

# Safety HandBook

**2017-2018** (revised 22.7.17)

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**This Safety Handbook carries only a brief summary of the Department of Chemistry Safety Rules. More detailed information and reference data can be found in the Safety Manual on the Internet at <http://www.chemistry.nus.edu.sg/PSSO/>**

## Emergency Telephone Numbers

CAMPUS SECURITY	6874-1616 (24 h)
	6516-2365 (Bioscience only)
Department Safety Office	6516-1672
Nearest Hospital (NUH)	6772-5000
Fire/Ambulance	995
Police	999

## Basic First Aid

**If anyone becomes unconscious following an injury, call 6874 1616 (security) if after office hours**

### Cuts

Control the bleeding by applying pressure over the wound with a pad of paper tissue or towel roll. Do not attempt to remove any broken glass etc. Seek medical attention.

### Avoid contact with blood

### Burns

Douse the burn with copious amounts of cold water e.g. under a running tap. Do not attempt to remove anything sticking to the burn. Seek medical attention.

### Chemicals

**On Skin:** Wash off with copious amounts of water. Seek medical attention if necessary.

**In Eyes:** If available use an eye-wash spray with the eyelids held open. Otherwise use a cold running tap. Seek medical attention if necessary.

**Inhaled:** If possible, move to fresh air. Seek medical attention.

**Swallowed:** Seek medical attention. Identify the chemical.

**Electricity**  
Switch off power. Call 6874 1616 for help.

**Other injuries - falls, blows**  
Call for medical attention.

## First Aiders

**In the event of a serious injury, use the emergency number 6874 1616 which accesses University Security on a 24 hour line.**

**For minor injuries, First Aiders may be called.**

Han Yanhui	64406	NMR Lab, S8-01-06
Jiang Xiaohui	68990	FST Lab, S14-05-02C
Lee Chooi Lan	68990	FST Lab, S14-05-02C
Leng Zhi Jin	62691	Lab Supplies, S5-B1
Lew Huey Lee	68990	FST Lab, S14-05-02C
Gideon Lin Hansheng	62690	Physical Lab, S5-01-05
Ong Bee Hoon	62685	Analytical Lab, S8-04-03

**IN CASE OF SEVERE ACCIDENT, RING 6874 1616 FIRST.**

## First Aid Boxes

First Aid Boxes should be kept stocked according to the list posted on the front or within the box. If the plastic lock is broken, the items taken need to be replaced.

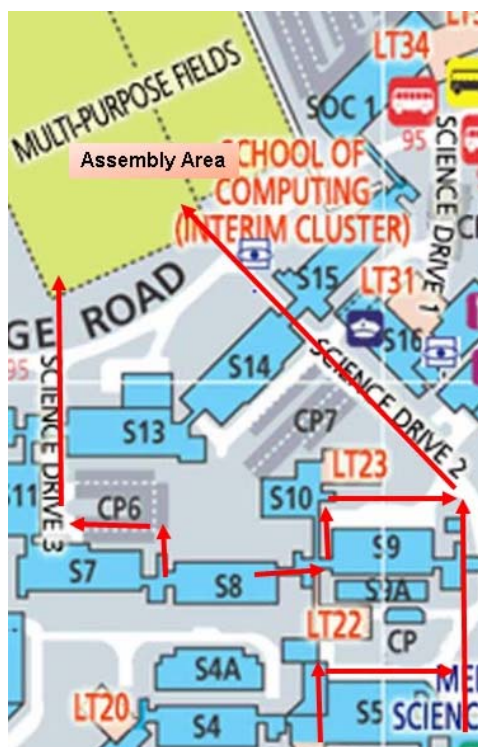
**All First Aid material is available from the Chemistry Store and Staff in charge of laboratories should nominate a member of that laboratory to see that the stock of the First Aid box is regularly maintained.**

## Emergency (Fire) Alarms

The buildings in the Chemistry Department are equipped with a fire detection system that will sound the alarms if a sensor detects flame, heat or smoke or if the break-glass alarm button is activated.

There is unfortunately a high incidence of false alarms on campus due to ageing and defective fire detectors. **In the event of an alarm, spend a few seconds** only in turning off heating equipment or making your experiment safe before leaving the building by the route that has been described to you. Do not use the lifts. Assemble at the designated area for a roll-call.

Do not attempt to enter the building until you have been told it is safe to do so.



## Coping with an Emergency

**Normal Working Hours:** These are from 8:30 a.m. to 6:00 p.m. Monday to Thursday and 8:30 am to 5:30 pm on Friday.

**Precautions** Know at least *two* routes from your workplace to an Exit.  
 Know the locations of: **Telephones, Fire Extinguishers and Blankets, Fire Alarm Points, Safety Showers, Eye Wash Stations and First Aid Boxes.**  
 Know how to contact Campus Security.  
 Know how to switch off electricity, gas, water etc. in and around *your* workplace.

**Evacuation Procedure** All tests sounding of the alarms will be notified in advance. **In the event of an evacuation, follow the route given in the Dept of Chemistry Emergency Evacuation Route map. Never use a lift.** Assemble away from danger and clear of the building. Do not re-enter the building until you are told that it is safe to do so.

