Australian National University

Research School of Chemistry

SAFETY REGULATIONS

April 2012

FOREWORD

The RSC Safety Committee is an Area Committee of the University's Occupational Health and Safety Policy Committee. The RSC Safety Committee is made up of academic and general staff members who have a wide range of expertise. The Committee Chair is chosen by the membership in consultation with the Director. The membership of the present R.S.C. Committee is given in **Appendix A**. The Committee is responsible to the University's Occupational Health and Safety Branch and operates under the broad framework set out in various OHS policy documents, the overarching one being the ANU Occupational Health and Safety Policy. Links to this and other policy and procedure documents can be found on the RSC OHS web page.

The primary purpose of the Safety Regulations is to promote safe working conditions for everyone in the building. No one in the School is competent to interpret the legal niceties of accident liability. The following is a thumbnail sketch of the position. Anyone who wants the full story should see the School Manager in the first instance. The Regulations are made to *prevent* accidents. By law and under the terms of its workers' compensation and Occupational Health and Safety agreement, the University is required to take all reasonable precautions to prevent injury. The R.S.C., through the Director and the Director's Advisory Group, has the authority to introduce safety regulations and is responsible to the University for their observance.

If an accident occurred in which an injured staff member or student was in breach of the Regulations, the University might not be able to arrange compensation on behalf of the injured person. In the case of third party injury due to negligence of a staff member, there could also be difficulties, though not of a kind to affect compensation for the injured person. All staff have the special responsibility of looking after the safety of those they supervise. Do not assume that less experienced workers are as aware of hazards as you are. To give a warning that turns out to be unnecessary is better than saying nothing and regretting it.

Even where regulations are for the personal protection of the worker (e.g., safety spectacles, safe clothing, and footwear, etc.) rather than for the safety of others, the School is obliged to make every effort to secure observance. For their own sakes, and in their own interests, all staff and students are required to observe the Regulations.

Tony Hill
Chair
R.S.C. Safety Committee

THE TEN COMMANDMENTS OF THY SCHOOL

1. THOU SHALT be careful when handling all chemicals, especially if they be toxic or explosive.

2. THOU SHALT acquaint thyself with all manner of safety devices and clothe thyself in protective raiment.

3. THOU SHALT cause neither fire nor explosion nor be guilty of any other kind of accident.

4. THOU SHALT NOT eat nor drink in thy laboratory.

5. THOU SHALT NOT work out of hours on dangerous projects no matter what thy status.

6. THOU SHALT seek help by calling out, or by contacting thy reception desk, or by pressing thy panic button.

7. THOU SHALT evacuate thy building when the klaxons sound

8. THOU SHALT protect all manner of visitors, and SHALT NOT suffer little children to come into thy laboratory nor into thy computer room.

9. THOU SHALT report all chemical misdeeds to thy big brothers/sisters.

10. THOU SHALT control thy supply of inflammable solvents and dispose of thy chemical wastes according to the laws of thy School.

Insofar as ye shall observe all these Commandments ye shall continue to receive the blessings of thy higher authority.

Insofar as ye shall break this covenant then surely shall thy School be as ashes and ye may enter THE GREAT LABORATORY IN THE SKY sooner than ye had planned. And there shall be a great wailing and gnashing of teeth.

