UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha

Department of Chemical and Process Engineering

CAPE Induction and Health and Safety Manual

Version	Date	Author
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Section 1:

Introduction

The goals of this document are to help you:

- Go home each day unharmed and avoid hurting those around you.
- Prevent damage occurring to the natural environment.
- Ensure your work and your actions comply with all relevant University and New Zealand health and safety regulations.

This laboratory safety induction manual will act as a supplemental resource to the in-person laboratory induction process.

This document covers CAPE-specific safety information and rules, and guidelines are valid for all lab users (student, staff, visitors).
For general University information regarding emergency response, please read http://www.canterbury.ac.nz/emergency/ or the flip charts displayed in various locations.

If you have any concerns or questions about safety in the Department, please contact your supervisor, the Safety Officer, or the Head of Department.

Figure 1 – The structure of the Safety Management System in the Department of Chemical & Process Engineering

Induction

- College staff/student safety induction
- CAPE Safety manual
- ENCH495 Safety Briefing & lab induction
- ‘Experimenting with Disaster’ video
- Training to use specific safety processes
  - Fume cupboard, spill kit, labelling, chemical disposal
- Training to use custom apparatus
- Contractor inductions

Risk Identification & Minimisation

- Hazard and Risk Checklist
- Job conferences
- Discussions with supervisor about specific safety issues and/or past relevant safety events
- Review of chemical/biological hazards with appropriate technician

Operations

- Day-to-day practices
  - Hand washing, disinfection, housekeeping, Get Home Safe App
- Proper use of safety gear
  - Eye protection, lab coat, gloves, fume cupboard, etc
- Safety culture
  - Offering safety advice to colleagues
  - Improving safety systems

Review

- CAPE Safety Quiz
- Monthly safety tour, College/University safety programmes
- Incident/near-miss/unsafe situation reports

Figure 2 – Components of the CAPE Safety Management Plan

Section 2:
Laboratory Management

General:

University of Canterbury staff who have management responsibilities for the laboratory facilities themselves or for personnel working in laboratories (including students), are responsible for ensuring that the environment operating under their control creates a safe and legally compliant workspace for all users.

Key elements of the CAPE laboratory management structure, including tasks and responsibilities associated with each of these elements are described in the sections below.

Authorised Laboratory Users:

Authorised laboratory users are personnel who are trained and authorised to carry out approved research or teaching work in designated laboratory areas.

Authorised laboratory users are required to comply with all CAPE laboratory rules, instructions and training provided by the Laboratory Managers, their supervisors, or the Department Safety Officer in relation to laboratory health and safety.

Authorised laboratory users are also required to report any health and safety incidents or near misses to these personnel.

Laboratory Managers:

Laboratory managers are appointed to oversee and monitor day-to-day operation of the CAPE laboratories. Key responsibilities include:

- Ensuring that both they and all other lab users comply with any instructions or training in relation to the management of laboratory health and safety (including hazardous substances)
- Providing details and information on hazardous substances for the purpose of maintaining chemical inventories or managing specific high-risk substances.
- Notifying the health and safety officer of any general or hazardous substance related laboratory health and safety issues, including incidences or near misses that may have occurred.
- Notifying the health and safety officer of any high-risk procedures and helping create/signing off on appropriate documented risk assessments for such procedures as required.
- Coordinates the laboratory chemical waste disposal service.

Health and Safety Officer:

The Health and Safety Officer performs the following key functions:

- Provides advice, training and support to the laboratory managers and authorised lab users.
- Monitors compliance with the requirements of this manual through internal audits (walk-throughs), and investigations of incidences. All significant non-conformances are reported to the Head of Department
- Communicates information on health and safety legislation and policy changes and requirements to laboratory managers.
- Assists with the development of policies, procedures, and resources to support laboratory health and safety.

Health and Safety and Wellbeing Committee:

The CAPE Health and Safety and Wellbeing Committee is made of technical, academic and administrative staff as well as student representatives. The committee is responsible for the approval of proposed policies and procedures, or amendments to current policies and procedures. The committee will also assess the close out of internal audits (safety walk through) actions and address any reported incidences from the previous month.

CAPE Health and Safety Representatives:

Health and Safety Representees will be nominated and selected to represent the CAPE staff and students. These people are elected to represent the members of their work/student group on all department health and safety matters at department health and safety meetings.

Health and Safety representatives play an important role in keeping workplaces healthy and safe, as well as advocating for the wellbeing of their colleagues. These representatives provide a voice for staff and students who otherwise might not speak up.

CAPE Technical Staff:

In addition to your supervisor, CAPE technical staff are an excellent source of information and advice to identify hazards and minimise risks.

If you have any questions about information or procedures in this document or have any concerns about the safety of your experiments, please don't hesitate to approach them.

Details for the CAPE Technical Staff can be found at the CAPE website.

Section 3:
CAPE General Safety Rules Summary

(This is a **brief summary**; lab users are required to read the appropriate section for additional details)

Personal Protective Equipment:

All lab users must always wear the following:

- Safety Glasses
- Covered shoes (no jandals, open-toed shoes or bare feet)
- Lab coat
- Additional PPE may be required based on your risk assessment.

Chemical Handling:

- For each chemical, the lab user must assess the risk for fire, reactivity, and toxicity. This includes when the chemical is transported, prepared, used, and disposed.
- Eating or drinking in laboratories or workshops is always prohibited.
- All containers/beakers/vials etc. must be labelled when unattended, listing owner, date & contents.
- No chemical may be removed from the University without approval.
- Dispose of waste or excess chemicals properly; seek advice.

Hazard & Risk Checklist:

- A Hazard & Risk Checklist is required for all new experiments or new users of equipment for all students and staff. Exceptions are outlined in the Hazard and Risk Checklist section.

- Working alone at night or on the weekend increases the consequences from an accident. Review this requirement regularly with your supervisor, if necessary.

Emergency Response / Security:

- Be aware of how to handle an emergency in your lab including evacuation and the location of eye wash stations, drench showers and fire extinguishers.
- For emergency assistance, call Security at 0800 823 637 from a cell phone. Or 92111 from lab phone
- For non-emergency security advice call (03) 369 2888
- Do not allow unknown people into the Department after-hours. They must use their own swipe card. Report any suspicious behaviour to Security.

Electrical Safety:

All electrically powered equipment requires a valid electrical certification prior to use, including temporary equipment brought in from outside the Department.

- No safety devices (e.g., alarms, relief valves, etc.) may be disabled by users.
- All equipment removed from the Department must be registered with the Tech. Services Manager.

Biological Work:

- Work with all non-native biological material must comply with Ministry of Primary Industries (MPI) regulations.
- All researchers entering PC2 labs must receive approved training prior to entry or be supervised.

Access:

Access to CAPE labs is for authorised persons only. Doors should not be blocked open when unattended.

Compliance / Penalty Policy:

Not following the policies outlined in this manual will lead to performance reviews and can lead to penalties.

COVID-19

Any changes to CAPE safety procedures related to COVID management will be communicated directly via email and the website.

Conditions impacting safety:

Should you have a medical condition or a situation which could affect your health or safety in the department, please speak to the H&S team or your supervisor.

Magnets:

Please note we have two powerful magnets in lab 205 on the North Bench. If you have a heart pacemaker, please inform the lab managers. The use of metal tools in close proximity with these instruments should be avoided.

Mechanical Workshop:

The mechanical workshop is located on level 1 of the CAPE wing. It is not permitted to be in the mechanical workshop without supervision from a technician.

Section 4:
Reporting Via Assura

Reporting for safety incidents, near misses, safety observations and all field trip work is completed through Assura.

Safety Incidents and Near Misses:

Near misses and incidents, which are collectively called "events", will happen in the Department. It is important that they be reported for continuous improvement of Department processes.

Near Misses –Events where something *almost* goes wrong, from as minor as slipping on spilled coffee in the stairwell, to a tool falling from above when someone was not wearing a hard hat, up to a reactor blowing up, but no one is injured. Reporting these lets the Department make changes or warn people to stop a similar event from causing an injury in the future, as appropriate.

Minor Accidents – Usually involve a minor injury or a non-trivial chemical spill or release. In regard to injuries, it is things like a minor burn or cut which do not involve a visit to the doctor's office. For releases, an example would be a spill of a chemical that requires special resources to clean up like a spill kit. Like near misses, patterns of minor accidents sometimes mean changes or possibly improved training is required to stop other people from receiving the same injury. Often there are lessons to be learned from this type of an event and changes made to keep it from happening in the future. Reporting these is very important.

- All minor accidents or near-miss incidents must be reported to the Safety Officer with a report submitted on Assura as soon as possible.

Serious Accidents – An event, where someone receives a serious injury that requires medical assistance, must be reported immediately. It is possible that the event may qualify as notifiable under the Health and Safety in Employment Act, which means that WorkSafe must investigate. In this type of event, once the person involved is moved to a position of safety and the situation is not at risk of escalating (e.g., fire, major spill of flammable chemical etc.) the area must be cordoned off and not modified, as an investigation may be required. A "serious harm" accident must be reported immediately to the Safety Officer or the HoD, and to the Director of Health and Safety.

Safety Observations:

You may also observe a risk, hazard or positive safety experience. Reporting unsafe practice, conditions or incidents is not about blaming or 'telling on' your colleagues. We need to know so we can ensure everyone's safety and learn from our mistakes.

Safety observations - Where there is the potential for harm, or an idea/action that could or does prevent harm. Examples include: unsafe practice, unsafe conditions, or suggestions. This should also be used for raising examples of good safety practice. Find more explanations at Report an Incident at UC | University of Canterbury

To report an event or safety observation, log on to Assura and register the event as soon as practicable.

Field Work:

Field can be planned and managed via Assura. More on managing field work via Assura can be found here.

Section 5:
Personal Protective Equipment and Additional Safety Devices

Personal protective equipment (PPE) is used to reduce the risk of working with hazardous chemicals and equipment.

The minimum PPE that must be worn by all lab users at all times while in the labs include safety glasses, lab coat and covered shoes.

Details about these specific requirements are outlined below. Other safety gear may be required for specific situations. Researchers and their supervisors need to continually assess the need for additional PPE.

Eye Protection:

		
Safety Glasses	**Safety Goggles**	**Face Shield**

- **Basic Policy** – Safety glasses will be worn by all staff, students and visitors in all CAPE laboratories and workshops **at all times**.
- **Safety Glasses MUST be worn at all times in the following locations/situations:**
  - All CAPE laboratories and mechanical workshops.
  - Safety glasses may be temporarily removed for very specific tasks like using a microscope, but care must be taken to put them back on when the task is completed.

Offices and briefing rooms are exempt from this requirement. Other work areas may be designated as exempt from the safety glass requirement upon approval of the Safety Committee.

When working outside the Department in a controlled setting, then CAPE's eye glass policy should be followed but an exemption can be requested. Field work in an uncontrolled setting falls under the University Protocol "University Field Activities" which should be referred to prior to the activity.

- **Goals**
  1. Improve eye protection.
  2. Raise safety awareness in the laboratory and workshops.
  3. Have an eyeglass policy that is consistent between undergraduate labs and research labs and a policy that is consistent with similar laboratories in New Zealand.
- **Eye Protection Specification**
  - The minimum requirement is close fitting, impact resistant glasses with side shields.

- If working in a fume cupboard with the sash lowered to the correct height, then safety glasses are acceptable when working with corrosives.
- **Chemical goggles must be worn when working with corrosive materials**.

  Examples of where chemical goggles must be worn include:

  - Aqueous solutions below pH 2 or above pH 11.5.
  - When pH is not a sufficient indicator, a mixture is classified as a corrosive and goggles are required if the solution contains more than 3% by weight of corrosive chemicals (HSNO classification 8.3A: eye corrosive).
  - When working with larger volumes or higher temperatures with corrosives, a face shield may be more appropriate. Seek advice from the lab manager or your supervisor.
- **A face shield must be worn when handling or working with liquid nitrogen**.

Safety goggles are available from the PPE supply in each of the labs. Please contact the laboratory managers if you cannot locate these.

The hazard and risk checklist associated with a researcher's orange card should explicitly state where safety goggles are required in the place of safety glasses.

- **Obtaining safety glasses –** One pair of high quality, non-prescription safety glasses will be provided to all staff, students, interns, and visitors staying for a significant time period. Temporary visitor glasses are also mounted outside most labs in the Department.
- **Prescriptive Safety Glasses:**

  Option 1 – Safety glasses that are designed to fit over prescription glasses are available. This is the most appropriate option for undergraduate students.

  Option 2 – Prescription safety glasses can be obtained from any eyeglass retailer.

  - The Department will cover the cost of prescription safety glasses (not the prescription itself) for all full-time, continuing staff members spending considerable time in the laboratories. Approval of the HoD or manager is required before purchasing. Staff should use their P-card for purchases. Some staff may be eligible for prescription reimbursement under the University computer usage policy.
  - The Department may subsidise the cost for other staff and students towards the purchase of prescription safety glasses. The amount will depend on the proportion of full-time employment, time left in PhD study, etc. In the first instance approach your supervisor.

Lab Clothing Protocol:

- **Lab Coats -** Anyone actively working in a lab is required to wear a lab coat. This is to ensure protection of people and their clothing, as well as to create a professional image and awareness that labs are hazard containing environments.
  - **Lab coats or other protective clothing should never be worn outside of a lab**, because there is a risk of carrying a dangerous substance out of the lab.
  - Lab coats must not be worn in areas where food is consumed.
  - Lab coats can move between labs but not to offices.
  - Visitors to the labs are not required to wear lab coats.

- Dirty lab coats should be taken to the storeroom technician for cleaning. **Never take dirty lab coats home.**

- **Shoes** – Sturdy, closed toed shoes must be worn in the lab at all times.
  - Jandals (flipflops) or dress shoes where the top of the foot is exposed are not permitted. Pay attention to the sole of your shoes, some shoes have very slippery soles and could be a slip hazard in the labs.
  - Bare feet are never allowed in any labs or hallways adjacent to labs. The only exception is the Design Office.
  - For some projects sturdier footwear may be required, such as puncture resistant soles or steel-capped boots. This would be if you are regularly moving very heavy things or working around a lot of dropped nails or screws. If this is the case, discuss with your supervisor.
  - Anyone using hot materials, or very corrosive liquids, should be dressed so that these materials cannot get inside footwear. Footwear with solid tops and spats can be appropriate.
- **Long Pants** – Long pants must be worn when handling liquid nitrogen or working with steam.
- **Hair Restraint** – All long hair should be tied back when entering the lab, to prevent it from falling into solution or vessels or become entangled in rotating equipment[1].
- **Dangling Jewellery, Ties and Loose-Fitting Clothing** – Low hanging jewellery, neck ties and loose-fitting clothing should not be worn in the labs or workshops. Loose items can fall into vessels or become entangled in rotating equipment.
- **Gloves –** Wear the appropriate gloves for the appropriate activity to avoid contamination.
  - Disposable nitrile gloves are available to keep your hands from being exposed to chemical or biological material or just general cleanliness. These are readily available throughout all labs.
  - Long cuff nitrile gloves are available where acutely toxic dermal (6.1 A or 6.1B dermal) substances are being handled. These gloves are thicker and provide extra protection from these acutely toxic substances which are harmful via the dermal route. The need for these gloves will be assessed on the hazard and risk check sheet by the lab manager. The lab manager will issue you with a box of long cuff nitrile gloves where applicable.
  - A common error of lab users is to leave "dirty" gloves on while handling common equipment such as microscopes, sinks, door handles or phones. Whatever is on your gloves is transferred to the surface you are touching. Please regularly throw gloves away before touching these objects.
  - Remember normal disposable gloves can be quite permeable to some organic chemicals. **Please seek advice about the best glove choice when using organics[2].**

[1] http://www.nytimes.com/2011/04/14/nyregion/yale-student-dies-in-machine-shop-accident.html
[2] **Assurance.pdf (ufl.edu)**

- Heavy duty long rubber gloves are more appropriate for working with large volumes of corrosive chemicals or cleaning applications. These are available in the designated PPE areas in each of the labs.
- Hot mitts are available for working hot items associated with ovens, furnaces, and hot plates. These are available in the designated PPE areas in each of the labs.
- Cryogenic gloves must be worn when working with liquid nitrogen. These are located next to the liquid nitrogen dewars in the lab.