**Fire** If the fire is clearly minor, tackle it with an extinguisher **but do not endanger yourself.** Normally the sensors will detect any fire and the Alarm will operate automatically. Otherwise, operate the nearest Alarm Point and call Campus Security at 6874 1616

**Escape of Toxic Material** Leave the area immediately. Close all doors on exit. **Operate the nearest Fire Alarm Point.** Warn people to avoid the affected area and inform Campus Security at 6874 1616.

**Aiding an Injured** Either phone for a First Aider or if more serious call Campus Security

**Person** at 6874 1616 first, then a First Aider. **Even if the Alarms sound, do not attempt to move the injured person out of the building unless there is imminent danger.** Stay with the injured person until help arrives. If the injury is slight they should be taken by taxi with a First Aider in attendance or, if the injury is more serious, by Ambulance.

**Flood** If it is obvious, stop the leak; phone Campus Security at 6874 1616. Warn people in labs below to safeguard papers and equipment. **Do not attempt to move wet electrical equipment until it is disconnected from the mains.**

**Failure of Mains Service** Failure of fume-hood, gas, water, electricity or lift during working hours, call Maintenance Response Centre at 1515. **Out of hours, call Campus Security at 6874 1616.**

<b>Emergency Telephone</b>	<b>Departmental Safety Officer Security</b>	<b>61760</b>
	Maintenance Response Centre	<b>62365/6874 1616</b>
	Police	61515
	Fire/Ambulance	999
		995

## Health and Safety Procedures in the Department of Chemistry

The Internet based "Safety Manual" may be found at <http://www.chemistry.nus.edu.sg/PSSO/>

If your time is to be spent in Office or Computing work solely, the information that you need to absorb will not be great, but for those working in workshops and laboratories, there is much more, in keeping with the greater potential hazards in those areas, hence it is important that you spend some time to read the Safety Manual.

The list of people involved with Health and Safety in the Department of Chemistry can be found on Page 15 of this Handbook or in the Safety website at:

<http://www.chemistry.nus.edu.sg/PSSO/safety/People.htm>

A statement of Health and Safety Responsibilities, including yours, can be found at:

<http://www.chemistry.nus.edu.sg/PSSO/safety/Policy.htm>

<http://www.chemistry.nus.edu.sg/PSSO/safety/RSPI.htm>

## Risk Assessments

**If you are a member of Academic or Supervisory Staff**, you should read the following information, as it applies to different categories of Personnel, as a guide to the application of Health and Safety procedures within the Department of Chemistry.

**Risk Assessments** are procedures to estimate the risks to Health and Safety associated with any work activities you perform and to devise rules and methods of work to minimise these risks. The Workplace Safety & Health Act requires that Risk Assessments be carried out for all work that you do and that you are informed of the outcome of the assessment and are trained to carry out your duties safely. The Risk Assessment procedure applies to all kinds of work activities from the use of computer equipment to the manual handling of heavy items.

**If you are not working in a Laboratory or Workshop**

If your workplace is not a laboratory or workshop, e.g. if you are a member of the Secretarial staff or a researcher carrying out a project which is purely computational, then the only Risk Assessments you need to read are those concerning **General Office Work, Visual Display Equipment** and **Standard Electrical Equipment**. You can access these from the list at:

<http://www.chemistry.nus.edu.sg/PSSO/safety/risk/office.htm>

**If you are a Researcher**, you need to record the fact that you have read these Assessments and so you should go to the Section below entitled "**Forms you need to complete**".

**If you are working in a Laboratory**

**Risk Assessments:** If you are carrying out research work, your Supervisor should supply you with a copy of your **Project Risk Assessment**. This will give you some guidance as to the individual Prepared Risk Assessments relevant to your Research Project which you must read and then undergo any necessary training. The full list can be found at:

<http://www.chemistry.nus.edu.sg/PSSO/Safety/Risk/risk.htm#Common>

You should also complete a comprehensive activity-based risk assessment for your work. This is the Excel template where each step in an activity is considered. **The Project Risk Assessment form and the detailed comprehensive risk assessment forms should be kept in your lab** for reference.

**Teaching Laboratory Technical Staff**

There are specially Prepared Risk Assessment documents and forms for Teaching Laboratory Technical Staff.

**If you are working in a Workshop or Stores**

Local specific rules and Risk Assessments apply if you are working in Stores or Workshops.

## **Forms you must complete**

If you are carrying out research work in the Department of Chemistry, once you have read the appropriate **Prepared Risk Assessments**, then you must:-

- Complete the **Risk Assessment Record Form for Graduates and Research Workers** remembering to indicate your status (Graduate, Research Fellow, etc.) and giving a brief description of your Research project.
- Sign the form and have it signed by your Supervisor.
- Keep the form in your lab safety folder.

**You must renew the form if the nature of your research project changes substantially.**

**When you have finished** research work, you are required to clear any chemicals, samples, equipment etc that you may have used. A form to indicate that you have done so is available and further information can be obtained at the website.