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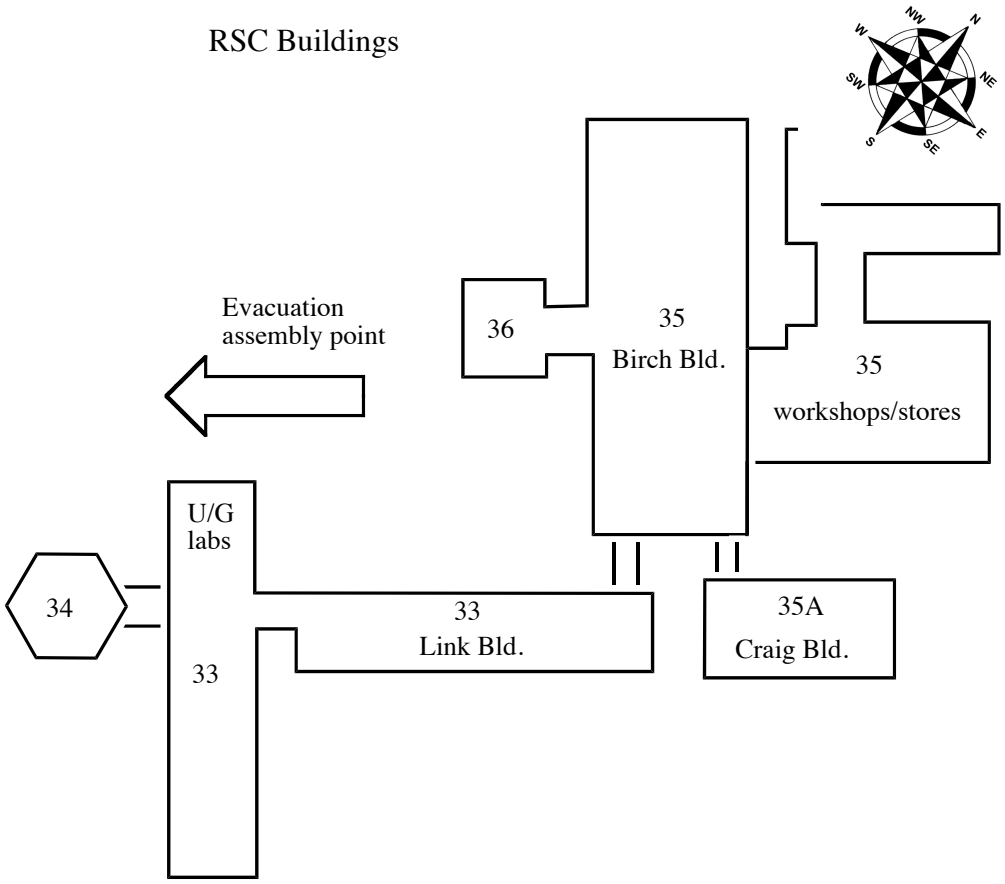
INTRODUCTION

Building numbers

These Safety Regulations apply to Buildings 33, 34, 35, 35A and (part of) 36, all of which make up the Research School of Chemistry's Research and Teaching Divisions on the ANU's Acton Campus. All occupants of the RSC - staff, students and visitors - are subject to the Safety Regulations insofar as the Regulations are relevant to them.



Responsibilities for Occupational Health and Safety in the workplace

The Director and RSC Management have responsibilities under Duty of Care provisions to provide a safe working environment for all staff, students and visitors to the School. Equally, individuals working within the School are required to conduct themselves in a way that does not jeopardise the wellbeing of their colleagues.

RSC Director

- Budgetary provision is made to enable the establishment and maintenance of a safe and healthy working environment within the Budget Unit.

- Appropriate delegations are made to group leaders, operations manager and supervisors for OHS responsibilities.
- No hazardous research, teaching or operational work is undertaken by the Budget Unit until a risk assessment of the work is completed and the Director, Dean or Head is satisfied that the hazards associated with the work are controlled, as far as is reasonably practicable.
- Observance of University OHS policies by staff, students and visitors.
- Staff, students and visitors are provided with appropriate information, instruction, training and supervision to enable them to effectively undertake safe work practices and procedures.
- Any OHS incident that occurs is notified using the University's OHS incident notification process.
- Any OHS incident is reviewed by the Dean, Director or Head to ensure correction of deficiencies and facilitate continuing improvement to hazard management practices within their Budget Unit and throughout the University.
- Prompt response is made to OHS recommendations received from the relevant DWG OHS Committee.

Individuals

- Taking personal action to eliminate, avoid or minimise hazards.
- Bringing to the attention their supervisor any unsafe situation or procedure.
- Complying with all work procedures and instructions.
- Active participation in OHS training and induction programs.
- Making proper use of all safety devices and personal protective equipment.
- Seeking information and advice where necessary before carrying out new or unfamiliar work.
- Maintaining dress standards appropriate or required for the work being done.
- Being familiar with emergency and evacuation procedures and the location, and use, of emergency equipment.
- Using the University's OHS incident notification process to notify hazards, incidents, injuries or exposures.
- Being aware of the DWG OHS Committee members and health and safety representative for the work area.