Personal Articles*:*

Where reasonable personal articles (e.g., backpacks, jackets, etc…) should not be brought into the lab. If personal items are in the lab they must be on your person or stored in a way, that they will not be exposed to hazardous chemicals. Backpacks and coats must be hung on hooks, not placed on surfaces.

Ear Protection:

Ear protection must be worn in noisy environments. Working in a noisy environment, even for a short period, can cause hearing loss that may become permanent over time. Health monitoring is available for those working in environments that are inherently noisy.

- Common examples of noisy equipment in CAPE include (but is not limited to) compressors, blowers and pumps. The mechanical workshop also has a number of noisy devices (saws, drills, metal cutting). When working in these situations, please use the ears muffs available in the department. Please see the Safety Officer or the Purchasing Officer to obtain these. However, be aware ear protection can increase your risk by not being able to hear what is going on around you (see next paragraph).

The use of headphones/ear buds to listen to music can potentially increase your risk in a lab environment. The volume must be low enough so you can hear what is going on around you (people, uncommon noises, alarms, etc.). **Noise cancelling headphones must not be worn in a normal lab environment**. Some activities may require that no headphones are permitted. If you have any questions, please discuss with the lab manger or the Safety Officer.

Hard Hats:

When working in areas where people may be working above you, hard hats are required. An example being the gasifier. In these circumstances, hard hats are required. In some cases, temporary cordon ropes may be required to exclude people from hard hat areas.

Hand Washing:

Washing your hands after lab work is considered best practice.

Should you have a medical condition or be in a situation which requires you to need additional or specialised PPE, please speak with your supervisor, and one of the lab managers or the safety officer to establish a plan to make you time in the lab comfortable and enjoyable.

Additional Safety Devices:

Fume Hood:

Whenever a task may release hazardous fumes, it should be done in a fume hood. If you require a fume hood, please discuss your needs with the Safety Officer or the lab manager.

Due to the high demand of fume hoods throughout the department, once your task is complete – and especially when others are waiting to do their experiments – please clear your equipment out of the way, and ensure all chemicals are properly stored.

Any unlabelled experiments/equipment (without name & contact details) can be removed from a fume cupboard without notification. **Chemicals are not to be stored in the fume cupboards**.

Emergency Eye Wash Stations/Drench Showers:
Locate the nearest ones to your work area. You want to be able to find one quickly when you need it. Please ensure access to these is not blocked.

Risk Reduction (Active Devices):

These are devices unique to each apparatus designed to minimise the risk of getting hurt. The important thing is they must not be ignored, modified, or bypassed to eliminate their action and if done would be considered a serious breach of College and Department safety rules. If a risk reduction device is broken or hindering operation, report it immediately.

Common examples of devices include:

- *Pressure Relief Valve* – if you notice a valve leaking or if it has corrosion notify the safety officer.
- *Power Outlet Cut-Out in Fume Hoods* – if the fan fails in a fume cupboard, most are designed so that the power outlet is de-energised. It is important not to use power outlets outside a fume cupboard to power equipment inside the cupboard.
- *High Temperature Shut-Off Switches* – common on ovens and temperature controllers. It is important they are set to an appropriate temperature.
- *Hand/Hair Guards* – Devices with rotating shafts or cutting blades often have guards in place to protect hands and to keep long hair from being entangled causing scalping or strangulation. Do not operate equipment with a guard missing.
- *Gas Alarms* - CAPE has a variety of gas alarms to indicate gas leak. These include personal, local and a central alarm system in 205 These include: Carbon Monoxide (CO), Carbon Dioxide (CO2), Lower explosion limit (LEL), Oxygen Depletion (O2), Hydrogen Sulphide (H2S), Ammonia (NH3) and Chlorine (Cl2). If you are working in a space with gas alarms, please familiarise yourself with the local emergency response plan, which includes evacuation.

Malfunctioning Safety Devices:

Occasionally alarms and automatic shut-off devices trip in error or because of how a piece of gear is being used. It is not permitted to disable a safety device without approval of the Safety Officer. Any modified equipment must be appropriately labelled with the Safety Officer's signature.

Function Review:

Active safety devices will normally have to be checked periodically to confirm function. These devices will have a tag with a date. If the tag is out-of-date, the main apparatus cannot be operated. Seek advice on getting the active safety device checked. Confirmation of active device function review is part of the Hazard and Risk Checklist.

Fire **E**xtinguishers**:**

The Department has fire extinguishers located in a number of locations. Find the nearest one to your work area. In the event of a fire, they can be used if you feel safe doing so. Please note that different types of fires require different types of extinguishers (paper, oil, electrical, etc.). Please confirm you are using the correct type of extinguisher.

First Aid Kits:

The Department has first aid kits in a number of locations. If you find some item is missing or understocked, please contact Glenn Wilson. If your accident is more serious, please seek medical aid immediately. An event report should be filled out on Assura.

Section 6:
Chemical Handling

For each chemical that will be used, a researcher must assess the risks associated with the chemicals in their experiment at all the relevant conditions. This includes handling the chemicals at all stages, mixtures, varying process conditions and disposal, and what actions should be taken in the event of a spill or environmental release.

Safety Data Sheets:

A safety data sheet (SDS) can be a great source of information for guidance on how to handle, store and dispose of a particular chemical. An SDS is comprised of 16 different sections, which detail the following information:

Section 1) Identification

Section 2) Hazard(s) Identification

Section 3) Composition/Information of Ingredients

Section 4) First Aid Measures

Section 5) Fire Fighting Measures

Section 6) Accidental Release Measures

Section 7) Handling and Storage

Section 8) Exposure Control/Personal Protection

Section 9) Physical and Chemical Properties

Section 10) Stability and Reactivity

Section 11) Toxicology Information

Section 12) Ecological Information

Section 13) Disposal Considerations

Section 14) Transport Information

Section 15) Regulatory Information

Section 16) Other Information

Databases for obtaining safety information (SDS's) about the pure chemicals are available on the CAPE Health & Safety website. The best database to start with is ChemWatch, which can be accessed via the 'CAPE Safety Page' on Learn.

The default option of the mini-SDS is the minimum requirement to be printed out in hardcopy for each chemical used in a laboratory. The expectation is that this is read and understood before working with each chemical. There are folders for the SDS available from the Safety Officer. Place the SDS folder in the rack outside the laboratory where you are working.

SDSs are also readily available on the web from suppliers. An SDS is commonly written for industrial quantities, so the information in relation to handling and spills normally reflects these large quantities.

Hazard Classification and Identification:

Chemical hazards are extensive and include flammability, corrosiveness, reactivity, human toxicity and ecotoxicity. This information would be present in section 2 of the chemical's SDS.

In New Zealand, there are three systems to categorise chemical hazards.

1. The first system is the **ChemWatch Hazard Rating** system. ChemWatch, the database the University of Canterbury employs for SDS generation, breaks hazards into five different categories and ranks them 0-4, with 4 being the highest hazard. The five hazard classes include:
    - Flammability
    - Toxicity – internal contact, inhalation, or swallowing.
    - Body contact – body contact or skin or eye contact
    - Reactivity – leading to fire or explosion.
    - Chronic – long term health effects.

These ratings can be found in Section 2 of ChemWatch Gold SDS for the specific chemical. The hazard rating for methane is shown in (Fig. 3).

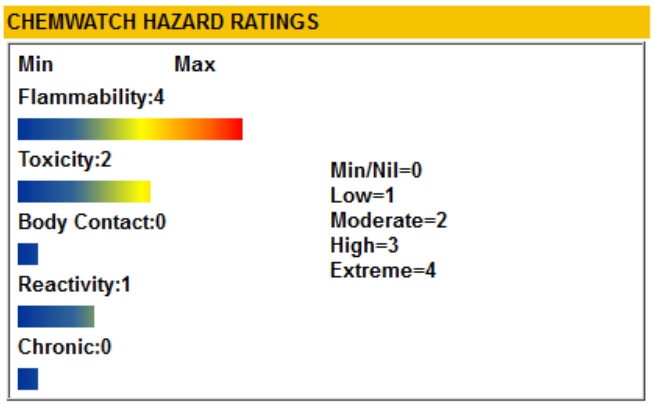


Figure 3 – ChemWatch Hazard Ratings for Methane.

In some instances, the ChemWatch Hazard Rating Data may not appear on the Gold SDS when opened. In such cases, the advanced setting must be accessed, and "ChemWatch Hazard Rating" must be applied. The setting should then be saved, and the SDS will update to show the ChemWatch hazard rating data.

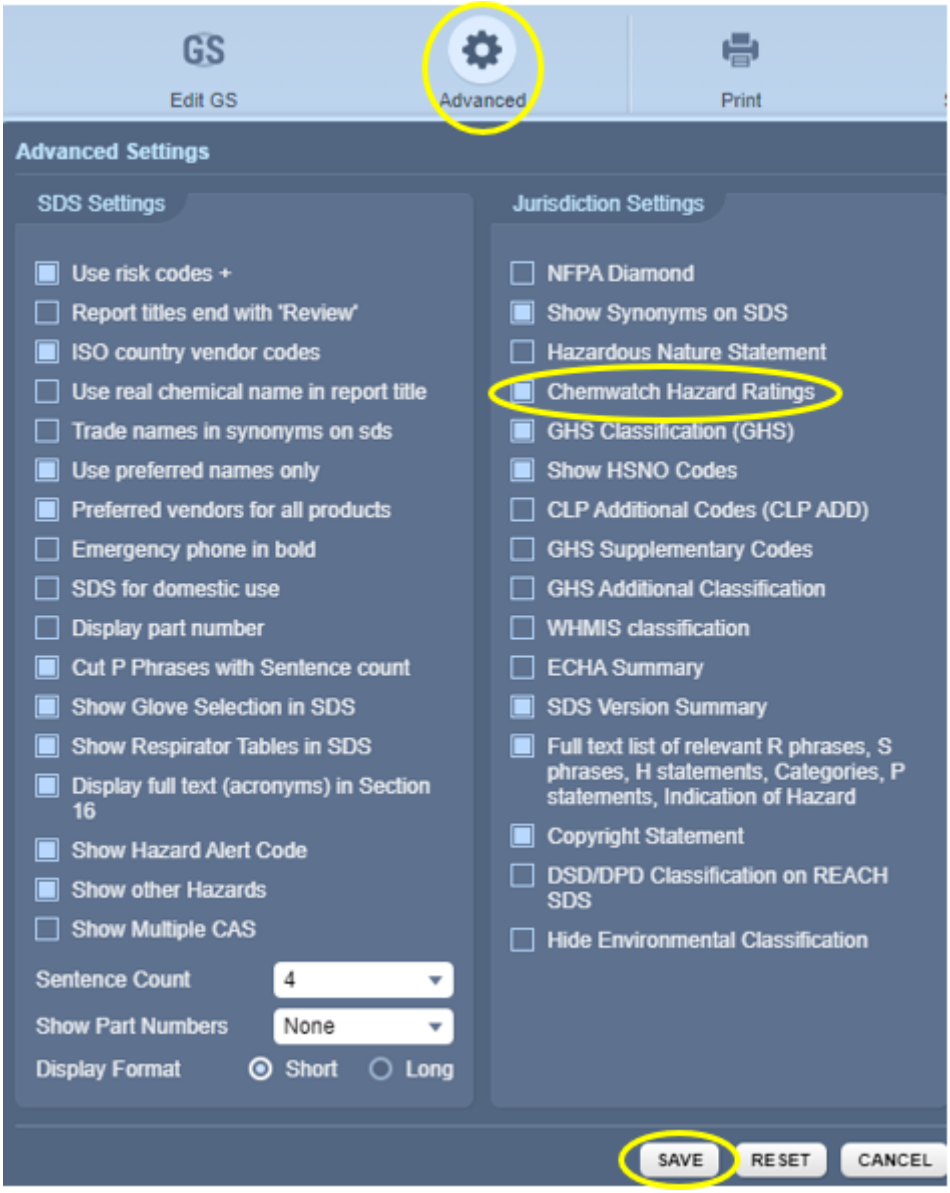


Figure 4 – Advanced Setting Options for ChemWatch to Enable ChemWatch Hazard Rating

2. The second, more detailed, system of hazard classification and identification, as regulated by NZ Environmental Protection Authority (NZ EPA) under the Hazardous Substance and New Organism Act (**HSNO**), categorises chemical hazards into nine different classes (based on a United Nations system). The most common categories are listed in Table 1. Most of the classes have sub-classes to group similar compounds.

Table 1 – HSNO Chemical Classes

HSNO Class Number	Description
1	Unstable Explosive
2	Flammable Gas/Aerosol
3	Flammable Liquid
4	Flammable Solid/Self-Reactive Substances
5	Oxidisers
6	Human Toxicity
8	Corrosive
9	Toxic to Aquatic Life

*Full details of the different classifications are available here[3].

Within a specific class/subclass, a letter system is used to signify the degree of hazard, with "A" being the most hazardous.

For example: *In Class 3.1 (Flammable Liquids), diethyl ether (3.1A) is a more flammable liquid than ethanol (3.1B) based on the flashpoint temperatures and boiling points.*

Some classes have only one degree of hazard. For example, any chemical considered corrosive to the eye has a rating of 8.3A, there is no lower hazard rating.

For acutely toxic substances (i.e., 6.1A, B and C), it is important to include the route of exposure in the hazard classification. The route of exposure can be dermal, oral or inhalation. This information is important as it will help you to assess what PPE is required when handling such substances.

A chemical may have multiple hazard classifications. For example: *Chromium oxide has the following classifications 5.1B, 6.1B, 6.5A, 6.5B, 6.6A, 6.7A, 6.8A, 6.9A, 8.1A, 8.2B, 8.3A, 9.1A, 9.2B, 9.3B as it is an oxidant, toxic, corrosive and ecotoxic*.

3. The third system is known as the **Globally Harmonised System (GHS)**.

   GHS is an internationally agreed system of classification and labelling of chemicals, which was developed under the guidance of the United Nations. The purpose of the GHS was to replace the assortment of hazardous material classification and labelling schemes previously used around the world. It is intended to cover all hazardous chemical substances, dilute solutions, and mixtures, address how labels and SDS should be used to convey information about their hazards, and how to protect people from adverse effects. GHS uses hazard codes, hazard statements and hazard pictograms to communicate hazard classification information. New Zealand follows the guidelines set forth in GHS 7.

