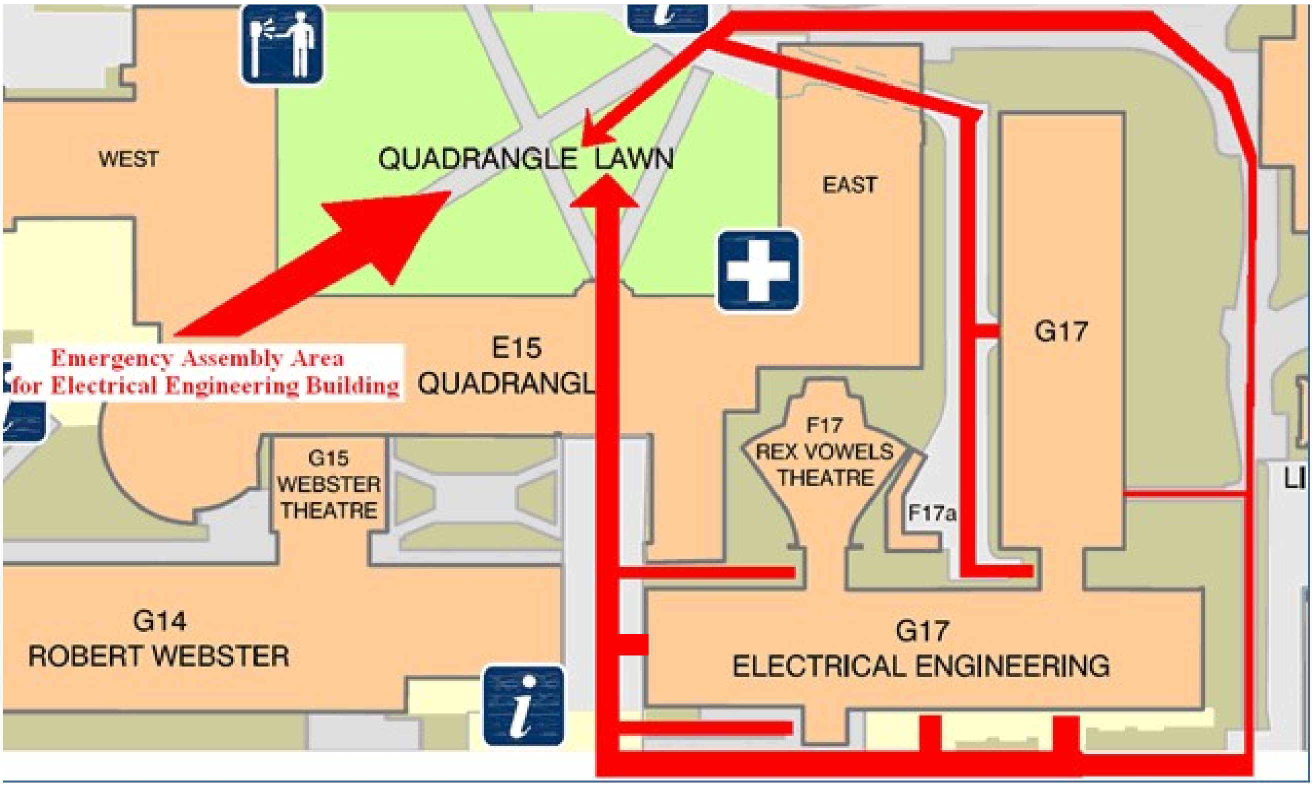
If the alarm sounds as a constant "*beeep-beeep-beeep-beeep*" ***prepare*** to evacuate and follow instructions from any public announcements or emergency team member. Save files, turn off equipment and remain calm.

If the alarm sounds as a rising "*whooop-whooop-whooop-whooop*" ***evacuate the building immediately***. Leave the building via the nearest safe emergency exit. Do not use the lifts. Proceed as directed to the official Evacuation Assembly Area, which is the ***Quadrangle Lawn*** to the west of the building.

Remain in the assembly area until notified by the Emergency Team that it is safe to return to the building.

Always remember:

- Follow all instructions from the Wardens.
- Leave the building by the nearest safe exit.
- Do not delay collecting personal possessions.
- Do not run, push, overtake, etc.
- Do not use the lifts.



5.2 Lockdowns

In the event of an emergency requiring a lockdown, it is crucial to follow these procedures to ensure the safety of all personnel within the laboratory and building. Lockdown situations may arise from various threats, including security breaches, or external threats in the vicinity. Adhering to the following steps will help protect everyone in the lab:

(i) Alert Notification

- Upon receiving a lockdown alert (via PA system, alarm, or other communication channels), immediately cease all lab activities and render equipment to a safe state.
- Notify everyone in the lab of the lockdown status calmly and clearly.