Content of the Safety Regulations

The RSC Safety Committee encourages feedback from all staff and students regarding the content of the Safety Regulations. Should you have any suggestions as to how the current Safety Regulations may be improved, please contact a member of the Safety Committee, whose names appear in **Appendix A** of this document.

Appendices

The RSC Safety Regulations has four Appendices:

- **Appendix A** contains the names of people who have OHS responsibilities, including: Members of the Safety Committee, the Emergency Response Team and First Aid Certificate holders. Only brief contact details are provided. However, a more complete set of contact details for these, and every other person in the RSC, can be found in the RSC, internal use, website: http://rsc.anu.edu.au/internal/index.php?option=com_wrapper&Itemid=74
- **Appendix B** contains the names of people to consult who have skills in a specialist area, such as radiation or biological chemistry or chemistry that involves the use of highly air sensitive materials. The types and locations of high hazard laboratories are also included. The formal experimental risk assessment guidelines are also in Appendix B and, as an aide to making a risk assessment, an overview of how hazardous chemicals are classified is included.
- **Appendix C** contains information designed to make life safer for bench chemists when they are carrying out activities associated with synthetic chemistry. Various topics are included in the text such as, how to choose, prepare and dispose of cleaning mixtures; how to handle alkali metals and their compounds and treat their residues; how to choose gloves appropriate for use with a particular solvent or corrosive mixture. It is intended that this site should be continually updated and added to a-la-Wikipedia, so should you feel the urge to write something relevant, or whether you want someone else write it for you, please contact the RSC Technical Manager.
- **Appendix D** is concerned with the protocols and procedures that the Emergency Response Team has to follow when dealing with emergencies.

University OHS Policies and Procedures

In the Bibliography section of the Safety Regulations (Section 19) a number of links to University OHS Policy and Procedure documents are listed.

1. EMERGENCY PROCEDURES

NOTE: The RSC emergency procedures, along with site and building plans and contact details of the Emergency Response Team are kept in the Red Folder at the Reception Desk in Building 35.

1.1 Alarm Systems

Buildings 33/34 and Buildings 35/36 operate on separate alarm systems. However, the alarm systems do function in the same way, both using the Early Warning Integrated System (EWIS).

The EWIS has two levels of alarm:

Warning sirens

Alarm sirens sound (repeating short low tone) – **amber** lights flash: There is no need to leave the building, yet.
The sirens are set off automatically by the triggering of one of the smoke or temperature-sensitive detectors. The corridor smoke doors close automatically; all exit doors controlled by security card system open automatically; appropriate staff are notified; an announcement is made over the public address system informing building occupants about the nature of the problem. Bells will ring *outside* the building. The fire brigade is called automatically.

Evacuation sirens

Alarm sirens sound (repeating long rising tone) – **red** lights flash: Evacuate building immediately by nearest safe exit.
The House Warden sets off the evacuation sirens manually after the level of danger has been assessed. The danger may be from fire or from some other reason, such as a chemical spill.
If the smoke or temperature sensitive detectors have *not* been activated, as with a chemical spill, then the House Warden will open all doors controlled by the swipe card system manually. (In an emergency, the security doors can be opened by using the "break-glass" door release panel.)

NOTE: Outside business hours and at weekends, the system is operated automatically and so, with no one to switch it off, the warning siren will always default to evacuation.

NOTE: In the event of a dangerous chemical spill, the warning sirens would *not* ordinarily sound. In these situations, the House Warden will make an announcement

over the public address system informing building occupants about the nature of the problem, before activating the evacuation sirens.

In general:
The first level of alarm is indicated by low-pitched sirens sounding and amber lights flashing. No evacuation of the building is necessary at this stage, but all personnel should be ready to evacuate if this becomes necessary. Advice will be given over the public address system.
The second stage of alarm is indicated by high-pitched sirens sounding and red lights flashing. All personnel must evacuate the building immediately.

NOTE FOR HEARING IMPAIRED PEOPLE: Flashing amber lights indicate warning. Flashing red lights indicate evacuation. Should there be any doubt about the status of an evacuation and there is no one to ask, hearing-impaired people should leave the building immediately.

Red panic buttons: These are located in high hazard laboratories and in controlled temperature rooms. When activated they alert those officers in the Emergency Response Team who carry dedicated mobile phones. After hours, they alert the Duty Security Officer.