[3] thresholds-classification-guidance.pdf (epa.govt.nz)

As mentioned, under the NZ EPA HSNO system there are 9 discrete hazard classes. Under the GHS system this is broken down further into 34 different **hazard classifications**:

Acute toxicity, dermal

Acute toxicity, inhalation

Acute toxicity, oral

Aerosols

Aspiration hazard

Carcinogenicity

Chemicals under pressure

Corrosive to Metals

Desensitized explosives

Explosives

Flammable gases

Flammable liquids

Flammable solids

Gases under pressure

Germ cell mutagenicity

Hazardous to the aquatic environment, acute hazard

Hazardous to the aquatic environment, long-term hazard

Hazardous to the ozone layer

Oxidizing gases

Oxidizing liquids

Oxidizing solids

Pyrophoric liquids

Pyrophoric solids

Reproductive toxicity

Reproductive toxicity, effects on or via lactation

Self-heating substances and mixtures

Self-reactive substances and mixtures; Organic peroxides

Sensitization, respiratory

Sensitization, Skin

Serious eye damage/eye irritation

Skin corrosion/irritation

Specific target organ toxicity, repeated exposure

Specific target organ toxicity, single exposure

Specific target organ toxicity, single exposure; Narcotic effects

Specific target organ toxicity, single exposure; Respiratory tract irritation

Substances and mixtures which in contact with water, emit flammable gases

The **category** is the ranking of the hazard class. Several different terms are used, such as type, category, division, or 'other'. Ultimately, the lower the numerical value the higher the risk.

For example*: Flammable liquid or vapour.*

Category 1: Extremely flammable liquid or vapour

Category 2: Highly flammable liquid or vapour

Category 3: Flammable liquid or vapour

Category 4: Combustible liquid

The GHS has nine different hazard **pictograms**. These pictorially display the hazard(s) associated with a material.

Table 2 – GHS Pictograms

GHS Pictograms and Definitions are detailed below:

GHS01		Explosives, self-reactive substances, organic peroxides
GHS02		Flammable, pyrophoric, self-heating substances; water reactive
GHS03		Oxidising Substance
GHS04		Compressed liquified or dissolved gasses
GHS05		Corrosive, skin damage, eye damage
GHS06		Acute toxicity via oral, dermal or inhalation
GHS07		May cause immediate health effect – skin, eye, respiratory
GHS08		Aspiratory or respiratory hazard, carcinogenicity, mutagenicity
GHS09		Hazardous to the environment

The **hazard and precautionary statements** are those adopted by the GHS to describe health effects. These statements apply internationally. The hazard phrase replaces the old R phrase e.g., H200: Unstable explosive.

Often more than one H phrase and P phrase is employed. The H and P phrases of a substance can be found in section 2 of an SDS.

General Rules for Handling Hazardous Materials:

All experiments must be designed and carried out to minimise hazardous chemical exposure. If hazardous material must be used, care must be taken, and appropriate procedures followed.

All Hazardous Chemicals

- Eating and drinking in laboratories and workshops is prohibited at all times. This includes water bottles.
- Substitution of hazardous chemicals for less hazardous chemicals should be carried out wherever practical.
- Design experiments to use the minimum amount of hazardous chemical required.
- Always close containers when not in use.
- Minimize the surface area of open containers e.g., use a flask instead of a beaker for a flammable chemical if possible as this minimises the dispersal of flammable vapours.
- Clean up all spills immediately.
- Consider reactive or heat of mixing hazards when mixing chemicals either as part of an experiment or accumulating wastes.
- Use additional personal protective equipment beyond the minimum (safety glasses and lab jacket) if required.
- Some people are particularly sensitive to certain chemicals. If you notice any adverse and unexpected reactions after handling a chemical (light headedness, extreme headache, skin rash, etc.), please stop work immediately and consult with the Safety Officer.

Liquids:

- Never pipette by mouth; use a bulb or syringe pipette.
- Goggles or a face shield must be worn when working with corrosive material.
- Work with hazardous volatile liquids in fume cupboards whenever possible.
- Review and eliminate where possible potential ignition sources (motors, switches, open flames) when working with larger quantities of flammable liquids (> 50 ml).
- Do not overfill liquid bottles. Fill only to the shoulder of the bottle to avoid liquid expansion breaking the bottle when warm.
- The heating of an oil bath with a hot plate or other heating element must be done in a fume cupboard.

Powders:

- When weighing powders on a balance, all spilled powders must be cleaned off the balance when finished. Many powders become corrosive when they absorb water from the air and damage the balance.
- If the powder has a toxicity or body contact hazard level of 4, especially if a low-density powder prone to easy air dispersal, it should be used in a fume cupboard or if not possible, use an appropriate respirator when handling the powder. In the case of using a balance, the powder can be handled in the

fume cupboard but transferred in a covered container for weighing on the balance. Do not open to manipulate the mass while on the balance. Any spills must be thoroughly cleaned.

- Many powders are flammable when dispersed in air, like flammable vapours. If working with large quantities of powder, treat the powder like a flammable liquid.

Gases:

- Work with flammable gases in fume cupboards whenever possible.
- All compressed gas bottles, except 9 kg LPG bottles, must be tethered to a bench or a wall in an approved fashion. Seek assistance if a tether point is unavailable at your gas bottle location.
- All fittings involving a hazardous gas must be leak checked after each re-connection. Seek advice from the Analytical technician if you are unfamiliar with how to do this.
- Each compressed gas has an approved regulator type. Use approved regulators on the bottles; do not make modifications to use non-standard regulators.
    - Do not use Teflon tape or oil/grease on the fittings between the regulator and the gas bottle. If a leak is on-going at the location replace the regulator
    - The connection between the regulator and the compressed gas bottle should be checked for leaks each time it is changed using Snoop or a similar liquid leak detector. A leak at that point has the most potential to leak a large quantity of gas. All fittings of flammable or toxic gases should be checked for leaks each time they are disconnected/reconnected. You should have specific training with gas bottles/regulators.
    - Never use oil/grease on any fitting exposed to pure oxygen as it is a fire risk.
    - Do not untether or move bottles between labs with the regulator attached. Always use an appropriate gas cylinder trolley.
- Bunsen burners must be attached to working surface with Blu-tack to keep the hose from tipping the burner on its side.

Oxidiser:

- Prevent unintentional contact with any organic material, flammables, combustibles, and strong reducing agents such as zinc, alkaline metals, and formic acid.
- Clean any clothing or work areas potentially contaminated with oxidiser.
- Store oxidisers in designated storage cabinets or oxidiser only secondary containers.

Working with Mixtures:

Working with mixtures potentially increases the hazards over those of pure chemicals including:

Preparation – e.g. – concentrated acids are always added to water to make dilute acid solutions not water to acid because the dense acid sinks, allowing better heat transfer and is less likely to spatter due to the heat of solution.

Operations

- Flammability limits and toxicity limits are unique to mixtures. e.g. – when working with flammable gases, you can be below the lower flammability limit for each compound in a mixture but exceed the lower flammability limit of the mixture.

- Dilute acid or base solutions may not be corrosive but through evaporation may become corrosive and require the use of goggles.

Disposal – mixed waste can often be difficult to dispose of (solvents + metals) and should be avoided if possible. Waste bottles label should list the name of each waste chemical and approximate concentration. See Laboratory Chemical Waste Handling and Disposal Guidelines for more details.

Exposure Limits:

The workplace exposure standards (WES) and biological exposure indices (BEI) are guidance values – not prescribed exposure standards (PES). They are intended to be used as risk criteria for health risk assessment and risk management purposes.

The New Zealand limits for various compounds are listed here. Note that mixtures have a cumulative effect; a weighted-average formula is used to determine toxicity levels for mixtures. If relevant, please confer with the lab manager.

Section 7:
Transportation of Chemicals

Be careful when moving hazardous materials between laboratories or buildings in the Department. If your work requires regular transportation of hazardous materials between buildings or off campus, please review this requirement with the laboratory manager or the Safety Officer.

Below is a list of procedures that must be followed when transporting chemicals within the department:

- Samples cannot be transported to or away from the University informally without consultation with, and permission from, a certified chemical handler (excludes formal shipping). Be prepared to discuss:
    - Receptacles for the samples
    - Method or mode of transport
    - Labelling
    - Hazard class
- Glass bottles of chemicals (liquid or powder) must be transported between laboratories in an approved chemical carrier. This requirement is to lower the probability of a spill in hallways and stairwells. Appropriate buckets are available from the Stores Technician or in the 205 Prep area.
- Never transport an open beaker of a hazardous liquid or powder between rooms. Cover it with a lid or plastic film.
- Most chemicals, with exceptions to those listed below must be moved via the staircase by the lift, not the main staircase up to Level 2
- Compressed gas bottles should be moved between rooms using the trolley designed for gas bottles. Never move a compressed gas bottle with the regulator attached as it makes an accident-causing significant damage to the main valve more likely.
- It is prohibited to ride in the elevator with hazardous chemicals (liquid or gas). This is to avoid being trapped with a hazardous chemical in an enclosed space in the event of an extended power outage (e.g., earthquake).
    - All gas cylinders must be transported via a gas cylinder trolley and moved between floors using the elevator. There should be no people in the elevator with a gas cylinder.
    - Heavy/large volumes of chemicals must be transported via the elevator. There should be no people in the elevator with the chemicals.

- A liquid nitrogen Dewar if overturned could create a low oxygen environment in an elevator relatively quickly.
- A broken solvent bottle would create a toxic environment in elevator.

- The Department has a trolley and Dewar for moving liquid N_2 from SPCS to CAPE. See the Lab Manager for more information.

Section 8:
Storage of Chemicals

Informal storage of chemicals, samples or equipment in cardboard boxes is not permitted because they tend to adsorb spills that go unnoticed. Instead find an appropriate plastic box. This rule does not apply to newly arrived items waiting to be unpacked.

Guidelines for Secondary Containment:

All class 6 and 8 chemicals (both liquids and solids) as well as vessels ≥ 1 L are recommended to be in secondary containment. This applies for vessels in a permanent or long-term set-up (e.g. chemicals being used actively on a bench or left alone for < 1 hour do not necessarily need secondary containment). Everything else is up to the researcher's discretion considering the proximity to other equipment, material compatibility, and the consequence of a spill (e.g. a permanent 500 mL bottle of water near a computer should be considered to have secondary containment around it). Secondary containment should hold at least the volume held inside the original vessel. Containers to use as secondary containment can be found in the supply cupboards in CAPE 205, the storeroom, or from a lab manager. Refer to Figure 5 for storage compatibility guidelines.

Short-Term Storage:

Chemicals being kept on benches or in drawers or on shelves above benches should be kept to a minimum – this includes both minimum volume and minimum length of time. Shelves above working benches are not meant for long term storage of chemicals. If you have finished using it, it should be returned to Stores. The amounts suitable for short term bench or shelf storage are:

- HSNO Class A (GHS Category 1 chemicals as must not exceed 1 L or 1 kg.
- HSNO Class B (GHS Category 2) and lower should not exceed 2.5 L.

No chemicals are to be stored on the top shelf above benches.

Experiment samples may be stored in the lab during the course of the experiment. If the sample possesses hazard classifications which warrant speciality storage requirements (i.e., class 3, class 4, class 5, class 6, or class 8) then the samples must be stored in the appropriate storage facilities within the lab. Any samples which do not require speciality storage may be stored in the drawers under lab benches, in secondary containment (e.g., 2L plastic container with lid), to prevent samples mixing and reacting if a break/spill occurs. The samples and the secondary container should be labelled. Should you have any questions on sample storage, please consult a lab manager.

Medium-Term Storage

When not being actively used on the bench, flammable, corrosive, and oxidiser chemicals must be stored in the appropriate cabinets:

Flammable

Oxidiser

Corrosive

Toxic

- The volume of chemicals in storage cabinets must not exceed capacity listed on the cabinet.
- Secondary containment in the cabinets must be sufficient to hold 50% of the volume.
- Acid and bases are stored separately, please check you using the correct cabinet.

Ownership of chemicals in these cabinets must be noted. These cabinets are provided for the storage of day-to-day working chemicals – not as long-term storage. When a chemical is no longer required, it should be returned to the storeroom with the help of the store technician or lab manager.

Any chemical not labelled with a name and date is subject to removal.

Long-Term Storage

All chemicals for research purposes have long term storage locations and are grouped based on the chemical hazard classification. These areas are all locked, and staff can provide access as required.

- Flammable Liquids – Flammable liquids store HS12D.
- Gas storage – Gas Stores HS12B (Flammables) and HS12A (Non-Flammables & Inert Gases)
- Dry chemicals – CAPE 105B
- Acids – CAPE 105B
- Oxidisers – CAPE 105A
- Non-flammable liquids and flammable solids – CAPE 105D
- Bases – CAPE 105D

Refrigerators

The Department has a number of refrigerators for storing temperature-sensitive chemicals and samples.

- All items stored in refrigerators must be appropriately labelled either individually or grouped in a larger, appropriately labelled container.
- Food for consumption must never be stored in laboratory refrigerators and chemicals for laboratory use must not be stored in refrigerators designated for food.
- Flammable substances requiring refrigeration with rating of 3.1A or 3.1B must be stored in either Lab 205 fridge 5 or fridge 6, designated as *flammable only* fridges.

- Oxidising substances requiring refrigeration with rating of 5.1.1A, 5.1.1B or 5.1.1C must be stored in Lab 205 fridge 1, designated as *oxidiser only* fridge.
- All hazardous chemicals stored in refrigerators must be in secondary containers which will hold the entire chemical volume in the event of a broken bottle.

Please remove samples and chemicals from refrigerators when a project ends.