(ii) Secure Entry Points

- Usher those outside the lab into the laboratory if they will become stuck in the hallway
- Close and lock all doors to the laboratory. If doors cannot be locked, barricade them using heavy furniture or equipment.
- Close all windows and blinds or curtains to obscure visibility into the lab.

- Where possible turn off lights to make the lab appear unoccupied.

(iii) Silence Electronic Devices

- Silence all mobile phones and other electronic devices to avoid drawing attention to the lab.
- Refrain from making phone calls unless it is to communicate with emergency services.

(iv) Hide and Remain Silent

- Instruct all personnel to move away from doors and windows and take cover behind sturdy furniture or lab equipment.
- Remain silent and avoid any noise that could reveal your presence.

(v) Stay Informed

- Monitor official communication channels (e.g., email, PA system, text alerts) for updates on the situation.

(vi) Do Not Leave the Safe Area

- Remain in your secure location until an official "all clear" signal is given by authorized personnel (e.g., security, law enforcement).

(vii) Wait for Official Clearance

- Do not leave your secure location until you receive an official notification that the threat has been resolved and it is safe to exit.

5.3 Emergency Procedures

UNSW AUSTRALIA

Emergency on Campus
Call 9385 6666 (ext. 56666)
State your name or zID and location on campus

Never Stand Still | Facilities Management

Fire
- If you see fire or smoke, do not panic or shout
- Remember **RACE**:
  - **R**escue people
  - Raise the **A**larm – use white break glass button
  - **C**ontain fire and smoke – close doors and windows
  - **E**xtinguish only if trained to do so

Medical Emergency
- Call for a first aid officer
- Dial UNSW Emergency and state '**AMBULANCE**' if required
- **Call '000'** (after contacting UNSW Emergency) to obtain direct advice
- Reassure the patient
- **Never** leave the patient alone

Bomb Threat
- If you receive a bomb threat, **do not** use a mobile phone
- Alert others nearby to call UNSW Emergency
- Carefully note details of the threat (location of bomb, accent, background noises)
- **Do not** touch or move any suspicious package

Suspect Package
- **Stop** what you are doing and put the item down or **do not** touch it
- Alert others nearby
- **Do not** use mobile phones as they can trigger an explosion
- Evacuate the area

Power Outage
- Provide assistance to others if necessary
- **Evacuate** if advised to do so
- Make equipment safe that may auto restart
- Treat all electrical equipment as live as power may be restored at any time

Gas Leak
- **Turn off** gas supply if it is safe to do so
- **Activate** the emergency isolation if it is present
- Evacuate the area

Report all emergencies on campus 9385 6666

Chemical Spill
- Is it Minor or Major?
- If Major, **evacuate** area
- If Minor, **evacuate** others, work in pairs and clean up spill as per Safe Work Procedure

Environmental
- An environmental emergency includes any incident, or potential for an incident of uncontrolled discharge of a substance into water, air or land that harms or threatens to harm the environment
- **Alert** others nearby
- Contain the emission if safe

Personal Threat
- Threats to self or others may include harassment, assault, suicide, robbery, self harm or armed hold-ups
- **Do not** take risks
- Observe offender's characteristics and **avoid** eye contact

Natural Disaster
- **Remove** anyone from immediate danger if safe to do so
- **Take shelter** in strongest part of building (such as the basement)
- Keep clear of windows

Evacuation
- **Alert** the floor warden
- Know your Evacuation Assembly Point
- Follow instructions to evacuate
- Exit in a safe and orderly manner
- **Do not** use lifts
- **Do not** re-enter building until authorised
- Follow the direction of Security, Wardens and Emergency Services

Shelter in Place or Lockdown
- Take immediate shelter where you are, such as inside a building
- Keep doors locked
- **Remove** yourself from the immediate threat
- **Never** risk your safety
- Follow the direction of Security, Wardens and Emergency Services

6 Reporting procedures

Safety can only improve if people are active about making it happen. For the safety of oneself and that of others in the building, please report any accidents as soon as possible, to the first aid officers, other responsible persons or on Salus.

6.1 Incidents & hazards & near misses

An *incident* is when someone gets hurt. A *hazard* is something that only threatens safety. A near miss is an event that could have resulted in injury, or damage but did not, either by chance or timely intervention.

Report all incidents and hazards.

Any incidents related to safety can be notified to the School, using either the online reporting system through Salus or safety.unsw.edu.au or discussion with the schools HS Committee's Chair (Dr Torsten Lehmann) or the School's WHS Officer (Zhenyu Liu). It is crucial to maintain a safe environment in our laboratories and throughout the school. Ensure you report the following:

- **Accidents:** Report any accidents that occur, whether to yourself or to others. This includes even minor incidents that may seem harmless at first. Every accident should be documented to ensure appropriate follow-up and prevention measures.
- **Potential Hazards:** If you notice any potential hazards in any activities or places within the school or university, report them immediately. Identifying and addressing hazards early can prevent accidents and injuries.
- **New Safety Concerns:** Notify your supervisor or the designated safety officer about any new safety concerns that arise from new activities or projects. If these concerns have not been addressed before, it is important to bring them to attention promptly to develop appropriate safety measures.