## Preventing Fires and Floods

A laboratory door signage must be clearly posted outside each lab. The form gives details on the person(s) to contact in case of emergency and the type of hazards to be expected in the lab. The form can be downloaded from <https://www.nus.edu.sg/osh/labsign/default.aspx>.

**Fire:** Apart from the obvious dangers of horrendous injury and even death, fires are enormously destructive. **Remember, after a fire, you may have lost all of your work and your equipment will be gone.**

**The Fire Detection System:** All parts of the Department of Chemistry are fitted with fire detectors that are on alert at all times. A red light appears when a detector is activated, the alarms sound and you must leave the building until the alarm is over.

**Take great care to avoid causing “false” alarms. However if you think that something you have done has caused the alarm, inform Campus Security at 6874 1616 immediately.**

**Solvents in Laboratories:** You should store only a working minimum of flammable solvents in your laboratory since, in the event of fire; excess amounts of solvent could endanger life and the fabric of the building. **In any case, under the Fire Safety Regulations (2005), the maximum quantity of flammable liquids (L) stored in any one laboratory or workshop is based on 1.6 x floor area of the lab in m<sup>2</sup>.** As far as possible, and certainly overnight, solvents should be stored in the ventilated safety cabinet provided for the purpose.

**Leaving a Laboratory or Workshop:** When you leave your workplace in the evening or during the day if you are to be away for long, you have the responsibility to check that:

- there are no obvious problems with reactions or equipment left running (these should be properly labelled).
- unnecessary electrical equipment, e.g. ovens, are turned off and **no naked flame or flammable gas is left on;**
- flammable solvents are properly stored in closed storage cupboards;
- fume-hoods are closed;
- lights are turned off ;
- fire doors and other doors are closed.

**Floods:** Apart from the damage they can cause to equipment and paperwork and the considerable inconvenience to victims, floods can be dangerous, for example, by bringing down ceiling boards and wetting live electrical equipment. The greatest care must be taken to avoid floods.

**Water Cooling Connections.** Plastic tubing carrying cooling water to rotary evaporators, diffusion pumps or any other semi-permanent or temporary systems **must be fastened on to the apparatus and the water taps with wire, plastic tags or screw clips.** The exit tube must pass the water properly down a drain which is able to cope with the flow and be anchored to prevent splashing or ejection if the water pressure rises.

## Personal Safety

*General principles-*

- Think before you start a piece of work.
- Wear the proper protective equipment.

- Never work alone.
- Keep your workplace tidy

### ***Eating, Drinking or Smoking***

Eating or drinking is forbidden in laboratories and workshops and smoking is forbidden in all parts of the Building. Eating or drinking is only permitted in designated student areas where there is no contact with chemicals.

### ***Protective Clothing***

**Safety Glasses** Safety Glasses are available from Lab Supplies – payable from your supervisor's grant for the first pair but you must pay for replacement of losses. Safety Glasses must be worn in all designated areas and whenever you are handling chemicals, glass vacuum or pressure apparatus and equipment with moving parts.

**Contact Lenses:** There is an ongoing debate as to whether it is safe to wear contact lenses in a Chemistry Laboratory. The most important advice remains: **wear Safety Glasses.**

#### **Laboratory Coats**

Wearing a lab-coat can give considerable protection against splashed chemicals and flash burns. Lab-coats must be worn in areas where wet chemistry is carried out. **This is the case in all synthetic chemistry laboratories.**

#### **Protective Gloves**

Disposable gloves give short-term protection against some chemicals but some solvents may attack them. Many grades of gloves can be obtained which offer more, or less protection.

See [http://www.aps.anl.gov/Safety\\_and\\_Training/User\\_Safety/gloveselection.html](http://www.aps.anl.gov/Safety_and_Training/User_Safety/gloveselection.html) for full details of available gloves and guidance for their use. Even if you have been wearing gloves, wash your hands frequently when working.

**Never wear rubber or plastic gloves when working with a naked flame. Never wear gloves outside the lab. Gloves should not be worn for handling computer terminals, any equipment or door knobs.**

#### **Shoes**

Shoes which **fully** cover the feet and toes and not slip-ons should always be worn in a lab to protect against chemicals and glass cuts. Sandals, flip-flops, clogs, backless shoes, cloth shoes, open-toed shoes, high heeled shoes and stiletto-heeled shoes are **strictly** not allowed. In the laboratory, wear shoes with uppers made of leather or polymeric leather substitute.

#### **Personal Attire**

Clothing must offer good protection against chemical spills and splashes. Tank tops, off-shoulder tops, halter-necks and shorts are not allowed. Legs and waists must be covered by your clothing. Excessively loose and flowing clothing should not be worn to labs.

### ***Fume-hood Safety***

Fume-hoods in the Department of Chemistry are of the built-in ducted type that vent to the outside through outlets on the roof. The sashes should be kept down as far as possible for maximum efficiency in coping with the removal of vapours.

### ***Chemical Safety***

It is mandatory under the Workplace Safety & Health Act to make a Risk Assessment of your work before you commence. These include an assessment of the health risks to you in handling chemicals **before the materials are used.** There are several legislations in Singapore relating to the use and storage of chemicals. Please refer to OSHE's website at [https://inetapps.nus.edu.sg/osh/portal/chem\\_safety/chemsafety.html](https://inetapps.nus.edu.sg/osh/portal/chem_safety/chemsafety.html) and inform yourself on the relevant chemicals.