Specific locations of panic buttons are listed in **Appendix B.**

1.2 Fire and Fire-fighting Devices

Fire brigade: The fire brigade is alerted by the School's automatic alarm system. The fire officers must be met when they arrive. As soon as is possible, inform **University Security** by dialling **extension 999** on any internal telephone.
Try to put out minor fires, but do not take personal risks.

Extinguishers: Two types of extinguishers are available in each laboratory:

CO_2 (General purpose, especially solvent fires.)

Use a CO_2 extinguisher initially. If this fails, use the dry powder extinguisher.

Dry powder (General purpose, especially electrical fires and fires caused by pyrophoric substances, such as alkali metals and their compounds.)

1.3 Emergency Response Team

For the purpose of controlling emergencies (fire, chemical spills, etc.) the School has an Emergency Response Team consisting of the House Warden, Deputy House Wardens and Floor Wardens **[See Appendix A]**. Floor Wardens have specified safety duties and procedures to follow during an emergency or building evacuation. In particular, they have the responsibility of ensuring that all occupants leave the building during a general evacuation. Some officers have First Aid training and some are trained in the use of self-contained breathing apparatus **[See Appendix A]**.

PLEASE NOTE: If any staff member or student is involved in an emergency situation and they are unsure what to do, call out for assistance and/or ring the RSC EMERGENCY NUMBER – 53636.

1.4 Evacuation of Building

When the evacuation sirens sound, all occupants must leave the building as quickly and as safely as possible.
The following points should be observed during an evacuation:
(i) Personnel must leave the building by the *nearest* exit. Exits are clearly identified by **EXIT** signs in white on a green background.
(ii) The lift **must not** be used during an evacuation.
(iii) Occupants must leave the building when directed to do so by the Floor Wardens.
(iv) Evacuees should assemble outside the main entrance to the Birch Building (Building 35) or as directed at the time of the emergency. (Refer to plan in Introduction section of Safety Regulations.)
(v) Do not re-enter the building until informed by a Warden that it is safe to do so. Logic and common sense should prevail.
(The Emergency Response Team's evacuation procedures are in **Appendix D**.)

All staff, students and visitors are requested to adhere to these points during practice evacuations in order for the Emergency Response Team to assess the procedures.
Outside Normal Business Hours (see Section 6), Wardens may not be available. If the sirens sound during these periods, the Duty Security Officer will endeavour to ensure that all personnel leave the building. For this reason, it is essential that all occupants sign in and out of the building using the computer on the Reception Desk in the Front Foyer of Building 35, or by using their own computer networked within the RSC.

1.5 Emergency Exits in Laboratories and Offices

Every laboratory or office in the School has one or more emergency exits, in addition to the "normal" entry doorway. In some cases, the emergency exit is a second doorway. On the ground floor, windows can be opened for emergency escape. On the upper floors, laboratories or offices that do not have at least two doorways have an emergency exit in the form of a readily and safely breakable panel leading into an adjacent laboratory or office. *These panels must be kept clear of heavy items that would obstruct their use in an emergency.*

NOTE: New arrivals must make themselves aware of where these escape routes are located. This is dealt with in the RSC Induction Procedures.

1.6 Emergency Equipment

Breathing apparatus: The locations of self-contained breathing apparatus and positive-pressure breathing suits and the names of the people trained in the use of self-contained breathing apparatus are given in **Appendix A.** Two 45 minute self-contained breathing units are kept on the wall adjacent to the Main Stores counter in Building 35. Fire Wardens are trained in the use of this equipment.

1.7 Emergency Victim Assistance

The Emergency Response Team are trained to aid victims of accidents and can administer first aid and arrange for rapid transport to hospital. The emergency protocols to assist victims of accidents can be seen in **Appendix D**.

2. FIRST AID

2.1 Assistance

The School has a number of staff on each floor who hold First-Aid Certificates **[see Appendix A]**. In every laboratory there is a list of simple First Aid instructions designed for untrained people to use in an emergency. After hours, or in the absence of a trained member of staff, if there is any concern about the state of an accident victim, call (1) 000 from any internal telephone and ask for an Ambulance.