By reporting accidents, potential hazards, and new safety concerns, you contribute to a proactive safety culture and help ensure the well-being of everyone in the school.

UNSW has an online safety reporting and management system called Salus. Salus is the go-to place for all reporting and management of safety concerns, incidents and hazards and relevant risk assessments. It only takes 3 minutes to report a hazard or incident, including the ability to easily upload photos. Incidents can also be reported by going to safety.unsw.edu.au, this has clear instructions on how to report incidents and hazards Salus has a mobile phone app called

Salus Roam which can be downloaded to report incidents, hazards and concerns directly from your phone. Alternatively, a member of staff can complete the report for you. If you are unsure whether something really is a hazard, talk about it.

6.2 Improvements to safety

You can help improve safety by making suggestions and raising your concerns. Improved safety needs a collective effort. Knowledge advances by discussion.

OSRN has developed the following structure for “consultation”:

(i) In the first instance all safety concerns should be raised with your teacher, either the lab demonstrator or the lecturer-in-charge.

(ii) Your undergraduate School Committee Student Representative, namely the current President of ELSOC, who is *ex-officio* a member of the School’s Level 3 Committee.

- Visit ELSOC in room 210, or Email: president@elsoc.net

(iii) Chair of the School's Health & Safety Committee, Dr Torsten Lehmann.

- Email: t.lehmann@unsw.edu.au

(iv) The Health & Safety Advisor Team, who can be contacted for general or anonymous concerns.

- Email: eng.gen.hse@unsw.edu.au

The school recognises its duty to consult with all stakeholders about WHS and the raising and resolution of such concerns. It is committed to providing a safe workplace.

7 Students & UNSW – rights & duties

Every student has the right to work in a safe and healthy environment. Students, in turn, have the obligation to make this possible by following the safety procedures and guidelines set by the school and described in this manual. Failure to follow these regulations may result in personal injury or risking the injury of another. This constitutes ***formal misconduct*** and may involve students being given a warning, expelled from the electronics laboratory and other laboratories, or, in the worst case, being expelled from the University.

The school has the responsibility to provide a safe and healthy environment, in accordance with the NSW Workplace Health and Safety Act (2011). This act requires UNSW, through its procedures, to ensure that safety measures are implemented, and that adequate and necessary steps have been taken to prevent and/or minimize risks or accidents. The school has consultation obligations, and these are fulfilled by the processes outlined in 6.2 above. The regulations further require that the school takes steps to ensure that students are aware of any potential hazards and that the laboratory regulations are followed by both staff and students.

The school has a committee responsible for considering **all safety concerns** raised by anyone. ELSOC's President (or nominee) is, ex-officio, a member to present the students' voice. The Committee's Chair is also available for consultations.

Students, too, have legal obligations, as set by the NSW Workplace Health and Safety Act (2011) which requires you to co-operate with the relevant safety directives of UNSW and not to cause a hazard to others. If you fail to do this and there is a 'reportable' incident – typically someone getting badly hurt – then you may get prosecuted.

7.1 Thesis/project work in laboratories:

In all laboratory activities that are not part of a scheduled class, for example experimental work associated with a thesis, as a student, ***you must complete a risk assessment before starting the experimental work***. The relevant UNSW form (HS017) should be used. This risk assessment form must be given to your supervisor, or to the laboratory supervisor, for approval prior to commencing the experimental work.

In summary, you are responsible for being **safe**, the school's responsibility is to **make this possible**.

8 A preview of some other hazards in EE&T

Beyond the electronics laboratories, our School has many other labs that contain more dangerous hazards. It is essential to stay vigilant and adhere to safety protocols across all environments. ***Always pay attention to warning signs on laboratory doors***, as each lab may have specific hazards requiring additional training and induction.

8.1 General Safety Hazards

- Slippery & Uneven Surfaces:
  - Always be aware of your surroundings and "look where you are going." Report any spills immediately so they can be cleaned up. Also, report any broken or uneven floors and walkways to ensure they are repaired promptly.
- Ergonomics:
  - Prolonged sitting at computers is a common hazard for students. To minimize ergonomic injuries such as repetitive strain injury (RSI), follow advice on proper workstation setup. You can find helpful resources from the WHS website on Hazardous manual tasks and ergonomics.
- Manual Handling:
  - Lifting heavy items is a major source of injury. Learning the correct techniques for lifting is essential for your safety.

8.2 Specific Laboratory Hazards

More detail about the specific hazards and risks associated with a particular laboratory will be covered in the induction for that laboratory or can be found in the RMF for that laboratory. More information on specific laboratory inductions can be found here.