The following points are worth emphasising:



**Common Solvents** Many common solvents, e.g., CH<sub>2</sub>Cl<sub>2</sub>, are toxic and in handling (or spilling them) in the open laboratory you may exceed danger limits for the vapour concentration. Use an effective fume-hood whenever possible. Dusty substances can be as dangerous as highly volatile substances both in toxicity and in explosion risks.

### Spills

Absorbent materials to mop up spilled solvent are available at Lab Supplies or in the laboratories. **If you are using large amounts of acid or base or any amount of strongly smelling material you must keep a neutralising agent at hand.**

### Carcinogenic Materials

**Category 1** - substances known to be carcinogenic to humans. There is sufficient evidence to establish a causal association between human exposure to the substance and the development of cancer. **Category 2** - substances that should be regarded as if they are carcinogenic to humans, for which there is sufficient evidence, based on long-term animal studies and other relevant information, to provide a strong presumption that human exposure may result in the development of cancer. **Category 3** - substances that cause concern owing to possible carcinogenic effects but for which available information is not adequate to make satisfactory assessments.

**Categories 1 and 2**, if purchased from a supplier will carry the "toxic" (T) symbol and the [Risk Phrase](#) R45 (**May cause cancer**) or R49 (**May cause cancer by inhalation**). **Category 3**, if purchased from a supplier carries the "harmful" (Xn) symbol and the [Risk Phrase](#) R40 (**Limited evidence of a carcinogenic effect**).

### Cyanides

Great care must be taken when working with cyanides. The use of cyanides outside of normal working hours is forbidden.

### Hydrofluoric acid

**Great care must be taken when working with HF. The use of HF outside of normal working hours is forbidden.** At concentrations above 1M (2%) in water, HF can cause very painful burns that may not be apparent for some hours. Always wear gloves, a lab-coat and safety glasses when using this acid. Have available a tube of "**HF Antidote Gel/Calcium Gluconate**" which should be applied if concentrated acid contacts the skin.

In the event of HF accidents, contact Safety Officer Junaidi (61760) or A/P G. K. Chuah (62839).

### Electrical Safety

#### Notice the danger signs

On all electrical equipment you use, watch for signs of wear on the cable and insulation problems where it connects to the plug or equipment. Replace or rectify as necessary.

#### Plugs and Fuses

If you put a mains plug on a piece of equipment, follow the wiring colour code:

BROWN	LIVE
BLUE	NEUTRAL
GREEN-YELLOW	EARTH

**Use the correct fuse for the equipment.**

#### Water and electricity

Wet electrical equipment is very dangerous. Disconnect from the mains before touching it. **Beware of wet heating mantles.**

#### Safety Testing

All portable electrical equipment (i.e. equipment that can be unplugged) must be tested regularly.

New, second-hand and old equipment must be tested before being brought into use.

Equipment that carries a "Failed" sticker must never be used.

### ***Mechanical Safety***

**Carrying solvents** Winchester bottles of solvents may be carried in the corridors or lifts only in carriers (maximum load per person, two carriers) or on appropriate trolleys

**Rotary equipment** Equipment with rotating parts, e.g. stirrers, rotary evaporators, rotary pumps must not be allowed to catch hair or clothing or any trailing wires or tubing.

**Gas cylinders** Large cylinders of compressed gases must be moved only in proper trolleys (which are designed to be pushed, not pulled) and transferred carefully to positions where they can be securely strapped. Only cylinder in use can be in the lab. If a cylinder trolley is showing signs of wear or is giving any trouble, inform Lab Supplies.

There are a number of types of regulators in use with different pressure scales: mark on your regulators the maximum safe pressure for routine work in your laboratory.

**Never attempt to fit compressed gas cylinders if in doubt.**

### ***Glassware Safety***

**Evacuated glassware** When glassware under vacuum breaks, the implosion may spray glass pieces around. So, any glass Dewar vessels or evacuated flasks must be covered with strong sticky tape, plastic netting or be metal shrouded.

**Glassware under pressure is even more dangerous and should only be used with total containment.**

**Broken glass and empty bottles** Broken glass or used disposable pipettes and other items, may be put only in waste bins labelled **Sharps** - this is for the safety of cleaning staff who empty waste bins.

**Empty glass bottles can be disposed in the special bins provided at the Technical Solvent Store. They should be disposed during solvent collection times. Before they leave your laboratory it is vital that all bottles for disposal are treated in the following way:-**

- Any sodium residues in bottles must be carefully destroyed and the bottles washed with water;
- All bottles should be completely emptied of solvents and chemicals then washed and dried to the extent that there is no residual odour from them. Label the bottles with your name and the PI.