2.2 First Aid Facilities

First Aid Room:

There is a First-Aid Room on the Ground Floor of Building 35 in Room 42, which has a bed, shower and first aid cabinet.

First Aid cabinets:

The locations of the First Aid cabinets are listed in **Appendix A.**

The School has a contract with a company to keep stocks of first aid materials replenished. However, the School's First Aid Coordinator **[see Appendix A]** must be notified if it is noticed that items in the cabinets are running low.

The Oxyviva unit is located at the Reception Desk, Foyer, Birch Bld (Building 35)
The Oxi-sock unit is located in Room 1.83, Link Bld (Building 33)

Emergency showers:

Emergency eye-wash showers are fitted on every laboratory sink in the Birch and Craig Buildings and in Building 33. These showers have been adjusted to deliver a certain volume of water. Please do not adjust these showers. It is important to wash off chemicals quickly, for example, acids or alkalis on the skin or in the eyes. Full body showers (with eye-wash attachments) are located in every corridor in the Birch Building and in Rooms E3 and E207 in the Craig Building. In the western wing of Building 33, the 1st, 2nd and 3rd Year undergraduate laboratories have four, four and three full body showers respectively. Elsewhere in Building 33, one each can be found in Rooms 1.12, 2.16, 2.21 and in the roof laboratory. There are no full body safety showers in Building 33 Link.

3. ACCIDENT REPORTING

3.1 Notification

In the event of an accident, as soon as is practicable notify the Technical Manager, or the School Manager or an Area Safety Officer. **[Appendix A]** After hours, contact the Duty Security Officer by ringing 53636, or by pressing the 'PRESS IF DESK UNATTENDED' button on the counter of the reception desk in the Front Foyer.

3.2 ANU OH&S Incident Notification Form

Anyone sustaining an injury, or exposure that requires any kind of treatment, or which may require time off work, should contact the Technical Manager, or the School Manager or an Area Safety Officer and complete an OH&S Incident Notification form:
http://policies.anu.edu.au/forms/incident_notification_form_ohs/form
For insurance purposes, it is essential that these forms be filled in as soon as possible after the incident has occurred. Even on occasions where nobody has been injured, an incident should be reported.

3.3 RSC Accident Report Form

In consultation with the Technical Manager or Group Technical/Research Officer or an Area Safety Officer, the person(s) involved in the accident must complete Section A of the Accident Report Form (available from the Technical Manager, or electronically from 'Office Admin' Public Folder) as soon as possible after the accident. The Technical Manager or an Area Safety Officer or the Group Technical/Research Officer, in consultation with the Supervisor of the person involved, will complete Section B. Section C will be completed by the Chair of the School's Safety Committee. The completed form will be kept in the Technical Manager's office. The Safety Committee will review the report at its next meeting.

3.4 Unsafe Condition or Hazard Report

If you think that any of the current safety procedures could be improved, you should report the matter to a member of the Safety Committee **[see Appendix A],** who will, after broader consultation, decide whether to take it up with the Chair. If the matter concerns a change in School policy, the Chair will convene a meeting of the Safety Committee. If the matter is a localised one, the Chair may attempt to resolve it by discussions with the Director, the Technical Manager and the person making the report. Should you wish to report a potential hazard or near-miss, follow the procedure at the following site:
http://policies.anu.edu.au/procedures/hazard_reporting_at_the_anu/procedure

4. PERSONAL PROTECTION

Mandatory items of personal protection:

- Eye protectors (glasses or face shields) and laboratory coats **MUST** be worn at all times in all laboratories where chemicals are being used or other hazards exist.
  NOTE: Laboratory coats **MUST NOT** be worn in areas that are not rated as laboratories (common room, toilets, write-up rooms, etc.).

- Substantial footwear (shoes or boots) **MUST** be worn anywhere in the School.
  NOTE: Open footwear, such as sandals and thongs **MUST NOT** be worn.

- Information on appropriate choice of gloves can be found in **Appendix C**.
  NOTE: Laboratory gloves **MUST NOT** be worn outside the laboratory as they can leave contamination on handrails and door handles.

The choice of what other personal protection equipment and facilities to use (blast shields, high hazard laboratories, etc.) will be determined by Risk Assessment. [See Section 6]

5. SMOKING, EATING AND DRINKING

5.1 Smoking

Smoking is not permitted in the School or within 10 metres of the external walls.