Chemical Storage Compatibility Chart:

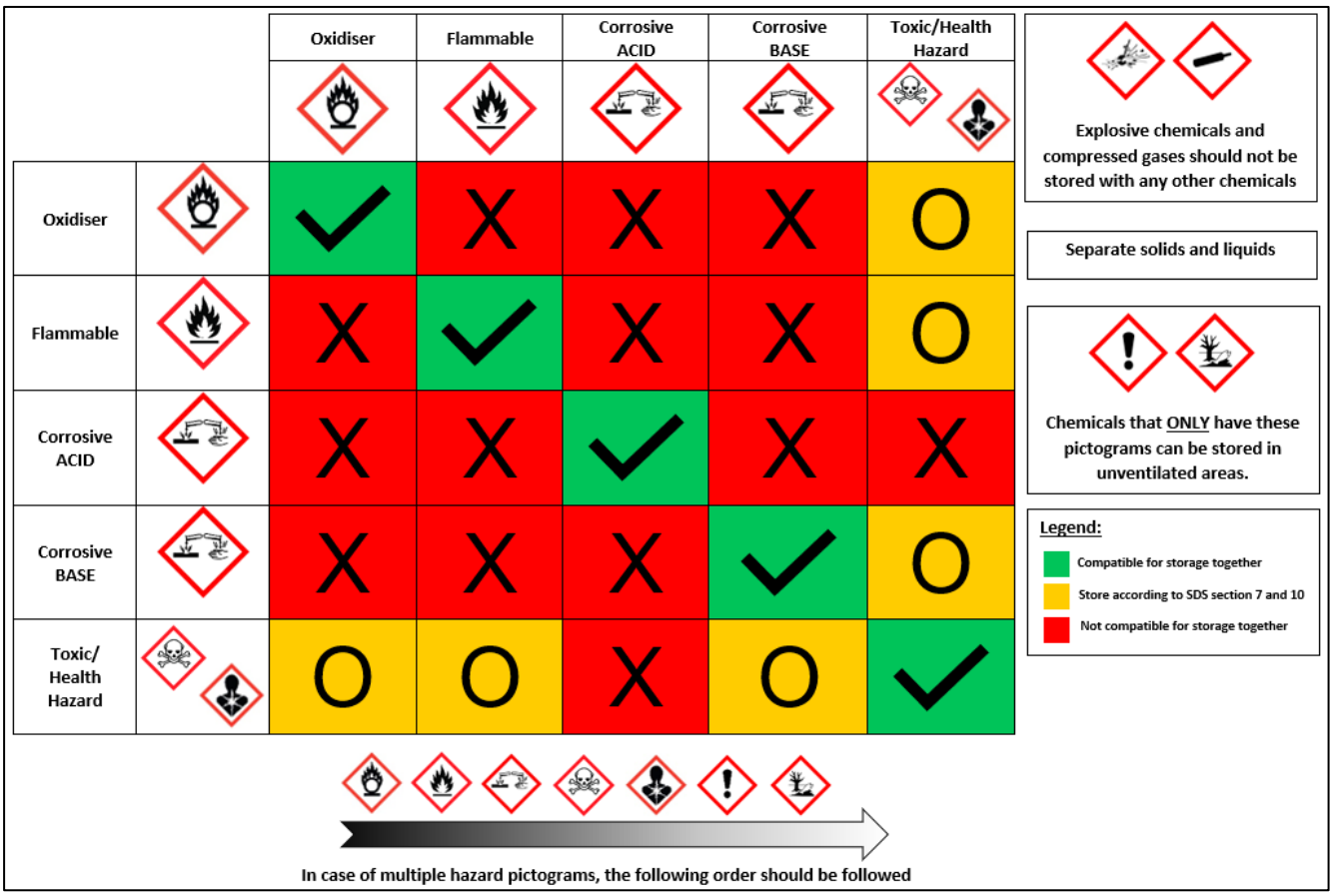


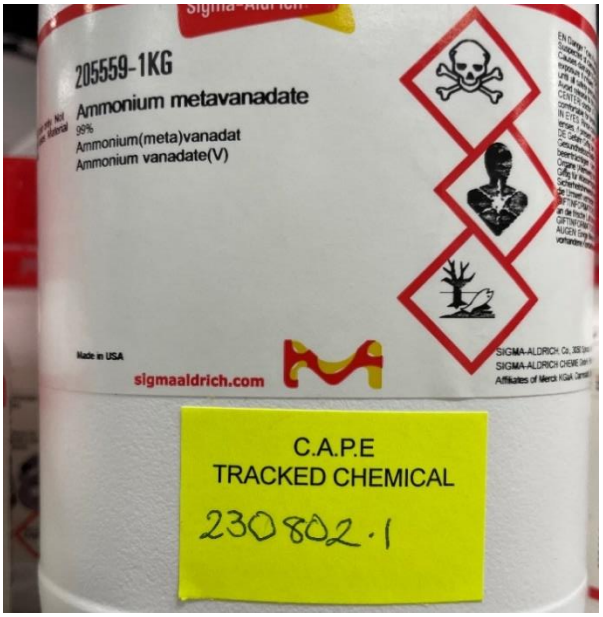
Figure 5 – Chemical Storage Compatibility Chart – ***Note****: This should be used as a guide only. Please refer to the substance SDS for detailed information for individual substance*.

Section 9:
Tracked Chemicals

There are a number of chemicals in the CAPE Department that are required to be tracked as required by the New Zealand Environmental Protection Authority (EPA).

Tracked chemicals are considered particularly hazardous or have potential illegal uses. Therefore, all use must be accounted for.

- All substances must be stored in the original container marked with the designated yellow "CAPE Tracked Chemical" sticker.



- The store person or lab manager will assign the tracked chemical with a unique code (Julien code) which is specific to that chemical.
- The lab manager or store person will log the chemical upon receipt and completed a tracking record sheet for the specific chemical.
- The tracking sheet record must stay with the chemical in the location of use/storage.
- The sheet must be filled out each time the chemical is used adjusting for the weight of the chemical remaining, to the nearest milligram.
- If being returned to the storeroom, the chemical must be signed in by the lab manager or store person. Information for this procedure is available from the Stores Technician or the Laboratory Managers.

Some specific chemicals with these categories do not require tracking, see CAPE H&S page for information regarding tracked chemicals in NZ.

The hazard categories that must be tracked are detailed in table 3 below:

Table 3 – Tracked Chemical Classes

Chemical Class (GHS/HSNO)	Hazard Statement	Pictogram
3.1A – Flammable Liquid Category 1	Extremely flammable liquid and vapour	
3.2A – Liquid Desensitised Explosive Category 1	Fire, blast, or projection hazard; increased risk of explosion if desensitising agent is reduced	
4.1.2A – Self Reactive Solid Category 1	Heating may cause an explosion	
4.1.2B - Self Reactive Solid Category 2	Heating may cause fire or explosion	
4.1.3A – Desensitised Explosive Category 1	Fire, blast, or projection hazard; increased risk of explosion if desensitizing agent is reduced	
4.2A – Pyrophoric Liquid/Solid Category 1	Catches fire spontaneously if exposed to air	
4.3A – Substance which in Contact with Water Emit Flammable Gas Category 1	In contact with water releases flammable gases which may ignite spontaneously	
5.1.1A – Oxidising Liquid and Solid Category 1	May cause fire or explosion, strong oxidiser	
5.2A – Organic Peroxide Category 1	Heating may cause an explosion	
5.2B – Organic Peroxide Category 2	Heating may cause fire or explosion	
6.1A – Acute Toxicity Category 1	Fatal in contact with skin/Fatal if inhaled/Fatal if swallowed	
6.1B – Acute Toxicity Category 2	Toxic in contact with skin/Toxic if inhaled/Toxic if swallowed	

Section 10:
WorkSafe New Zealand Health and Safety Legislation

All hazardous substances are required to have an approval under the HSNO Act. However, section 33 of the HSNO Act provides an exemption for this requirement for small-scale use of hazardous substances in research and development or teaching, providing:

- The use does not involve a substance for which approval has been declined by the EPA or which is a persistent organic pollutant.
- No hazardous substances, substances derived from them or products containing hazardous substances are sold, except under certain prescribed circumstances specified in section 33 of the Act.
- The use of hazardous substances occurs in a laboratory that meets the requirements of the Health and Safety at Work Act (Hazardous Substances) Regulations 2017

The CAPE laboratories operate under this exemption and are therefore governed by Part 18 of the Health and Safety at Work Act (Hazardous Substances) Regulations 2017[4].

Section 11:
Laboratory Layout

Appendix 1 depicts the CAPE facilities floor plan, showing the layout of Lab 205 and the special purposes labs.

These floor plans also show the location of the emergency exits, the drench shower/eye wash stations, fire extinguishers, first aid kits and indicates areas where hazard substances may be in use.

Section 12:
Labelling of Chemicals

All bottles and other containers of chemicals must be clearly labelled at all times.

As per New Zealand WorkSafe legislation, all labels within laboratories and storage facilities must meet the following requirements[5]:

- Labels must be in English.
- The product name or chemical name.
- The concentration of the substance (where applicable)*
- All relevant GHS hazard pictograms consistent with the substance's classification.
- The 'owner' of the substance (person responsible).
- Reaction vessels will be labelled where the reactants remain in the vessel for more than 24 hours.

* For complex mixtures such as microbial growth medium and other simple salt solutions, the concentrations of all the salts are not required.

There are several 'reference recipes' available in folders on top of the fridge in both the SP lab foyer area and D180. It is permitted to label with these names instead of individual ingredients:

[4] Health and Safety at Work (Hazardous Substances) Regulations 2017 (LI 2017/131) (as at 05 January 2022) Part 18 Laboratories – New Zealand Legislation
[5] Labelling | WorkSafe

- Nitrate mineral salt medium for bacterial growth
- M9 salt medium for bacterial growth
- Cesiumtrifloroacetate medium (CsTFA medium) for stable isotope procedure
- Morpholinopropane sulfonic acid (MOPS) minimal salts media for culturing bacteria
- Bold basal modified Awarua (BBMA) medium

The department of Chemical and Process Engineering employs the following labels for labelling of chemicals within the laboratory and storage facilities.

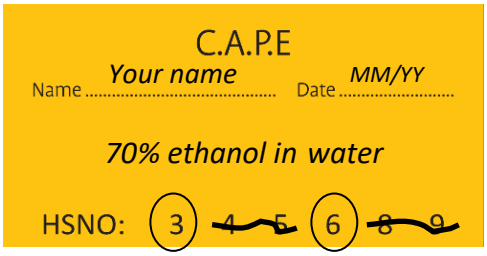


Figure 6 – Example of a label for a container storing a solution of 70% Ethanol in Water.

Table 4 – Hazard Classes for Labelling

General Class	Hazard
3	Flammable liquid
4	Flammable solid
5	Oxidizer
6	Toxic
8	Corrosive
9	Ecotoxic

Name: The 'owner' of the substance (person responsible). Should be first and last name.

Date: Date the chemical was created or decanted from supplier container (month and year)

Product/Chemical Name: Full Chemical name of substance. Please avoid trade names and abbreviations. The concentration of the substance should also be listed here.

HSNO Classes: Strike through all classes which do not apply and circle the hazard classes that do apply. *In the example above, HSNO classes listed in section 2 of the SDS for 70% Ethanol are 3.1B, 6.4A (flammable liquid and toxic) so the 4, 5 and 8, 9 on the label are struck through*.

Labels and instruction are available around the labs in wall mounted holders or may be obtained from the lab technician. When you have finished your task and no longer require the contents, dispose of them carefully (see above "Disposal of Waste Chemicals"), wash the container (removing the label) and return to store.

Notes:

(i) When storing small samples where the individual vial, bottle, etc. is too small for easy labelling, grouping the samples in a larger plastic container is appropriate. The container should then be appropriately labelled.

(ii) Old bottles or containers must not be used for temporary storage of samples or waste unless the label is completely removed or covered. Crossing out a label is not sufficient.

Section 13:
Chemical Waste Disposal:

Liquid Waste – Water soluble, non-hazardous substances (e.g., D-glucose), dilute aqueous (water-based) reagents of low hazard (e.g., buffers), low volumes of low toxicity organic solvents (e.g., 10% ethanol solution in water) and anions and cations containing no heavy metals may be disposed of down the drain.

Waste chemicals **not** suitable for disposal in the drain include:

- Corrosive solutions (pH <5.5 or >11)
- Substances that are not soluble in water
- Cyanide and Azide species
- Heavy metals
- Antibiotics/anything with biocidal properties
- Phenols, benzenes, or their derivatives
- Halogenated organic solvents
- Toxic organic solvents
- Large volumes of flammable liquids (>100 mL)
- Oxidisers

The decision tree in appendix 3 can be a useful tool in determine if chemical waste is suitable for drain disposal.

Hazardous liquid waste which cannot be disposed down the drain must be collected in appropriate containers for third party disposal. Containers of waste must be labelled with your name, month and year of origin, contents with estimated concentration of each component, appropriate GHS pictograms and clearly marked as waste. When a waste container is ready for disposal, deliver the correctly labelled container to the Lab Manager in an appropriate secondary container.

Generic waste bottles for small volumes of liquid waste are located in lab 205 prep area for the following,

1. **Mixed Class 3 Waste**
2. **Mixed Class 6 Waste**
3. **Mixed Class 9 Waste**
4. **Class 8 Waste (Bases Only)**

Note: Waste containing oxidisers cannot be disposed of into these containers.

Do not mix wastes of different types unless you have confirmed they are compatible with your supervisor or the lab manager.

Concentrated acids (concentration > 5M) acid must first be added to an equal volume of water in a container 3 or more times the volume of the liquid and in the fume hood.

Be aware of heat generated as a result of mixing and slow down mixing to prevent over-heating.

Note: Ensure you always add acid to water. Adding water to acid can result in violent reactions due to excessive heating.

Once these acids are diluted, they will be pH adjusted to pH 6 by the lab manager prior to decanting or disposal.

If generating greater than 500 mL of acid waste per week, you will be required to use a personal waste container.

Be sure when labelling personal waste containers, the concentration and identity of the acid waste is clear and legible

Solid Waste – Non-hazardous solid waste can be disposed of in the lab rubbish bins. Hazardous solid waste must be placed into an appropriate container and its contents labelled.

Glass – Glass bottles or broken glass should never be put in the general rubbish containers. The cleaners are at risk of cuts. Use the green buckets labelled for glass disposal.

Sharps – Sharps or syringe needles should not go in general rubbish. The cleaners can easily stick themselves when handling the rubbish. Use the yellow Sharps containers available. If your lab doesn't have one, see either Stores Technician or the Analytical Technician.

Batteries – Spent batteries can be returned to the electronic workshop for proper disposal.

More details on CAPE waste disposal can be found via the Department *Laboratory Chemical Waste Handling and Disposal Guidelines* **(refer to CAPE health and safety website).**

Section 14:
Chemical Spill Response:

Clean up procedures for all types of chemical spills should be known BEFORE a spill occurs.

Chemical spills need to be contained, cleaned-up and addressed as soon as they happen or are discovered - no matter how small.

It is unlikely that emergency services will need to be advised in the case of laboratory spill, however, emergency services could be required for larger spills that may occur in the dangerous good storage facility.

There are seven steps which should be addressed when dealing with a chemical spill in the laboratory.

Seven Steps to Spill Control

1. **Assess the Risk.**
    - Continues through-out the process.
    - Recognise dangers – people & environment.
    - Act immediately.
    - What substance is involved?
    - How much is involved?
    - How dangerous is the spilled substance– GHS classifications (check SDS).
2. **Protect Yourself / Protect the Environment**
    - PPE
    - If uncertain assume the worst.
    - Alert someone that you are dealing with a spill.
    - Avoid walking through spill, don't kneel.

- Be conscious of vapours – inform others.

3. Stop the Source

- Pick Up tipped over containers.
- Roll drums so leak is on top, apply a patch – tape, bung, etc.
- Establish an exclusion zone – be conscious of floor gradient and other external hazards (heat sources, etc.)

4. Confine the Spill

- Use a spill kit to dam or dike the spill.
- Give yourself space!
- Check with the lab manager if treatment needed.
- Absorb liquid spills or sweep up dusts and solids.
- Start at the furthest point and work in
- Do NOT use a hose!

5. Clean-Up

- Transfer collected materials to buckets or plastic bags for disposal.
- Final wipe-down or vacuum
- Avoid stepping in material.
- Have someone double check the area.

6. Decontaminate

- People and equipment.
- Wash or shower; launder PPE.
- A major spill may need a decontamination area to be established.
- Arrange for replacement of used spill kit components.

7. Report

- Fill in an accident/incident report on Assura.
- What, when, where?
- Who was involved in the clean-up?
- What happened to the waste? How much?
- Additional impacts – people, soil, water?

Chemical spill kits (20L red buckets) are located in easily accessible locations with the CAPE laboratories.

- **Lab 205**: 200L spill kit along South wall (near 205E) and 20L spill kit in prep area
- **SP Lab 180s**: Under Bio Hood in main foyer
- **SP Lab 170s**: In D174 prep room

- **Lab 112/113**: Under staircase on North side of building
- **X 1 Spill kit in each chemical storeroom**

The spill kit contains the tools required to clean up both hydrophilic and lipophilic spills within the laboratory.