### ***Cryogenic Safety***

**Refrigerators and freezers** An **explosion-proof fridge** must be used for chemicals. Do not use your refrigerator or freezer as a dump. Make sure everything you put in is tightly sealed in a way that will not leak when cold. Check the contents frequently and discard unwanted samples. **Food must never be stored in a refrigerator used for chemicals.**

**Liquid N<sub>2</sub>/ Solid CO<sub>2</sub>** **These substances can freeze-burn you.** Equipment cooled outside by liquid N<sub>2</sub> but open to air will allow liquid O<sub>2</sub> to form **inside** which can create a dangerous pressure rise on warming or an explosion with flammable material. Use liquid nitrogen to cool sealed or evacuated systems only.

See <http://www.chemistry.nus.edu.sg/PSSO/safety/risk/cryogenic.htm> for handling, transportation and storage of liquid nitrogen. Transport of liquid nitrogen in public lifts is especially dangerous. To avoid in possible risks

from nitrogen boil off during, for example, a prolonged period of lift breakdown, Dewars of liquid nitrogen **must not** be accompanied in lifts. Rather, two people should be assigned to transport the Dewars, one to load and one to receive at the destination floor. To prevent others from entering the lift, fitted straps should be pulled across the entrance.

### ***Radiation and Laser Safety***

#### **Radiation**

Only Radiation Workers who have been licensed to be engaged in radiation work are allowed to handle radioactive materials and waste resulting from radioactive materials they have used. Proper control, safe packaging and identification of the waste before the waste must be ensured for safe handling by nonradiation workers. You must keep the internal dose to yourself and others as low as practicable by (a) use of protective clothing; (b) employing good laboratory techniques to minimise surface and air contamination; (c) not eating, drinking or using of cosmetics etc. in the laboratory. You must monitor:- (a) your working area for contamination before and after each working session; (b) your work station for level of activity whilst you are working; (c) yourself by wearing any appropriate Thermo-Luminescent Dose (TLD) badges. You must (a) record all accessions and transfers on the record forms; (b) record waste route destinations every time an isotope is taken from stock; (c) keep all stocks secure; (d) report any incidents (e.g. spills) and follow procedure on room notice.

#### **Laser**

The major health risk for persons working with lasers is the potential for eye injury. Eye protection is required when working with lasers in and above Class 3b. Laser radiation should be discharged in a non-reflective and fire-resistant background. The appropriate safety goggles for the laser class must be worn. Laser light should not be in the line of direct vision. No reflective attire should be worn. Pre-employment and post-employment eye examinations are required.

### ***Noise and Safety***

Changes in sounds are often a first indication that something is wrong with equipment or machinery. Try to keep background noises from pumps, shakers, compressed air jets, etc. at as low a level as possible for the comfort of everyone and so that you can hear when something is going wrong. **Noisy radios are not permitted in laboratories.**

### **The use of personal audio equipment which include earphones is forbidden in the research areas and teaching laboratories of the Department of Chemistry.**

### ***Out of Hours Working***

There are special risks from working in a laboratory in the Department outside normal working hours (8:30 a.m. – 6:00 p.m. Monday to Thursday, 8:30 a.m. – 5:30 p.m. on Friday) as help may not be available in the event of an accident. **It is the duty of all Research Supervisors to be aware of the work being undertaken by their students and to ensure that out of hours work is properly regulated.** The following rules apply out of normal hours:-

- **Undergraduates are forbidden to be in laboratories unless a member of the academic staff of the Department is present with them.**
- **Lone working is forbidden.** Make sure there is always someone within calling distance.
- Experiments that involve any measure of risk must be left to normal working hours. **No work involving Cyanides or HF may be carried out outside normal working hours.**

### ***Unattended Experiments***

Experimental work left running unattended poses special risks in terms of fires and floods and must be carefully controlled. The following rules apply:

- Unattended running of experiments may be carried out **only when absolutely necessary**.
- Experiments involving overnight refluxing of solvents **must be within a ducted fume-hood**. All water lines must be fixed securely.
- All experiments left on must have a notice on
  - stating **Experiment in Progress Please Leave On**
  - and indicating **potential hazards in plain English** e.g., "*Flammable solvent*", "*Contains Toxic Material*"
  - and the **name and telephone number** of the person who is responsible for it:- This must be a **realistic telephone number where you can be contacted at all times** because **you** may be called out at any time to deal with **your** experiment.
  - If at all possible, this information should also be posted in a prominent position external to the laboratory.
  - If an unattended experiment is set up in a fume hood, the **lighting for that fume hood should be turned on**.
  - Electrical equipment left on should carry a **Do Not Switch Off** notice in yellow card giving the name of the person leaving the equipment and a contact phone number. For **large permanent equipment** like Electron Microscopes, NMR equipment etc. contact numbers should also be posted external to the laboratory and **Emergency Electrical OFF** switches clearly identified within the laboratory.

### ***Pregnancy***

Certain chemicals, radiation and physical tasks pose a greater than normal danger to an expectant woman and to her unborn child. If you become pregnant, you should inform your Supervisor **in writing** - they may then be able to help you to avoid exposure to such agents and to any problematic tasks.

### ***Tidiness***

The prospect that you and your co-workers stay safe will be increased if you all keep your **working environment reasonably tidy and free of obstacles**.