5.2 Eating and drinking

Food and beverages may only be consumed in the common room or in enclosed offices.

6. RISK ASSESSMENTS AND BUILDING ACCESS

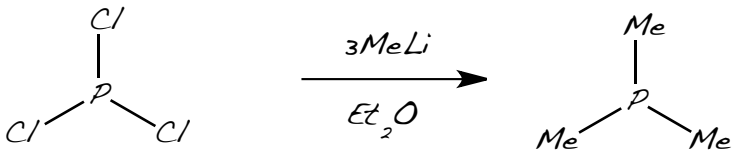
6.1 Assessing Risk

6.1.1 Identifying Hazards

BEFORE an experiment is attempted, the potential hazards must be considered and recorded in your notebook. From these the risk category can be assessed. A work plan must then formulated to reduce the risks associated with the proposed experiment.

E.g. Preparation of Trimethyl phosphine Risk assessed as **[see 6.1.2]**:

Cat C or Cat C (Ref Bk. X, p Y)



Reagents/Reactants /Products	Hazard Type (known or suspected)	Hazard Rating	Quantities
CH_3Li in Et_2O	Reacts violently with water	Extreme	3mol
PCl_3	Toxic, corrosive, reacts violently with water	Extreme	1mol
Et_2O	Flammable	High	250ml
PMe_3	Spontaneously flammable (pyrophoric)	Extreme	
Wastes/Residues	Potentially pyrophoric	Extreme	
Proposed treatment of wastes/residues:			

NOTE: If a risk assessment has been previously carried out for an experiment, it is unnecessary to repeat the details. All that is required is for the Book and Page number where the previous assessment was recorded to be referenced.

6.1.2 Determining Risk Categories

Before commencing any laboratory work, a risk assessment *must* be carried out.
The risk assessment would normally be based on:

- The hazardous properties of the reagents (flammable, pyrophoric, toxic, etc.);
- The quantities of those reagents used (small scale/large scale);
- The physical environment where the experiment should be carried out (eg. high hazard laboratories).

NOTE: For assessing hazardous properties, the material safety data sheets (MSDS) should be consulted. Conveniently, these can be found at the web sites for Chemwatch http://sails.anu.edu.au/chemwatch/ or http://chemistry.anu.edu.au (then click on Chemwatch).
Note should also be taken of the reagent's Dangerous Goods Class and its compatibility with other reagents of different classes. **[See Appendix B]** This information is also available from Chemwatch.

An abridged version of the guidelines for making risk assessments can be found in **Appendix B.** *This should be photocopied and pasted into the inside cover of laboratory notebooks for reference.* A more detailed account of risk assessment categories is outlined below.

NOTE: It is important to remember that when carrying out a risk assessment, the *physical* risks, as well as the chemical risks should be assessed. For instance, a procedure may involve the reaction of two or more relatively harmless substances, but the reaction conditions require high pressure. Accordingly, this reaction would be rated Category C (High Risk).

Category A: (minimal risk) Library work; work involving calculations, or laboratory work not involving chemicals or foreseeable hazards. Samples for measurements can be made up provided the quantities of materials are small. Work in instrument rooms falls within Category A, provided high pressure equipment is not in use.

Category B1: (low risk) Laboratory work involving small-scale reactions (<100 mL) and using low-risk substances. (Refer to B2 for substances considered moderate risk.) Procedures, such as solvent transfers, distillations and storage, drying and extraction, chromatography and cleaning, where volumes of flammable solvents used *do not exceed* 500 mL.

Category B2: (moderate risk) Laboratory work involving moderate scale reactions (<500 mL) using substances that are known to be moderately toxic, corrosive, allergenic, etc.; procedures such as solvent transfers, distillations and storage, drying and extraction, chromatography and cleaning, where volumes of flammable solvents used *do not exceed* 2.5 L.
Work with radioisotopes of I.A.E.A. Classes III and IV (e.g., ^{14}C, ^{3}H, or ^{35}S) should not exceed 10 μCi.