Additional personal protective equipment including respirators, face shields, apron, and gloves can be obtained from the storeroom technician.

Note: Before using a respirator, confirm a chemically suitable cartridge is installed and a fit test is carried out, consult a certified chemical handler or department safety officer.

Spill Waste Disposal:

Waste from a spill response should not be disposed of in the laboratory rubbish bins. Waste should be double bagged and them placed back into the red bucket provided with the spill kit. The lab managers will facilitate the appropriate disposal of this spill waste. Please ensure all waste is labelled with as much information as possible.

Section 15:
Hazard and Risk Checklist Process:

All work conducted in CAPE or by CAPE students will require the completion of a Hazard and Risk Checklist (even if the experiment is performed in another department or off-site). For off-site work please see requirements later in this section. This checklist is completed through the Assura CAPE Checklists page. You will see CAPE Checklists on the left of the page.

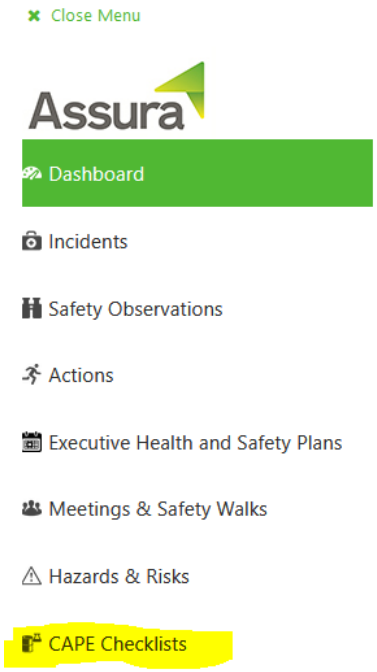


Figure 7: Home page of Assura showing the location of the CAPE checklist as highlighted

The Hazard and Risk Checklist (H&R checklist) accomplishes a number of things:

1) Helps the researcher identify significant hazards and minimise the risks for their experiment to an acceptable level.
2) Informs the Department about new/modified experiments.
3) Serves as a record of these activities for compliance requirements.

Successful completion of this checklist is not the end of thinking about hazards and risks. Researchers must constantly think about what they are doing in the labs in regard to how things might go wrong or new hazards that are introduced. The most likely person to be hurt if things go wrong is you.

Most researchers will need to fill out this form prior to starting their practical experimental work, however there are exceptions, some examples include.

- measuring the pH of non-hazardous, aqueous samples
- simple enzymatic reactions in a 30 °C water bath.

Hazard & Risk Checklist Form - Overview:

This form is divided into the following sections.

- Overview
- Risk Criteria
- Equipment and Materials (chemical and biological)
- Procedures and Emergency Response
- Hazards and Controls
- Researcher Declaration

Please fill out all required fields (*) with as much information as possible. Add any extra information that might be useful.

Overview Section:

Experiment Name – Something short and descriptive related to the activity e.g., "Metabolic uncoupler influence on toluene biodegradation" or "Impact of process conditions on the cleaning of ultrafiltration membranes".

Research Name – This can be your full legal name or preferred name

Research Contact Details – How you prefer to be contacted about your checklist application (phone or email)

Safety Quiz Question – All lab user must complete the safety quiz before gaining access to the lab

Applicant Category – Are you a 4th year student, academic staff, other UC department, post grad, or visitor?

CAPE Supervisor – Either academic supervisor or CAPE technical staff member

Location for Experiment

- The location(s) for your experimental work need to be determined prior to submission of your Checklist so that the experimental rig can be signed off by the appropriate technician. Therefore, your rig needs to setup and/or constructed prior to submission of this sheet.
- If the location for your experiment has not been identified by your supervisor, consult with Technical Service Manager to identify potential locations.
- If your experiment will require multiple locations where temporary gear or chemicals will be located while unattended, list them here. Also obtain multiple orange cards or make sure all locations are properly labelled with your name and contact details. During lab safety tours, staff need to be able to identify who is working where.
- Multiple locations can be selected.

Risk Criteria Section:

Low Risk Criteria – To qualify as low risk, all of the criteria must be met. If your experiment does not meet all of the above criteria for a low-risk checklist, a High-Risk Checklist must be completed. Select the "tick box" yes and the additional required information will be displayed.

Low-Risk vs. High-Risk Hazard and Risk Checklist:

There are two types of check list that can be completed:

- Low-risk checklists
- High-risk checklists

If you meet **all** of the following criteria, you may submit a low-risk checklist (a high risk Hazard & Risk checklist is not required).

Low Risk Criteria

To qualify as 'Low Risk' all the below criteria must be met.

- ☐ All of your chemicals must not exceed a hazard rating of 2 in any category including preparation or generated products, as determined from the Chemwatch Gold MSDS.
- ☐ Disposal of waste down the sink or in the rubbish is suitable for all waste.
- ☐ The temperature range must be between -10 oC and 50 oC at any time.
- ☐ The system (pressure x volume) < 2 bar L for a gas.
- ☐ The system (pressure x volume) < 10 bar L for a liquid
- ☐ You are not working with biological compounds that require physical containment as defined by HSNO. See the Biological Tech. for advice.
- ☐ Your experiment cannot make > 25 g/m3 of flammable or reactive dust/powder airborne outside of a fume cupboard.
- ☐ You are not working with a custom experimental rig that requires training.
- ☐ If after-hours or working in isolated areas is required, the risks have been discussed with and approved by the project supervisor.
- ☐ All electrical equipment has a current electrical certification and uses a RCD if required.
- ☐ The work will be completed in CAPE or other University labs. Work off campus must be reviewed separately (see CAPE Safety Manual).

If your experiment does not meet all of the above criteria for a low risk checklist, a High Risk Checklist must be completed

○ No ○ Yes Full Hazard and Risk Checklist Required?

These criteria are not a perfect measure of "minor hazard" and some hazardous conditions could still arise even though all the criteria are met.

For example: a simple electrochemistry experiment using ferricyanide would appear to meet the criteria. However, if a concentrated ferricyanide solution is sufficiently acidified with 3% hydrochloric acid, cyanide gas will be produced, which is a very hazardous chemical.

If a high-risk checklist is required, the "yes" check box will open up more fields on the checklist that must be completed.

1.1 Equipment and Materials

Equipment and Materials Table

New | Update | Delete | Max Items: 20

Equipment item name	Equipment tag #	Electrical Expiry Date	Training Done (or to be) by	Location	List normal operating extremes (T, P or pH)	Running unattended	Additional PPE required	Description	Tested? initial	Expiry
No records to display.										

Equipment Reviewer notes

1.2 Diagram

Attach a process flow diagram of the apparatus or line diagram of the experimental setup must be attached. It must be your own work; a direct copy of a previous diagram is not permitted. If you are setting up a new apparatus, it must be assembled before you submit this form.

Please indicate maximum operating flow rates, temperatures and pressures in the lines and vessels as appropriate. Also indicate key control valves or regulators.

Attach Diagram

New... | Max Items: 100 | Drag files here

	Title	Attached Date	Attached By	
No attachments.				

Diagram reviewer notes

1.3 Pressure test

○ No ○ Yes Pressure test design/certificate required?

1.4 Chemicals

Chemicals Table

New | Update | Delete | Max Items: 100

Chemical Name	Fire	Toxic	Body	React	Chronic	NZ EPA HSNO Hazard Class	Max Concentration	Working Concentration	Total lab volume/mass	Maximum mass/volume handled	Safety precautions, waste disposal, comments
No records to display.											

Reviewer notes

1.5 Biological

Biological Table

New | Update | Delete | Max Items: 20

Biological Material / Organism Name	Quantity and Concentration	PC 2	Are you P2 Trained	Pathogen	Source / Special considerations / Notes
No records to display.					

Figure 8: Additional Tables for High-Risk Checklists

Equipment and Materials Section:

1.1 – Equipment Table:

- Equipment Item Name – Name of the piece of equipment (ask the lab managers or electrical technicians if unsure)

- Equipment Tag Number – Four-digit asset number

    - Subcomponents of a custom apparatus may have individual equipment tag numbers, but the main apparatus may not have its own unique identifier.

- Electrical expiry – Any equipment that has an expired electrical certification sticker will need to be re-certified prior to use. There are currently two different forms of electrical testing stickers in use.

- Training – list the supervisor, researcher, technician or lab manager who has/will provide training. Use N/A if not applicable. The type of things that must be considered include:

    - Start-Up/Run/Shutdown
    - Direct operator to equipment instructions /manuals/text if available
    - Potential mistakes the operator may make.
    - Any risk to equipment or people associated with the equipment

- Running Unattended – This is an opportunity to discuss with your supervisor any additional risk associated with leaving your apparatus running unattended. Answers can include – never, short-periods, often, always.

- Additional PPE – Beyond the mandatory safety glasses, lab jacket and covered shoes could include earmuffs, goggles, fume cupboard, residual current device (RCD), dust mask, special gloves.

    - RCDs are required for electrically powered equipment involving water. Some lab power outlets have RCDs built-in, and some don't. Seek advice if you are uncertain.

- Active Risk Reduction – Devices include a pressure relief valve, power interlock triggered by fume cupboard failure, high temperature cut-out switch, fail-closed valve, or automatic shutdown procedures. List the most recent test dates for any items that can be tested.

Table 5 – Example Hazard and Risk Assessment Checklist Equipment Table

New Update Delete Max Items: 20

Equipment item name	Equipment tag #	Electrical Expiry Date	Training Done (or to be) by	Location	List normal operating extremes (T, P or pH)	Running unattended	Additional PPE required
Bench Top NMR	5401	01-Mar-2027	Hamilton-Cross, Nicole	Lab 205 North	Room temperature	No	NA

The electrical workshop technicians will sign off on the electrical information provided and will re-test any equipment which has an expired tag and test date.

1.2 – Diagram:

Identify all inputs, outputs, flows, measurement points and control points on the apparatus. Also include maximum (or minimum) operating conditions when significantly different from ambient.

- For existing setups, you must not submit a photocopy or make a direct copy of a previous diagram but should create one by studying the apparatus. Creating the diagram is an excellent way to develop a good understanding of the apparatus.
- In some cases, especially involving simple wet chemistry, a procedure may be sufficient and can be listed in Sec 2.1.
- Supervisors must confirm the diagram by visiting the apparatus. Signing without visual confirmation is a serious breach of department health & safety policy.
- **Please upload your diagram to Assura as a PDF.**

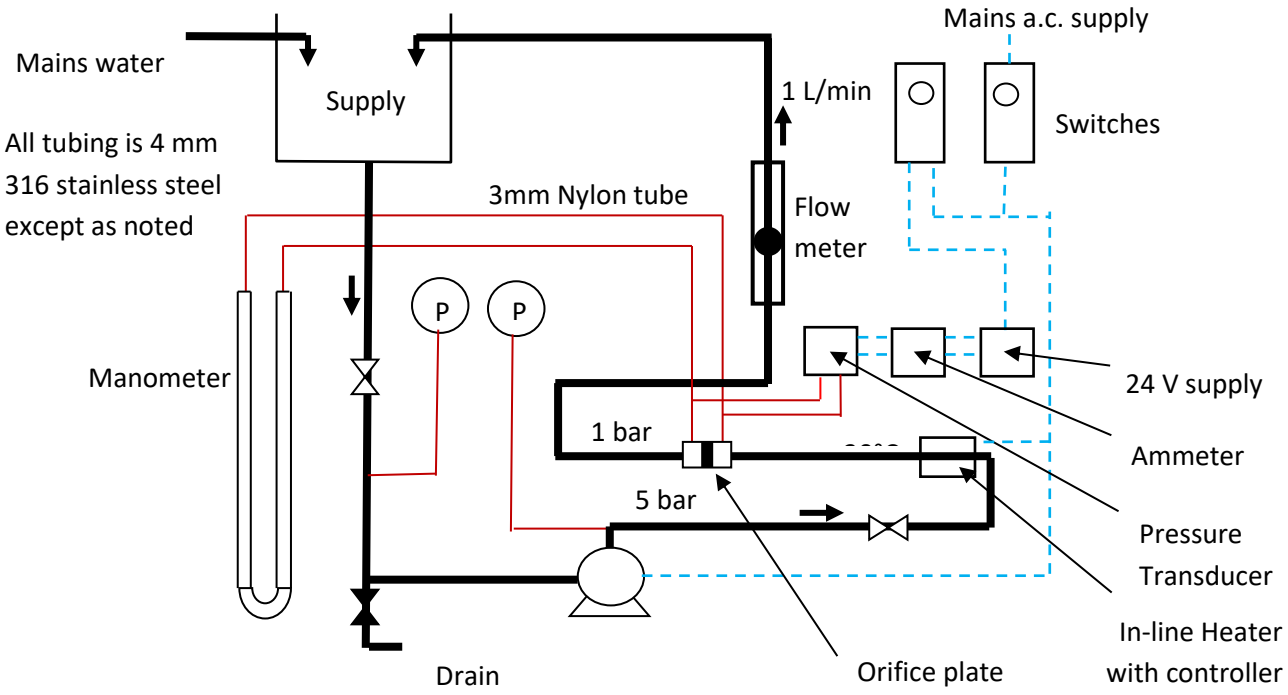


Figure 9 – An example process flow diagram based on the pump application lab. Colour is not required and is just added for clarity for this example.

The mechanical workshop technicians will sign off the diagram provided and will contact you if further information is required.

1.3 – Pressure Test Design/Certificate:

This is determined by (pressure x volume) and what is contained in the vessel according to Table 1 in AS 4343. If you are unsure then seek advice from the Mechanical Workshop staff. If the apparatus already has a certificate, it will need to be current. If you are going to have something built or use a pressure vessel from outside the Department and it exceeds 2 bar·L for a non-hazardous gas or 10 bar·L for a non-hazardous liquid or you are going to compress a hazardous chemical (any hazard rating of 3 or above) please consult early with the Mechanical workshop staff.

1.4 – Chemical Table:

Chemical Name – The chemical name is listed on the container including numbers, symbols, and hydration.

Hazard Rating – Are found on the ChemWatch Summary page for flammability (fire), toxicity (toxic), body contact (body), reactivity (react), and chronic (chronic). The hazard ratings run from 0 for non-hazardous to 4 for extremely hazardous materials.

Hazard Class – Find the EPA Hazard Classifications listed under the HAZARD PHRASES section in the ChemWatch Mini MSDS or on the ChemWatch summary page. Many chemicals have many classifications; you should list all relevant classifications. You should also list routes of exposure for acutely toxic compounds.

GHS H Code – List the GHS H codes for each chemical

Tracked Chemicals – The following classifications are tracked chemicals: 3.1A, 3.2A, 4.1.2A or B, 4.1.3A, 4.2A, 4.3A, 5.1.1A, 5.2A or B, 6.1A, or B. Please note in the Safety Precautions section of the Checklist.

Corrosives – Any chemical that has a hazard class 8.3A is considered an eye corrosive. While working with the pure chemical, the minimum eye protection is safety goggles. For eye corrosives in solution, when sufficiently dilute, safety glasses are often acceptable (dilute acid). Please see the PPE section of this manual for more information. If goggles are required, please note in the Safety Precaution section of the Checklist.