## **Reporting Accidents and Incidents**

If there is a dangerous event in the Department, it has to be reported so that the Chemistry Safety Committee can suggest ways of avoiding a re-occurrence of the event.

**Dangerous incidents** are defined as unplanned events in which no one was hurt but which either had the potential to cause injury or did cause damage to apparatus, equipment or the building. **Accidents** are defined as events in which someone gets hurt.

All accidents and incidents are to be reported to OSHE via the online reporting system. ([https://inetapps.nus.edu.sg/osh/portal/eServices/ehs360\\_aims.html](https://inetapps.nus.edu.sg/osh/portal/eServices/ehs360_aims.html)). OSHE will then disseminate the information to the respective Faculty Safety Officers/Committee. **Please note it is mandatory under the Workplace Safety and Health Act to report any accidents/dangerous incidents.**

## **Regulations on Purchase of Chemicals**

1. All deliveries of chemicals and solvents to the Department of Chemistry must have purchase orders originating from Lab Supplies, Department of Chemistry. The online purchasing site (<https://www.chemistry.nus.edu.sg/chemstore/userlogin.wp>) should be used for purchasing of chemicals.
2. If you are unsure whether the chemical is controlled under the CWC, or Misuse of Drugs Act (Amendment of Third Schedule) Order 2014, etc., and a licence is needed for purchase, you can check at <https://www.nus.edu.sg/rci/Default.aspx>. The application for licence to buy the chemical is also online at this website.
3. Strictly no Cash-On-Delivery for purchase of chemicals and solvents.
4. When buying chemicals from companies in China or overseas, inform the company that the chemicals have to be properly declared to Customs and on the packaging, in compliance with IATA rules. Improperly declared chemicals will not be accepted and no payment will be made.
5. Irrespective of the source of the grant, purchases involving excessive amounts of solvents and/or chemicals to be stored in the Department of Chemistry will not be approved. Should it be necessary that large amounts of solvents and/or chemicals be purchased, arrangements should be made with the supplier for storage at their site and partial delivery be made on an as-and-when-needed basis. Written verification from the supplier is necessary.
6. No chemicals/solvents are to be sent directly to any individuals. All chemicals and solvents must be delivered to Lab Supplies, Dept of Chemistry, Science Drive 2, Blk S5 Basement Office, Singapore 117543.
7. All chemicals and solvents not purchased and delivered in accordance with the above procedures will be considered illegal.
8. All chemicals and solvents must be properly stored in the appropriate safety cabinets.
9. Lab Supplies sells technical solvents, acids, alkalis and some common lab chemicals daily. To purchase these, the Letter of Authorisation for Collection of Solvents & Chemicals must be signed by the PI and submitted to Lab Supplies before 11:30 am. The solvents can then be collected at 2:30 pm (on Mondays and Thursdays – solvent disposal days) or 3:00 pm (on Tuesdays, Wednesdays, and Fridays) at the Technical Solvents store. For flammable solvents, the maximum volume that you can purchase each time is 60 L (12 x 5L). You MUST return the empty canisters otherwise they will remain under your lab's inventory. Once the quantity exceeds the maximum allowable quantity (MAQ), your lab will not be allowed to purchase any more PFM-regulated chemicals.

## **Chemical Waste Disposal**

For safety and environmental reasons, regulations make the disposal of chemical waste difficult and costly. It is a matter of sensible economics as well as good practice to generate as little waste as possible and, wherever practicable, substances should be recovered and recycled.

At the end of research projects it is necessary to dispose of all unwanted products or other chemicals and researchers are required to follow the instruction for laboratory clearance described in the Safety Manual.

## Waste Chemicals

The PI of the individual research project is to make arrangements with a chemical waste disposal company for disposal of unwanted chemicals. A list of such companies can be obtained from the Chemistry Safety Office.

All substances to be disposed of should, if possible, be identified by chemical name and molecular formula. If this is very difficult because there is a mixed waste, then the character of the mixture must be accurately defined, *e.g.* categorizations such as *a mixture of organic amines and their salts but with no compound boiling below 100 °C; some are suspect carcinogens* would be helpful and acceptable (provided it is true) but a categorization such as *mixture of organic liquids, smells of nitrobenzene* will not be acceptable and some work will have to be done by the originators of the waste to determine what else is with the nitrobenzene before it can be accepted. **It is very important that if there are known hazards associated with the waste, these should be stated on the label (see below) including, for example, the inclusion of hazardous drying agents.**

All substances to be disposed of must be put into leak-proof containers that are clearly labelled with the **identity or categorization of the contents, any known hazards, and some indication of boiling point range**. Substances identified only by a trade name will also not be accepted - there has to be some indication of the chemical nature.

**General:** If material is packed into used boxes, ensure that old labels are obliterated and the container is marked "**this way up**". The total weight should not exceed 5 kg and the dimensions should be about one foot cube. Organic or aqueous liquids should be in glass or plastic containers, solids in metal drums or plastic tubs.