NOTE: For protocols concerning Category C experiments, see also Section 6.1.3

Category C: Laboratory work involving known toxic or carcinogenic substances or radioisotopes (other than those mentioned previously), large scale reactions with flammable solvents exceeding 500 mL, or high pressure reactions. Category C work must be carried out at all times in the toxic, radiotracer, high pressure, or fireproof laboratories, as appropriate. Protective devices, gas masks or other emergency equipment, must be near to hand.

Category C: Work involving reactions in sealed glass tubing. These tubes must be sealed by the Workshop glassblowers or authorised persons. Safety shields must be used when these reactions are being performed*. No other people should be working in the fume cupboard when a sealed tube, or other vessel is under pressure.*

Category C: work also includes the use of naked flames associated with flammable solvents as used in the biological laboratories. Prior arrangements must be made with group leaders to ensure two members of staff are present on such occasions. The security staff may be used if necessary.

NOTE: It is forbidden to leave naked flames unattended in any laboratories.

6.1.3 Category C Experiments

All experiments assessed as being Category C require authorisation from the group leader concerned or other designated supervisor BEFORE the experiment is carried out. A request form must be filled out and countersigned by said designated staff.

REQUEST TO PERFORM CATEGORY C EXPERIMENTS

Nature of Hazard (tick)

- ➢ corrosive; irritant; pungent; stench
- ➢ toxic; mutagenic; teratogenic; carcinogenic
- ➢ oxidizing; pyrophoric; highly flammable; reacts violently with water
- ➢ potentially explosive (including sealed tubes)
- ➢ high pressure reaction; radioactive; large scale reaction
- ➢ other (specify):

Special Precautions (tick)

- ➢ special eye protection; safety shield; face shield
- ➢ respirator; special clothing
- ➢ other (specify):

Special Location:

Waste Disposal:

Approved by (sign/date):

6.1.4 Unattended Experiments

Experiments left unattended for *any* extended period of time during normal access hours, as well as experiments left overnight or at weekends, must carry a standard format PLEASE LEAVE ON sign.

PLEASE LEAVE ON

NAME: DATE:

CONTACT No:

DESCRIPTION
(eg.REAGENTS
& SOLVENT):

LAB BOOK/
PAGE No:

KNOWN
HAZARDS:

These signs must be displayed next to the apparatus that is being left on and under no circumstances should the name of another person be used without consent. For experiments involving large instruments, such as a spectrometer, clearly typed instructions for emergency action must be attached to the instrument. Electrical switches that are in use, but not marked clearly as such, will be turned off at night by the Duty Security Officer, as a matter of routine.

6.2 Access to Building [See 6.2.3 for Access According to Work Category]

6.2.1 Access Hours for Research Students and Non-Continuing Academic Staff

Normal access hours to the School for non-continuing academic staff and students are from:

Monday to Friday: 8.00 am to 9.00 pm
Saturday/Sunday: 8.00 am to 6.00 pm

Normal business hours in the School are from:

Monday to Friday: 8.00 am to 6.00 pm, excluding Public Holidays.

These are the hours when people trained to deal with emergencies would normally be in the building.

NOTE: It is at the discretion of the Director whether work will be permitted on Public Holidays.

6.2.2 After Hours Access

Access regulations are designed to ensure the well being of those in the building after hours, by enabling the Duty Security Officer to pay particular attention to areas where work is being done.

The security staff are responsible to the School Manager for the security and contents of the building and, after hours, for monitoring the observance of the Safety Regulations. Entry and exit to the School "after-hours" must be via the front doors of the Birch building.

Anyone wishing to be in the building outside normal access hours must arrange with their Group Leader for approval to be obtained, in advance, from the School Manager, Director or Deputy Director. Request for approval must include specific reasons why access is necessary and what arrangements have been made for supervision. Supervision would ordinarily be by the Group Leader or nominee. The type of work permitted outside normal business hours is also determined by the work category.

6.2.3 Access According to Work Category

Category A: Normal Access Hours.

NOTE: Keyboard work is permitted outside Normal *Access* Hours, but *it must not be done in laboratories.*

Category B1: Normal *Access* Hours.

Category B2: Normal *Access* Hours. However, outside Normal *Business* Hours, a trained chemist must be within audible calling distance of the person carrying out the work.

Category C *: Normal *Business* Hours only.