Max Conc. – This is the maximum concentration that will be handled. For example, you may use a dilute acid solution but during preparation you might handle concentrated acid. In the case of pure liquids, solids or gases indicate 100%.

Working Conc. – The concentration that will be commonly handled during the course of the experiment.

Total Lab Vol. – this is the total volume of the material in the lab including both storage and in your process vessel. There are different maximum volumes permitted depending on the hazard class. See the chemical storage section of this Safety Manual for additional information.

Safety Precautions, Special Disposal, Additional Comments – List the additional safety precautions that are beyond the mandatory safety glasses, lab coat and covered footwear. This could include special gloves, fume cupboard, ear protection, dust protection, goggles (corrosives) or special procedures (tracked chemicals).

List the method of disposal for all chemicals, especially those which may not be flushed down the sink or placed in the rubbish. Please refer to the Safety Manual for additional guidance.

		Chemical Name	Fire	Toxic	Body	React	Chronic	NZ EPA HSNO Hazard Class	GHS H Codes	Max Concentration	Working Concentration	Total lab volume/mass	Maximum mass/volume handled	Safety precautions, waste disposal, comments
		Ethanol	3	1	2	1	0	3.1B, 6.4A	H225, H319	100%	50%	200 mL	500 mL	Store in cool dry place, highly flammable so do not store with oxidisers or explosive chemicals. Disposal of ethanol in mixed class 3 waste bottle.
		Acetic acid	3	2	4	2	0	3.1C, 6.1D, 8.2A, 8.3A, 6.9B, 9.3C	H226, H302, H312, H314, H332, H373, H433	100%	50%	200 mL	500 mL	Keep away from heat, do not breathe vapours, keep container closed. Do not store with oxidisers or explosive chemicals. Dispose of in mixed class 3 waste bottle.
		Nitrogen gas	0	0	4	0	0	N/A	H280	100%	100%	~10 m3	~10 m3	May explode if heated, gas under pressure. No waste disposal needed as vented and extracted through ducts.
		Phosphoric acid	0	4	3	1	0	8.1A, 6.1D,8.2C, 8.3A	H290, H302, H314	85%	85%	100 mL	100 mL	Do not breathe vapours, wear chemical goggles while handling. Dispose of in class 8 mixed waste.
		Carbon Black	1	1	1	1	2	6.4A, 6.7B	H319, H351	100%	100%	500 g	500 g	Wear gas mask, handle in small quantities so as to not get everywhere (very electrostatic). Once used, put in bin as a solid coating on electrode material.
		Platinum	0	1	1	2	2	6.5B	H317	100%	100%	50 g	50 g	If in powder form, wear mask protection. Once used, put in bin as a solid coating on electrode material.

Figure 10: Example Chemical Table

Section 1.4 –Biological:

- **PC 2 –** Biological material not considered native to New Zealand per HSNO regulations or that has been genetically modified will need to be handled in a containment facility (normally PC 2). Only some labs are certified as a MPI PC2 containment facility, CAPE 205A has recently been certified as a PC2 space. If PC2 containment is required, additional training and safety procedure will be required. Check with the Biological Technician or the Safety Officer.
- **Pathogen** – check on the following website for your organism. If listed, print out the PSDS and discuss with your supervisor and the Biological Technician.
- **Source:** List the source of the biological material. If it is being obtained from another research organisation give the name. For strains that Canterbury is keeping, indicate UoC.
    - Obtaining biological material both protein and live cultures from outside organisations may require pre-approval from the New Zealand Environmental Protection Authority (EPA). Please consult with the Biological Technician.

Procedures / Emergency Response Section

Procedures:

At this stage the procedure should be detailed enough to convince someone else that you know what you are doing and that you have considered the steps required to complete your experiment. Custom-built equipment may require more detail including start-up and shutdown.

Animals/Native Plants:

Work with animals and native plants will require additional approval from the University Ethics Committee. Please seek advice from the Safety Officer.

Emergency Safety Equipment:

It is important to locate all these items before you start experiments. Looking for them during an emergency may cause very critical delays. Also please answer all the questions

Working Alone:

Working alone is when you are undertaking an activity without anyone helping or in the vicinity of the work. Working alone can increase the risk through the severity of an incident (e.g., The result of a fall or severe cut with no one to help).

You may be a lone worker because you are isolated (your lab is away from others), or you are working outside normal hours. As a department we want to avoid lone workers if possible and if not possible, manage the risk appropriately.

We have considered working alone when developing Lab 205 resulting in a glass wall between the lab and office as well as larger lab area to reduce isolated work. However, even with these measures we understand due to the nature of some of our work and locations other than 205 within the department (especially the SP labs), working alone may occur on occasion. We would like you to think about what you are trying to achieve and if you can do the work differently to remove or reduce the need to work alone. After-hours work must be for a specific reason (e.g., length of experiment, equipment scheduling), not because it is your preferred time to work in the lab. If the need still exists, we would like you to consider which of the following protections is most appropriate:

Working Alone App:

GetHomeSafe is a lone worker tool developed in New Zealand. This is a mobile app for smart phones that documents working intentions, location and provides the user with a remote panic button to request help. User can set tasks of a specific time for which your location is monitored. If things don't go as planned your "supervisor" is informed either by you not checking in or finishing your task on time. The app has a hierarchy on notifications so if the supervisor doesn't respond it is escalated to someone else. At present the Department safety officer and an academic are supervisors. If they have an alert, they will call the individual to check on them. If they cannot reach them, they contact any staff that may be onsite to investigate. If this is outside normal hours this will be Security. A motion detector is available to track motion. This app has been trialled in 2019 and early 2020 and it works, provided people consciously use it. The department can access door records to also monitor after-hours work to ensure the app is being used effectively.

Required Contact:

We recognise not everyone has a smart phone and this gives an alternative option. You would be required to maintain regular contact with someone else. For instance, ordinary or phone audible contact with a buddy every 15 minutes. This will need to be logged to provide evidence you are doing this. This will only be approved on a limited basis, as ensuring it will be used effectively is difficult.

Buddy System:

It may be neither the app nor the phone contact is sufficient. Therefore, you would require a "buddy" be within full-time audible and visual contact. This is applicable when there is potential for a rapid or serious incident.

The process for you to work through in assessing your need, risk and mitigation summarised in Figure 9. Key information can then be included in the Hazard and Risk Checklist.

Key Terms:

- **Working alone**: Working in a lab where other people are unlikely to be present for more than 30 minutes during normal working hours.
- **After-hours work:** Working outside usual the hours (7.30am – 6.00pm) Monday – Friday or anytime on the weekends or statutory university holidays.
- **GetHomeSafe:** a mobile app for smart phones that documents and records: working intentions, location and provides the user with a remote panic button to request help.

Other situations that require an H&R checklist submission include

- Multiple users of an apparatus all require individual Orange Cards, if they will be using the apparatus at any time individually and unsupervised.
- All lab demonstrators are expected to complete an H&R checklist for their experiment(s).
- If your experiments will be performed outside CAPE-operated labs, then other procedures may be required. Please consult with your supervisor or the Safety Officer.
- A very small number of experiments in the Department have required a more formal hazard and risk review such as HazOp, due to the scale or the mass of hazardous chemicals. Examples have included the gasifier and the 9" distillation column. If this is a possibility for your experiment, please consult with the Safety Officer early in the planning process.

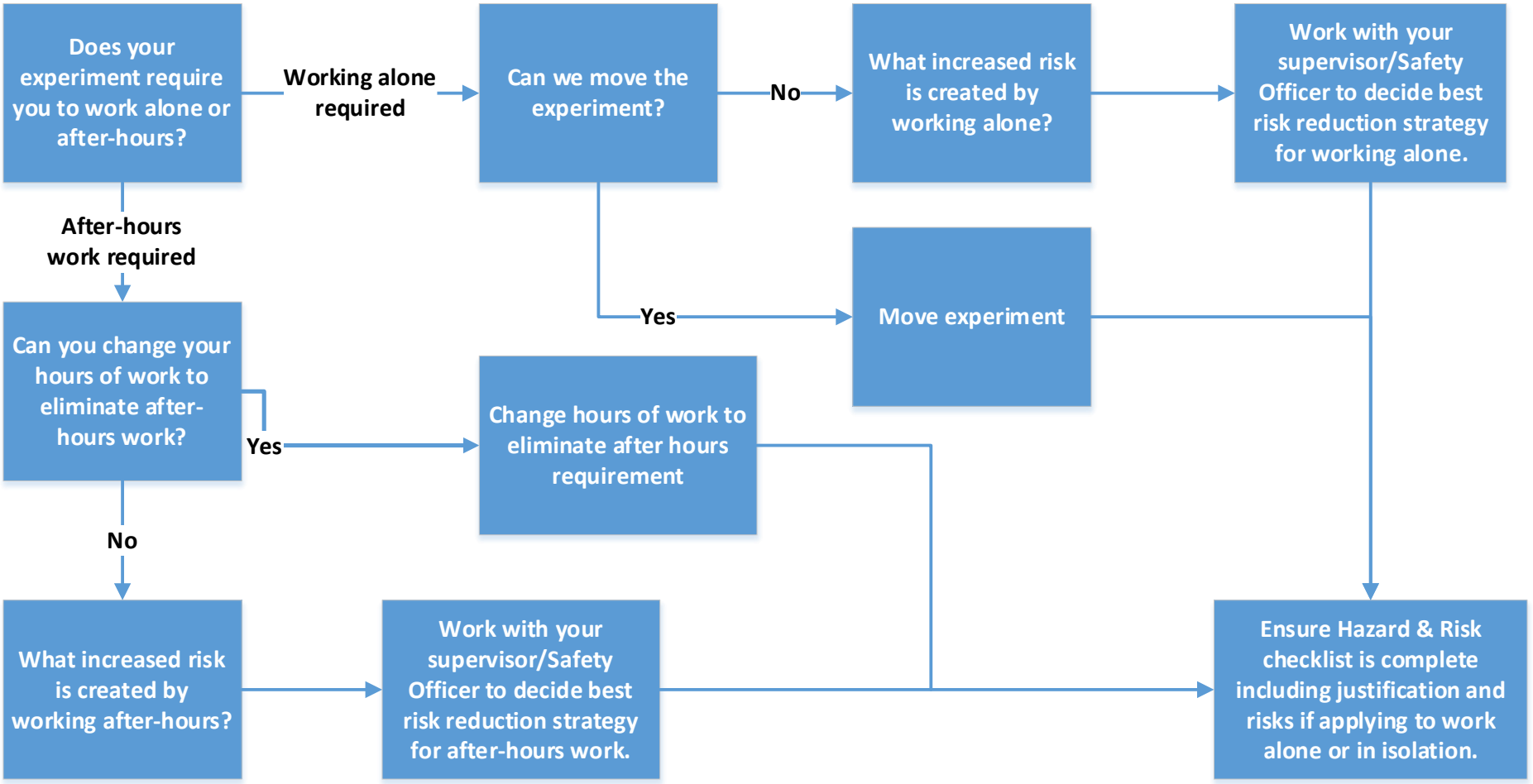


Figure 11 – Process for Reviewing Working Alone or After-Hours

Unexpected Events:

These are disturbances or process failures that could lead to safety consequences. Consider what might happen when you are there or unattended operation. Examples include:

- Loss of a service such as power, vacuum, compressed air, or cooling water for an extended period of time
- Temperature control fails causing full power to the heater
- Fume cupboard/extraction fails
- Mixing stops.
- A key pump fails
- Too much of a particular chemical (e.g., catalyst) is inadvertently added
- A procedural step is implemented out of order or skipped
- A pressure relief valve lift
- A significant leak of process fluid or cooling water; where will the fluid go?

Safety Incidents:

These can be found via Assura or by asking your supervisor.

Hazard & Control Table

What is a Hazard vs. Risk?

Risks and Hazards are often confused – It is NOT the HAZARD; it is the RISK!

Hazard – *A chemical or a set of process conditions with the potential to hurt people or the environment. With chemicals, it relates to things such as flammability, reactivity, corrosiveness or human- or eco-toxicity, etc. Process conditions of relevance are high pressure, high temperature, low oxygen, high voltage, etc. Once the hazardous compounds or conditions are identified, then the risk can be assessed*.

Risk – *An estimate of the probability of being exposed to the hazard and how bad the consequences will be. Risk is a combination of the fundamental hazard of the material/conditions, the size of the experiment and how many people might be affected.*

If the hazard is present, the risk cannot be zero, but it can be lowered to an acceptable level either by decreasing the probability of an accident or decreasing the consequences. There are number of things we can do to lower the risk. Examples include:

- Well-documented procedures lower the probability of mistakes that cause accidents.
- Pressure relief valves and leak trays minimise the damage from equipment failure.
- Carrying acetone in an appropriate carrying container between labs decreases the chances of a big spill but not the consequences.
- Safety glasses and a lab jacket can reduce the consequences of an accident but not the probability.

Deciding when the risk is low enough is never an easy decision. For experiments that follow the four steps listed below, the risk should be at an acceptable level:

a) Using the least number of hazardous compounds and the mildest conditions possible
b) Having the experiment and equipment evaluated through the Department's standard Hazard & Risk Checklist procedure (Orange Card process)
c) Apply best practice in the day-to-day lab operation (correct safety gear, no eating/drinking, etc.)

d) Complying with all regulatory requirements (labelling, incident reports, disposal rules, etc.)

Within the Hazard and Risk Check Sheet, the hazard and control table summarises the hazards and associated risk of a given experiment. This table is to summarise the significant hazards you have identified while completing the hazard and risk checklist.

In order to reduce the risk associated with certain hazards, controls should be implemented to improve the risk score. These controls should be implemented using the hierarchy of controls.

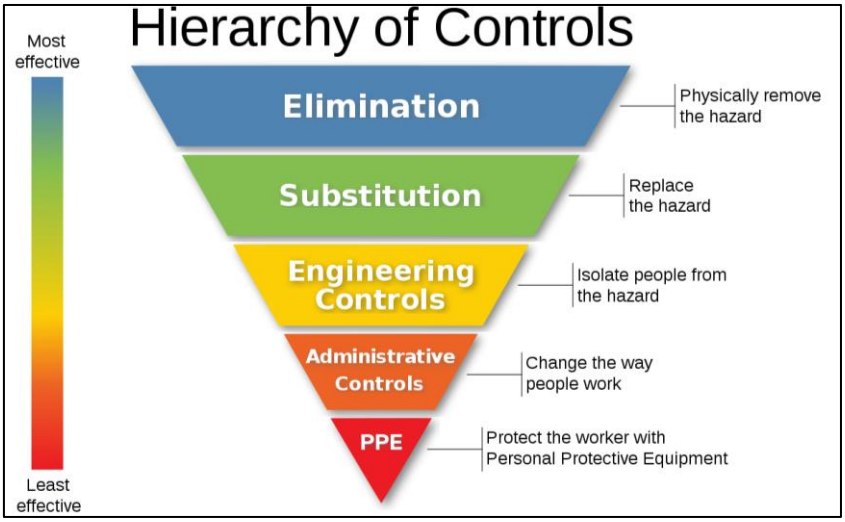


Figure 12 – Hierarchy of Controls

Once the controls have been assessed and implemented, the risk category rating (after controls) can be calculated. This calculation employs a 5 x 5 risk matrix approach.