## Waste Solvents

The Department has a twice-weekly arrangement to dispose of waste solvents (Mondays and Thursdays, subject to changes which will be announced by email). Prior to disposal, you are to submit a form listing the type and quantity of waste to be disposed. At present, the waste solvents are categorized into "chlorinated" and "non-chlorinated" waste and the contents must be identified. The date of first generation of wastes must be clearly written. **Waste solvent containers are not dumps** and may contain only approved waste organic solvents with limited amounts of solute. Reaction mixtures containing drying agents, oxidants or solutions of oxidants must never be put into the waste solvent containers. Acids and bases must be placed in separate containers and not into containers for organic solvents.

**No substances that are category 1 or 2 [carcinogens](#) may be put in the waste solvents in any form.**

### Organic liquids acceptable as Waste Solvents

#### *Non-chlorinated/halogenated*

- Mixed solvents - acetone, ethanol, ethyl acetate, ethylene glycol, hexane, isopropyl alcohol, kerosene, 1-methyl-2-pyrrolidinone (NMP), methanol, methyl ethyl ketone, methyl isobutyl ketone, propylene glycol, thinner, toluene, xylene

#### *Chlorinated/halogenated*

- C<sub>1</sub>: dichloromethane, chloroform, carbon tetrachloride
- C<sub>2</sub>: trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, 1,1,1-trichloroethane,
- C<sub>3</sub>: 1-chlorobutane plus small amounts of non-chlorinated materials but no water.

**Containers:** The accepted container for transfer of waste solvent to the Lab Supplies is a screw-capped 5 L polythene bottle. No other containers are acceptable. The containers must be filled only to the 80% level with approved solvents, sealed with their original caps, not leaking vapour or liquid or contaminated on the outside. Stores staff are not allowed to accept over-full, leaking or externally contaminated containers.

**Storage:** Separate containers for Chlorinated/Halogenated and non-Chlorinated/non-Halogenated solvents should ideally be kept in a fume-hood. Large polythene containers of flammable solvents are extremely vulnerable in case of fire and must be kept in a closed cupboard when not being used to receive waste solvent. Secondary containers are required for the waste canisters.

**Transport:** Waste solvents should be transported only in designated lifts. These lifts are closed to the general public for the exclusive transport of wastes from 2:30 – 2:35 pm. No one should enter the designated lifts when waste transportation is being carried out. Two persons should do the waste disposal. One person should push in the trolley, pull the sash across the lift to prevent others from getting in and press the button for the ground floor. The second person should wait at the ground level for the waste trolley to arrive.

**Collection:** Waste solvent is to be disposed every Monday and Thursday between 2:45 p.m. – 3:00 p.m. outside the Solvent Store. Lab Supplies Staff are not allowed to accept containers which do not meet the criteria described under "Containers" above.

**The waste containers must be checked by Lab Supplies staff before unloading or placing into the big bin of waste vendor.**

**Special disposal :** for disposal of other chemicals such as waste silica gel, acid and alkali wastes, the appropriate labels – silica gel, acid and base – must be affixed on the waste container. For solids, waste pump oils, please store them separately and arrange via Lab Supplies for disposal by the waste vendor.

## Applicable Legislations

There are a number of legislations applicable in our laboratories. Please check the Safety Manual on the web for more details. Below is a brief summary of the Acts.

### 1. Fire Safety (Petroleum & Flammable Material) Regulations 2005

#### *Flammable liquids*

- Secondary containment tray for all flammable liquids should be made of metal and not plastic.
- Minimal capture of these trays must be 20 %.
- The volume of flammable liquid wastes must also be part of the total licensed PFM volume stored in the laboratory.
- Waste container size cannot exceed 20 L.
- Wherever possible, activities involving flammable liquids should be performed in a fume cupboard, to prevent the build up of a flammable mixture in the room.
- Flammable liquid containers for Class I and Class II (flash point between 37.8 °C – 60 °C) cannot exceed 4 L.

All flammable liquids in NUS are classified as Class 1 (flash point < 37.8 °C) and the storage limit is as follows:

Liquid in Laboratory			
Excluding Qty in Cabinet		Including Qty in Cabinet	
Max Qty	Max Qty	Max Qty	Max Qty

(L/m <sup>2</sup> )	(L/m <sup>2</sup> )	(L/m <sup>2</sup> )	(L/m <sup>2</sup> )
0.8	250	1.6	500

#### Gases

- Spacing of 6 m apart is required for each group categorized below.
- Only two 4.5 kg LPG cylinders allowed in lab.
- Flammable gases must be in use in the lab.
- Labs cannot be used for storage of flammable gases.