- High Voltage:
  - High voltages can cause severe electrocution and are more likely to cause arcing than the lower voltages encountered in the electronics labs. Refer to Section 4 for detailed information.
- RF Electromagnetic Radiation:

- Used in wireless experiments, radiofrequency electromagnetic waves (including microwaves) can cause deep burns at high intensities. The effects of low-intensity exposure are still under study.

➢ Lasers:

- The Photonics Laboratories use both visible and invisible lasers up to class 4. These are housed in special rooms. Some student projects may involve class 3B lasers, which are not eye safe.

➢ Machinery:

- The machinery labs house motors, wind turbines (fans), and robotic arms. The primary dangers are being caught in or struck by moving parts.

➢ Dangerous Goods & Hazardous Substances:

- Research activities often involve solvents, flammable liquids, compressed gases, and caustic substances. Each chemical's Material Safety Data Sheet (SDS) details the risks and required precautions, including storage and PPE requirements. Proper labelling is critical.

➢ ANFF (Australian National Fabrication Facility):

- ANFF and The Centre for Quantum Computing has its own specialized training and induction programs. For more information you are required to reach out to them.
- By staying informed and following safety protocols, you contribute to a safer learning and working environment for everyone. If you ever encounter any unfamiliar hazards or have safety concerns, always seek guidance from your supervisor or safety officer.

9 Contacts, resources, references & training

You do not need to deal with safety on your own. UNSW is an educational institution and there is a diversity of expertise available. If you have any questions about safety, ***all you need to do is ask*** someone. As a student, in the first instance, this will be your teacher. You have no excuses. Just ask!

9.1 People who can help

- School's Chief Building Warden G17:
  - **Zhenyu Liu**, phone 55508, Rm G15
    - Email: z.liu@unsw.edu.au
- Chair of the School's Health & Safety Committee:
  - **Dr Torsten Lehmann**
    - Email: t.lehmann@unsw.edu.au
- Faculty Health and Safety Advisor Team:
  - Who can be contacted for general or anonymous concerns, within the school or the wider faculty.
    - Email: eng.gen.hse@unsw.edu.au

9.2 Web-based resources

The School's WHS webpages are the first place to look for EET-related policies and information. This provides detailed information about the school's processes as well as some guidance about working safely.

https://www.unsw.edu.au/engineering/our-schools/electrical-engineering-telecommunications/about-us/workplace-health-safety

The **UNSW Safety Unit** provides a wealth of information on safety related topics, as well as legislative requirements. Please refer to this link: safety.unsw.edu.au for more information.

Standards Australia publishes many standards about safety - 1008 standards have "safety" in the title. Three of relevance to this document are

- AS/NZS2243 Safety in laboratories series
- AS/NZS3000 Electrical installations
- AS/NZS3859 Effects of current passing through the human body.

You are encouraged to check out the standards relating to electrical safety. The standards can be accessed through the university's subscription to TechStreet, you can use this link here or search 'Australian Standards' through the online library.

9.3 Reference books

J. Cadick (1994), *Electrical Safety Handbook*, McGraw-Hill, Inc., USA

T. Kletz (2001), *An Engineer's View of Human Error*, 3rd edn, Inst Chem Eng, Rugby (UK)

9.4 Training

You might be interested in the following training courses.

- ***Laboratory Safety Awareness***.
    - This introduces procedures for working with "nasties." You can enroll for this on-line, via myUNSW.
- ***Green Lab***.
    - This discusses waste disposal procedures. You can enroll for this on-line, via myUNSW.

Additionally, you should give serious consideration to completing a ***First Aid*** course. Once upon a time it was a requirement to graduate with a BE, illustrating the emphasis the profession places on safety.

"One reason we are less happy with software solutions [i.e. methods of working, training, instructing, etc.] is that continual effort - what I call grey hairs - is needed to prevent them disappearing. If a hazard can be removed or controlled by modifying the hardware or installing extra hardware, we may have to fight to get the money, but once we get it and the equipment is modified or installed it is unlikely to disappear.

"In contrast, if a hazard is controlled by modifying a procedure or introducing extra training, we may have less difficulty getting approval, but the new procedure or training program may vanish without trace in a few months once we lose interest. Procedures are subject to a form of corrosion more rapid and thorough than that which affects the steelwork. Procedures lapse, trainers leave and are not replaced. A continuous management effort - grey hairs - is needed to maintain our system. No wonder we prefer safety by design whenever it is possible and economic; unfortunately, it is not always possible and economic.

"Furthermore, when we do go for safety by design, the new equipment may have to be tested and maintained. It is easy to install new equipment – all you must do is persuade someone to provide the money. You will get more grey hairs seeing that the equipment is tested and maintained, and that people are trained to use it properly and do not try to disarm it."

- Kletz (2001)