How to Use a Risk Matrix:

To make it easy to determine a consistent risk rating for each hazard, it is useful to have a tool that combines the likelihood of an accident or incident occurring with the potential impact. This analysis can be conducted easily through employing a risk matrix. **More information on the Risk Matrix can be found via UC Policy Number UCPL-4-221.**

Likelihood						
	Almost Certain (5)	Moderate *(5)*	Significant *(10)*	Major *(15)*	Catastrophic *(20)*	Catastrophic *(25)*
	Likely (4)	Moderate *(4)*	Significant *(8)*	Significant *(12)*	Major *(16)*	Catastrophic *(20)*
	Good Possibility (3)	Minor *(3)*	Moderate *(6)*	Significant *(9)*	Significant *(12)*	Major *(15)*
	Possible (2)	Minor *(2)*	Moderate *(4)*	Moderate *(6)*	Significant *(8)*	Significant *(10)*
	Highly Unlikely (1)	Minor *(1)*	Minor *(2)*	Minor *(3)*	Moderate *(4)*	Moderate *(5)*
	Risk Matrix	**Minor (1)**	**Moderate (2)**	**Significant (3)**	**Major (4)**	**Catastrophic (5)**

Impact

Levels of Risk:

Catastrophic (20-25)	Risk Treatment Strategies to be implement by DSO and must be taken to HoD for approval
Major (15-16)	Risk Treatment Strategies to be implement by DSO and where relevant, taken to HoD for approval
Significant (8-12)	Risk Treatment Strategies to be implemented by DSO
Moderate (4-6)	Acceptable – to be managed under normal control procedures
Minor (1-3)	Acceptable – to be managed under normal control procedures

Once the risk category rating (after controls) has been calculated, it should be added to the hazard and controls table.

An example is shown below in table 6.

Table 6 – An example Hazard & Control Table

Hazard Description	**Hazard Location**	**Summary of Controls to be Applied**	**Probability Before Controls**	**Consequence Before Controls**	**Probability After Controls**	**Consequence After Controls**	**Risk Category Rating (After Controls)** **Severity x Probability**
Use of liquid Methanol HSNO Classes: 3.1B 6.1C (Dermal) 6.1C (Inhalation) 6.1C (Oral) 6.4A 6.8B 6.9A	205	Wear PPE and use in accordance with CAPE safety manual guidelines. Work in fume hood. Considered the use of ethanol (lower toxicity) Reduced size of experiment from 1 L to 50 ml. Stored in flammable cabinet when not in use.	3	4	2	2	4

Upon completion of the form the Assura system will push you application to your supervisor who will sign off on your experiment.

Once this is completed, the safety officer will review your completed checklist and assign the appropriate technicians (chemical, electrical and/or mechanical) for review and approval. The technicians will review your checklist and supporting documents and will contact you should they have any questions or concerns about the information provided.

You will be contacted when the Safety Officer has issued the Orange Card.

- Orange cards are only valid for a year and the process must be repeated annually.
- For minor modifications including using additional chemicals, seek advice from the Safety Officer or the Lab Manager. In most cases, a simple attachment is the only modification required to your original Hazard and Risk Checklist (plus the inclusion of any new SDS into the appropriate folder if applicable).
- If an experiment is significantly modified including significant apparatus modifications, or significant changes in operating conditions, then the Hazard and Risk Checklist should be repeated, and a new Orange Card issued. Seek advice from the appropriate technician to determine if your modification is considered significant.

Working Outside of CAPE Labs:

If your experiments are going to be completed outside CAPE labs, different hazard assessments may be required

- Other University of Canterbury labs – either a H&R or Low Risk checklist must still be submitted unless the host department has something equivalent (some departments do, and some don't). All CAPE safety rules, and the host department's safety rules must be followed. In the case where one set of rules is stricter, then the stricter safety standard must be followed (e.g. – use of safety glasses, goggles, lab coats). So, for example, if the host department has an optional safety glasses policy, then CAPE students are required to wear safety glasses. An exemption to adopt non-CAPE requirements can be made by the supervisor.
- Controlled settings off-campus (e.g. - industry site) – Work off-campus as part of ENCH 495, ENCH 690, ENCH 790 or a similar course, still requires a H&R checklist to be completed. However, equipment numbers are not required and checks by the various technical staff are not required. In addition, answers to the questions below must be submitted with the H&R checklist.

  The company's safety culture should be explicitly considered by the supervisor prior to any student working at their location. Things that should be investigated and explained on the H&R checklist include:

  - What safety induction will the student(s) receive?
  - Does the company have an available Health & Safety policy specific to the site?
  - What PPE will be provided to the student(s)?
  - Do they have an accident/near-miss file that is readily accessible?
  - What is the chemical handling environment?
    - If you are collecting samples to bring back to the University, how will they be transported (receptacle/method of travel)? Note: Samples must be transported directly from location to University. You must seek advice from

an approved chemical handler before personally transporting hazardous chemicals to/from the University. Seek advice from the Safety Officer.

- Will you be working at height (e.g. – scaffolding, top of a vessel, etc.)?
- Is there a potential of entering an enclosed space (e.g., reactor, tank, container, ditch, pipe, etc)?
- How are the risks of new and on-going projects/experiments/processes assessed?

If the supervisor has never visited the site, in most circumstances they should before the student(s) commences work. Note – CRIs and companies well known to the Department are unlikely to require an additional safety assessment, but an approval/paper trail is still required for consistency.

- Uncontrolled settings – This situation occurs when working in the field such as collecting biological samples. This situation requires review of the University Protocol along with a normal H&R checklist. If the fieldwork/uncontrolled setting is part of work at another organisation, please seek advice.

Section 16:
Emergency Response

The University website has information on several different types of emergencies that could possibly happen on campus and the appropriate emergency response procedures to follow. Examples include earthquake, medical emergency, or bomb threat.

These procedures are displayed around the department as flip charts which are located on the health and safety notice boards. This document will just cover the emergencies that have a somewhat higher probability in CAPE.

Evacuation

In the event of an evacuation for fire, CAPE evacuation location is:

- the grassy area out the front of the Rāta on Creyke Roadside

A map covering evacuation areas for all buildings on campus is available at here.

In the event of a serious earthquake and you are not able to leave campus, the two main evacuation points are the parking lot off Engineering Road outside Communications Disorders and the main evacuation location is Ilam fields.

Fire

The worst mistake that can be made on discovering a fire usually stems from a natural reluctance to cause a disturbance. Many serious fires have developed from a failure to inform the Fire Service quickly or to evacuate the building whilst the opportunity exists. The priority must be to save lives. Therefore, if a fire occurs, contact the Fire Department by calling 111 or operating the nearest alarm and then telephone Security, (92111 or 0800 823 637 from a cell phone), and inform them of the situation. Often the emergency responders do not know the campus well and Security will help them find the appropriate location.

Use a suitable fire extinguisher to contain or extinguish the fire if you feel you can. If the fire is beyond such measures, leave the building and report to the Building Warden at the Building Clearance Board (see “Fire Wardens’ Clearance System”). The quick and orderly evacuation of all persons in the building

is of vital importance whenever alarm sirens or bells are sounded. Acquaint yourself with the location and nature of fire extinguisher equipment available in your work area.

Fire Wardens' Clearance System – The clearance system in the event of a fire alarm is based on confirming rooms and areas have been cleared through staff assuming the responsibility of Floor Wardens and Building Wardens.

Floor Wardens – all staff are considered Floor Wardens. If you pass one of the orange arm bands that hang on the wall in various locations when you are evacuating, it is your responsibility to confirm the floor has been cleared, if it is safe to do so. Follow the directions posted with the arm band.

Building Wardens - When the floor is clear, the Floor Warden reports to the Building Warden clearance board. For CAPE building this is located on level 1 at the north entrance near the stair well. For the Special Purpose labs, it is located outside the building on the wall next to Forestry Road. For the LINK building it is at the east end of the ECE wing

Each building has a designated Building Warden. Glenn Wilson for the CAPE building. For the Special Purpose Labs, the Floor Warden must also assume the Building Wardens duties. Once the Floor Wardens confirm what parts of the building have been cleared, Building Wardens then report this to the Area Warden who will be located at the Fire Panel Control board. It is possible that a Floor Warden may have to assume the Building Warden duties, as for the Special Purpose Labs, if the designated person is unavailable.

These procedures, when completed by the Floor and Building Wardens will indicate vital information to the Chief Fire Officer. The buildings must not be re-entered until the 'ALL-CLEAR' is given by the Fire Service.

Academics have evacuation responsibilities for lecture theatres when they are lecturing. These are described in each room. Please review when using a new room.

Accidents Involving Harmful Chemicals and Gases:

Clear the area of all persons and pass the alarm by word of mouth but *don't* activate the fire alarms. Telephone the Fire Service by dialling 111. Also, ring Security (92111 or 0800 823 637 from a cell phone) and contact the Building Warden.

Fire Exits - All emergency fire exit doors are to remain closed at all times except in an emergency. Internal smoke doors must not be held open except for those that have automatic holds that release when an alarm is activated.

Security – University Security can be reached at 92111 from campus phones or 0800 823 637 from a cell phone. For non-emergencies, call 364-2888 from off campus or 6-888 on campus. It is a good idea to add these numbers to your cell phone.

- Do not allow anyone who you don't know to enter the Department after-hours. They must use their own swipe card. If you are pressured or bullied into this, please ring Security, and report it. This stops thefts and the possibility that someone could be assaulted by an intruder.
- If you see anyone in the Department acting oddly who you don't know, please ring Security. There is no harm in being cautious.

- When leaving the Department after-hours, it is best to walk along the safe walking routes that are regularly patrolled.
- Anyone who requires an escort to their car, or the bus stop is welcome to call Security at 6-888. Note: leave sufficient time as there could be a delay in them arriving.

Section 17:
Electrical Safety

If your project or other work will use electrical equipment (other than computers and low-voltage battery-operated instruments), you must read and become familiar with this section.

It is of the upmost importance that you make use of the skills and advice of the technical staff within the department. You must not construct any electrical apparatus to be used by yourself or other people without the Electrical/Electronic Technicians approval of its construction and electrical safety.

All electrical equipment that requires a connection to the 230- or 400-Volt electrical supply must have a current electrical safety test tag or label attached to it, this includes power leads, extension leads and power board/ multiway/multi-plug power strip). Personal equipment requiring 230 V must be checked before it is used in the Department.

The following points may help to overcome problems in the construction and use of electrical equipment:

- Prior to using any equipment, you must familiarize yourself with all controls and adjustments by reading the Operating Manual and/or seeking advice and guidance from Electrical/Electronic Technicians. If the equipment requires servicing or an electrical safety test the technician will arrange to have this done.
- When you design any new equipment, you must consult the Electrical/Electronic Technicians about the electrical, electronic and instrumentation requirements.
- Researchers cannot modify electrical wiring on equipment where the voltage exceeds 24 V.
- A Residual Current Device (RCD) must always be used with all experimental equipment involving water, portable electrical tools, and inspection lamps. In the CAPE building all labs have RCDs inbuilt. However, in the Special Purpose Labs, only some mains circuits do. In unprotected Labs an RCD needs to be installed between the equipment and the wall socket. The Electrical/Electronic technicians will advise on this and make sure the equipment is safe to use.
- Each single or double outlet is limited to a maximum of 10 A or 2.4 kW. To prevent overloading and having the circuit breaker open, it may be necessary to plug high current devices such as water bath controllers, hot plates or other heaters into separate outlets to spread the load.

Batteries:

Return all used batteries to the Electrical/Electronic Workshop for correct disposal.

Using Equipment Outside the Department:

All equipment removed from the Department must be registered with the Technical Services Manager so we can find it in the future, even if in another department. Finding equipment loaned out to others or used in another department by CAPE staff and inadvertently left behind is difficult and time consuming without a record.

Section 18:
Compliance / Penalty Policy:

While we hope not complying with safety rules will only be an occasional oversight by researchers, penalties are required for repeated rule breaking.

Note: The department recognises accidents occur. Reporting an accident or near miss will never constitute a breach of safety rules. Identifying oversights in safety practice whilst working within the guidelines of your orange card, also does not constitute a breach of policy. Indeed, this is an essential part of an effective health and safety system where we aim for continuous improvement. However, consistently undertaking activities that are not in line with policy or that contradict the processes agreed in your hazard and risk checklist is not acceptable.

The Department performs unannounced safety tours approximately once a month to confirm compliance with the rules. However, everyone is encouraged to address noncompliance whenever they observe it, be it informally or formally through the Safety Officer. If a fault is identified that you are responsible for in the monthly tour, you must rectify it as soon as possible and then email the Safety Committee Administrator to let them know it has been addressed.

Below are the penalties for minor issues (e.g. – inadequate labelling of chemical storage containers). Breakage of significant rules (e.g. - disconnecting safety alarms or active risk reduction equipment) will jump straight to 2nd occurrence penalties. The Safety Officer will decide what constitutes significant versus minor non-compliance.

Non-compliance: Over a calendar year for minor issues

Undergraduate Students in laboratory classes

- 1st occurrence – verbal warning + name added to tracking list.
- 2nd occurrence – 2.5% off the final mark
- 3rd occurrence – refer to Safety Committee to determine further consequences (which may include referral to the Proctor or termination of lab access).

Postgraduates, research visitors/interns, Undergraduate researchers

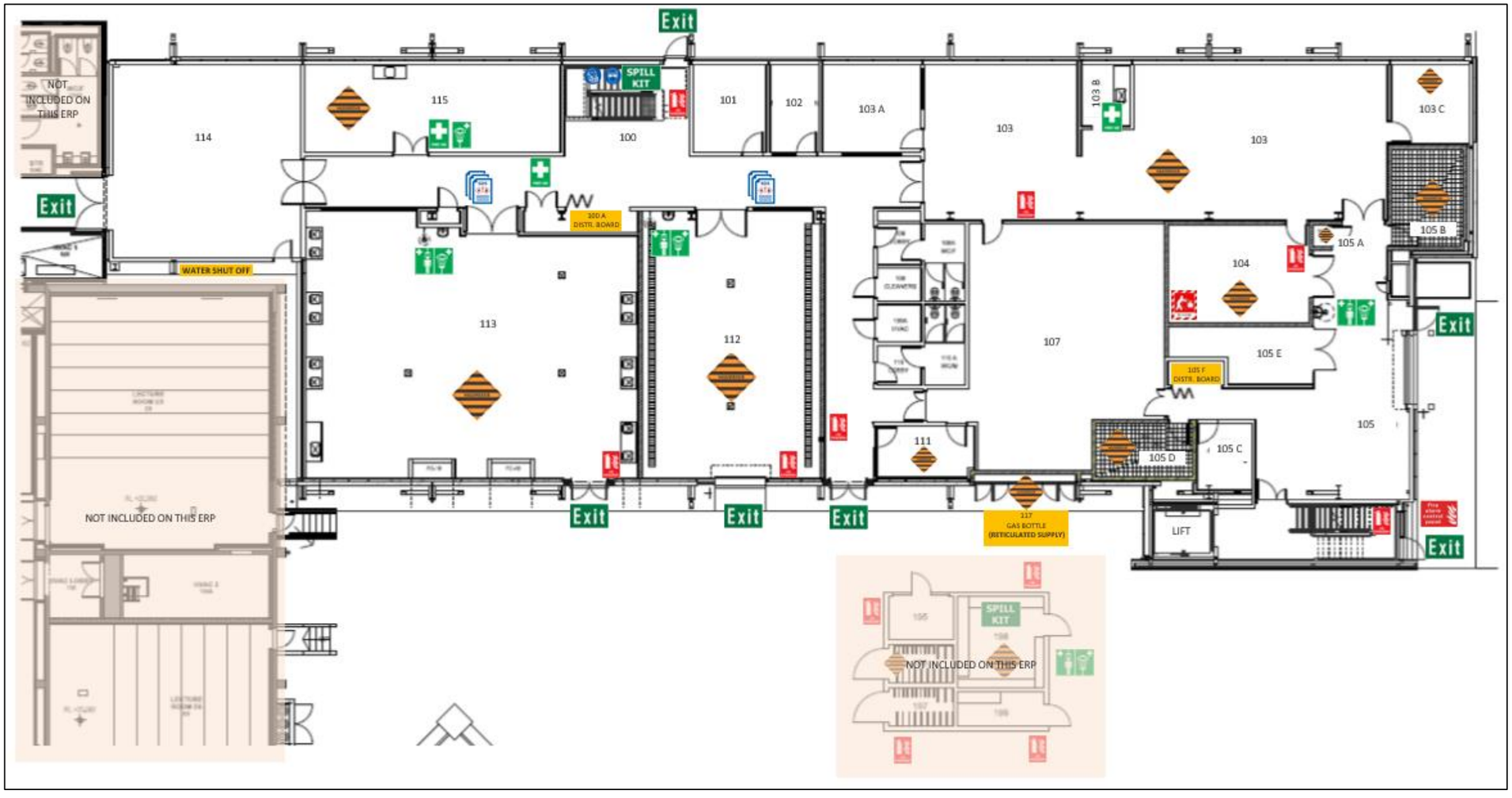
- 1st occurrence – verbal warning + name added to tracking list.
- 2nd occurrence – written warning + review lab access
- 3rd occurrence –
    - *ENCH 495 students* - ½ letter grade, loss of lab access for 2 weeks + meet with HoD for further review
    - *Postgraduates/visitors/interns* – loss of lab access for up to 1 month + meet with HoD for further review.