### 2. Workplace Safety & Health Act

- The principal investigator or lab-in-charge shall conduct a risk assessment in relation to the safety and health risks posed to any person who may be affected by his undertaking in the workplace.
- The principal shall take all reasonably practicable steps to eliminate any foreseeable risk to any person who may be affected by his under taking in the workplace.
- Every principal shall maintain a record of any risk assessment conducted, any measure or safe work procedure implemented, submit the record when required and shall be kept for a period of no less than 3 years.
- Every principal shall review the risk assessment at least once every 3 years, upon the occurrence of any bodily injury to any person as a result of exposure to a hazard or when there is significant change in work practices.
- All workplace accidents/dangerous incidents must be reported to OSHE.
- Mandatory reporting for workplace accident resulting in the death of an employee
- Mandatory reporting for workplace accident resulting in the injury of an employee who is unfit for work for more than 3 days, regardless of whether these were consecutive days of medical leave; or hospitalized for at least 24 hours. The reporting shall be done not later than 10 days after the 3<sup>rd</sup> day of the sick leave.
- Mandatory reporting for a subsequent death of an employee as a result of an injury at the workplace
- Mandatory reporting for a workplace accident which involves a self-employed person or member of public and results in his or her death or treatment in hospital for the injury

### 3. Environmental Protection and Management Act

- All hazardous chemicals must not be bought or used without approval and license applied for through Faculty Safety and Health Officers.
- Required to keep a record of the quantity of the hazardous substances.
- Storage of the hazardous substances in the approved container, in an area where entry is restricted to authorized personnel, with labeling stated in the code of labeling.
- Personnel are to receive adequate instruction and training to understand the nature of all the hazardous chemicals being stored.
- Establish and keep up-to-date adequate emergency response plan to deal with any spillage.

### 4. Poisons Act

- Regulates substances classified under Poisons (potent medical substances).
- All poisons must be kept under lock and key in a designated poison cupboard.
- Records of toxins and flammable chemicals must be kept. A softcopy record is allowed so use the ES Online system to update the amount remaining after use.

### 5. Arms and Explosives (Amendment) Act, Chap 13SPF

- Ammonium Nitrate
- Ammonium Perchlorate
- Barium Nitrate
- Potassium Nitrite
- Potassium Perchlorate
- Sodium Chlorate



- Guanidine Nitrate
  - Hydrogen Peroxide
  - Potassium Chlorate
  - Potassium Nitrate
  - Perchloric Acid
- Sodium Nitrate
  - Sodium Nitrite
  - Sodium Perchlorate
  - Tetranitromethane

Keep and maintain a register book or softcopy inventory via ES Online system.

#### **Environmental Public Health Act**

- Regulates disposal of toxic and environmentally hazardous chemicals.
- Only licensed waste collector must be engaged to collect hazardous waste generated.
- All generated toxic & hazardous waste must be treated & properly packed in specified containers with appropriate labeling.

#### **6. Sewerage & Drainage Act**

- Regulates the discharge of waste water into public sewers.
- NUS staff and students not to dispose hazardous materials into the sewer.

#### **7. Chemical Weapons Convention**

- Check if chemical falls under CWC at PSSO or OSHE website. The Principal Investigator (PI) has to seek approval by OSHE prior to the purchase of any chemicals listed under the Chemical Weapons (Prohibition) Act.
- PI must inform OSHE if he or she intends to use the chemicals of purposes either than those stipulated in the initial application
- A copy of the MSDS provided by the supplier must be made available in hardcopy in the laboratory at all times.
- The Principal Investigator must inform OSHE of the transfer of ownership of the scheduled chemicals. The Principal Investigator must inform OSHE of the loss of any scheduled chemicals within 24 hours.
- These chemicals must be kept in a storage cabinet or fridge under lock and key. The key shall be kept by the Principal Investigator. Only personnel authorized by the Principal Investigator will be allowed to use the chemical weapon.

#### **8. Biological Agent & Toxins Act**

- Regulate the possession, use, import, transfer and transportation of biological agents (BAs) and toxins that are known to be hazardous to human health in Singapore.
- Approval is required for the possession, import, handling and transportation of scheduled biological agents and toxins.
- Proper decontamination is required for all waste prior to disposal.
- Agent-specific license issued by MOH to PIs.

## **Security in the Department**

All doors should be locked when no one is in the lab or office. Also be alert if a stranger pops into your lab. Ask what he/she wants. You should contact security at extension 6874 1616 if you are unsure what the person wants.

All corridor doors should be locked after office-hours. **When you enter/exit a corridor, make sure that you have locked the door after you.**

The roll call form listing the persons authorized to work in your lab should be updated regularly whenever there is a change.

## Personnel Connected with Safety in the Department of Chemistry

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Prof. Richard Wong Ming Wah (Chair)	62659
A/P Chuah Gaik Khuan (Co-Chair)	62839
Asst/Prof Chi Chunyan	65375
Dr Chui Sin Yin, Stephen	63699
Mdm Han Yanhui	64406
Mr Junaidi bin Aminuddin (Deputy Chair, Safety Officer)	61760
Mdm Lee Chooi Lan	68990
Ms Leng Zhi Jin	62691
Mdm Lim Nyoon Keow	61672
Mdm Irene Teo Ai Hwee	63658
Dr. Liu Qiping	68991
Mdm Low Eng Hah	62841
Mdm Ong Bee Hoon	62685
Mdm Toh Soh Lian	62686
A/P Suresh Valiyaveetil (Deputy Chair)	64327
A/P Xu Qing-Hua	62847
Mr Daryl Yap Qi Jin	62690
Asst/Prof Rowan Young	62845

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## Internet Address and Further Information

The **Department of Chemistry Safety Manual** can be accessed at:-

<http://www.chemistry.nus.edu.sg/PSSO/>.

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