Staff on fixed term or permanent contracts

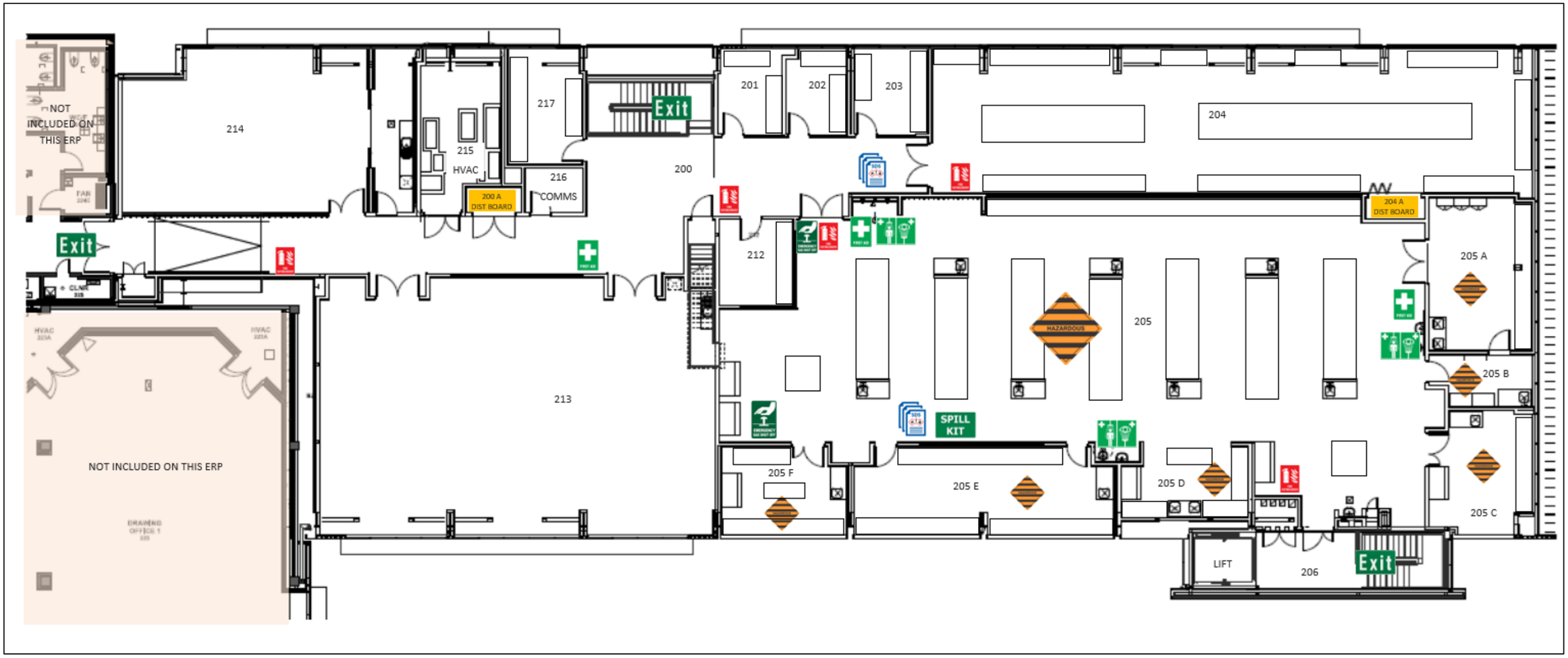
Health and safety is a core part of staff employment agreements and the staff code of conduct. Where breaches of the staff code of conduct occur by staff employed by the University under an employment agreement, matters may be dealt with in accordance with the staff member's employment agreement and the Employee Disciplinary Policy (Employee Disciplinary Policy)

Appendix 1: Cape Floor Plan

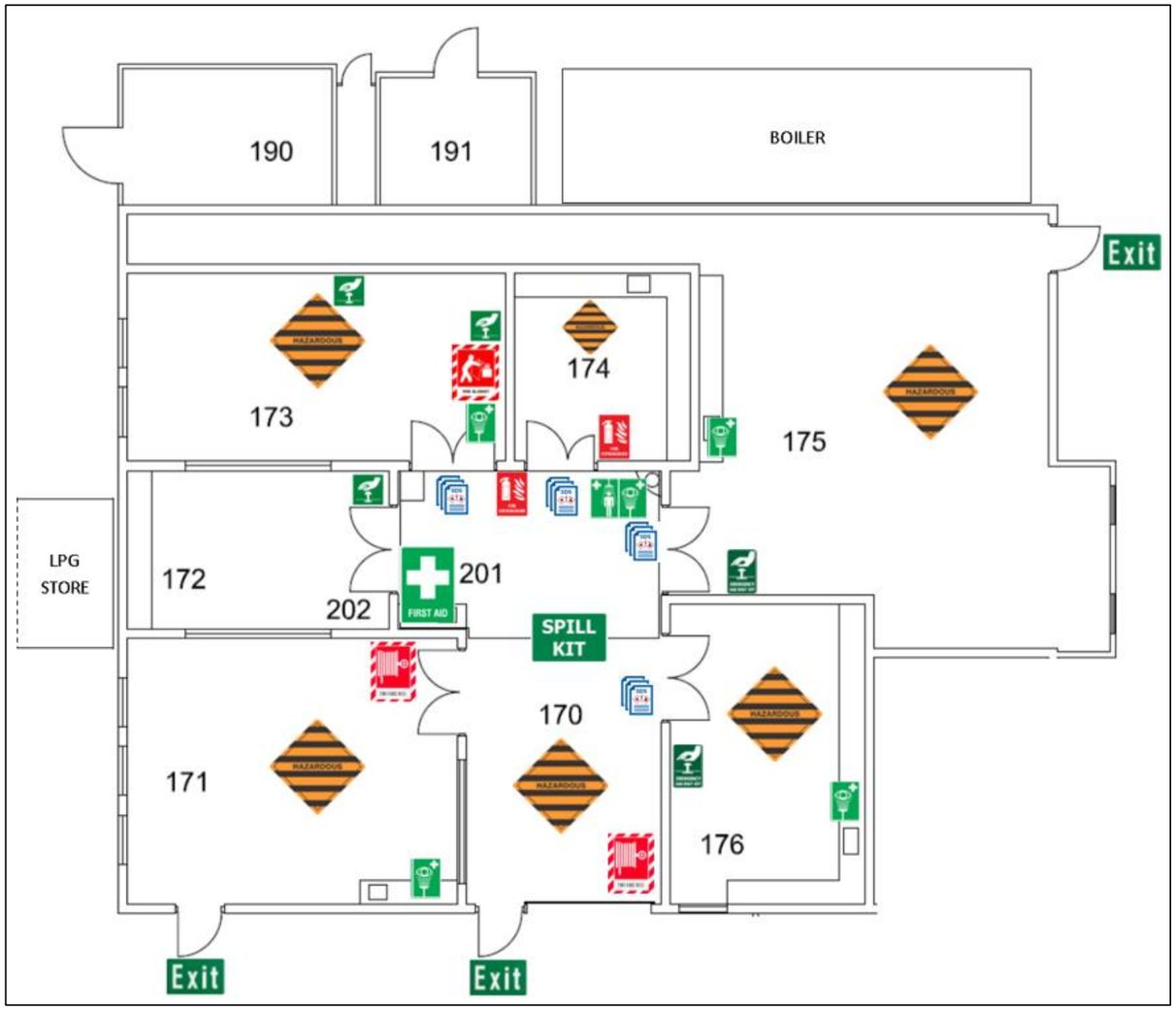
Floor Plan CAPE Level 1

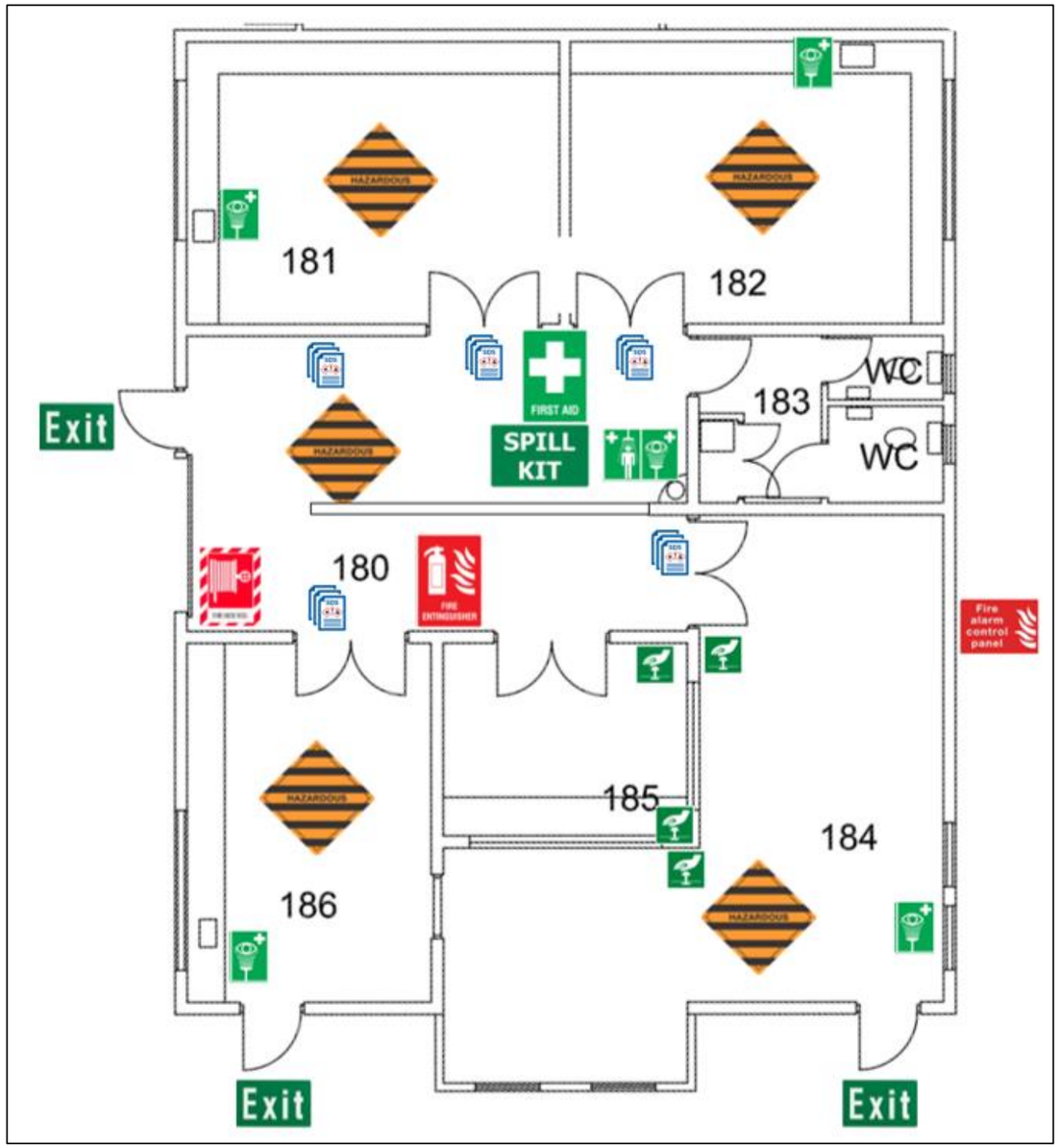


Floor Plan CAPE Level 2 (Showing Lab 205)



Floor Plan CAPE Special Purposes (SP) Labs





Appendix 2: Definitions, Terms and Abbreviations

- Lower/Upper Flammability Limit (LFL/UFL) – this is the concentration range in air sufficient to be ignited. e.g. – methane = 5% - 15%, toluene = 1.1% - 7.1% on a mole or volume basis. In the literature, the term "flammability limit" is interchanged with explosive limit (e.g., LEL/UEL).

  LFL information is readily available for pure compounds. Mixtures of vapours have a unique LFL based on relative volumetric percentage in air; if you have a mixture, seek advice. A high operating temperature lowers the LFL for compounds.

- Flashpoint Temperature (FP temperature) – this is the temperature when a flammable liquid's equilibrium vapour pressure exceeds the LFL for the vapour. Therefore, at temperatures above the flash point temperature, the vapour above the liquid can be ignited. (e.g. – toluene = 4 °C, n-butanol = 35 °C, diesel fuel > 62 °C). It is only relevant when a liquid is present. When a flammable liquid is diluted with a non-flammable liquid (e.g. – ethanol in water) the flashpoint temperature increases.

- Autoignition Temperature (AIT) – this is the temperature when a flammable vapour in the appropriate concentration range (LFL/UFL) does not require an external spark or ignition source to ignite. This temperature is generally much higher than the flashpoint temperature for a flammable liquid. (e.g. – toluene = 480 °C, n-butanol = 340 °C, diesel fuel > 210 °C).

  This parameter only relates to gas conditions and is most commonly a hazard when flammable gases are being compressed as part of normal operation or accidently pulled into an air compressor. Most flammable liquid or gas releases can find an ignition source eventually, so fire and explosion are significant hazard below the AIT.

Some additional terms that refer to exposure to toxic, airborne compounds include:

- WES: Workplace Exposure Standard
- WES-TWA: Time weighted average
- WES-STEL: Short-Term Exposure Limit
- BEI: Biological Exposure Indices

Appendix 3: Drain Disposal Decision Tree