* To carry out *any* Category C work, a Category C assessment form must be completed and authorised by either the relevant Group Leader, or the Group Leader's nominee *before* the work is commenced. [See Section 6.1.3]

6.3 Signing-In

Signing-In

Anyone entering or remaining in the building outside Normal Business Hours and any time on Saturdays, Sundays and Public Holidays, must 'sign in' using the computer on the Reception Desk in the Front Foyer of Building 35, or using their own computer networked within the RSC. Details of the type (Category) and location of the work must also be entered into the log. It is a requirement that people sign out, as well.

6.4 Visitors

Visitors other than scientific colleagues are not normally permitted in research laboratories. Children are allowed in the Front Foyer, but not in laboratories or in the computer room under any circumstances, but they may visit offices and the common room with the permission of the School Manager. Parents should note that when bringing children into the building the railings on the staircase are not safety railings and that a small child could easily slip through them. Children must be under **close** supervision at all times. Visitors must report to the Reception Desk, the School Manager's Office (Room 59), or the Head Security Officer to make their inquiry. Visitors to the Joint College Group offices in Building 36 must use the entrance adjacent to the RSC Lecture Theatre and not enter the RSC secure zone.

Visitors are not normally allowed in the building after hours or on weekends and holidays, although spouses and companions may accompany staff and students if prior arrangements (which may be on a long-term basis) are made with the Director or School Manager. Visitors may not enter laboratories where experiments are in progress, however, and under no circumstances are children permitted in the School after hours (with the exception of the reception area and tea room).

7. HIGH HAZARD LABORATORIES

All work carried out in High Hazard Laboratories is presumed to be Category C.

The following laboratories contain red panic buttons to call help in an emergency.

7.1 Flame-Proof Laboratories (Room 208, 112, 108)

In these laboratories there are three methods of extinguishing fires:
(i) The automatic CO_2 extinguisher, which is activated by smoke and an increase in temperature, will operate within 30 seconds (evacuate the room immediately); or,
(ii) Manual operation if the automatic system fails, the CO_2 extinguisher can be activated by breaking the glass at the RED BOX outside the door; or
(iii) For a minor fire the automatic CO_2 extinguisher can be deactivated by using the **gas release isolate** switch outside the door within 30 seconds and a hand extinguisher used.

If work is planned in one of these laboratories the automatic extinguishing mechanism must be understood before setting up the experiment. Remember that normal heating mantles are not spark-proof.

The flame-proof laboratories are designed so that there will be minimal damage in cases of fire. Potentially hazardous reactions to be left unattended at any time between 7.00 p.m. and 8.00 a.m. must be set up in one of these laboratories. It is advisable for all unattended experiments of this type to be set up in the flame-proof laboratories.

7.2 High-Pressure Laboratory (Room W12)

Use of this laboratory requires prior permission from an authorised officer. **[See Appendix B]**

The laboratory is designed for operations involving the use of high-pressure equipment or for potentially explosive reactions, for example, bomb or large sealed tube reactions.

7.3 Toxic Chemical Laboratory (Room 216)

Fume cupboards fitted with high capacity exhaust fans and with provision to be scrubbed with water or bleach, are located in the toxic chemical ('stinks') laboratory, Room 216. This laboratory should be used for all experiments using highly toxic and/or excessively 'smelly' compounds.

Intended work involving these types of compounds must be noted on the Toxic Emissions Warning Board located adjacent to Room 119, no matter which room the experiment is taking place. There is another scrubbed fume cupboard in Room 124, but this is only available on request. **[See Technical Manager]**

7.4 Radio-Tracer Laboratories (Room 236) [see Section 10]

Use of this laboratory requires prior permission from an authorised officer. **[See Appendix A]**

7.5 Microbiological Hazards Laboratory (Room 234)

Room 234 is setup as a PC2 microbiological hazards laboratory and houses a Braun Biostat C bioreactor. Use of this laboratory requires prior permission from an authorised officer. **[See Appendix A]**

8. SOLVENTS

8.1 Transport of Solvents and Toxic Materials

To ensure that no one is trapped in a confined space with a dangerous chemical, and to minimise the possible effects of an accident, the following guidelines are emphasised. Winchesters of solvents and other chemicals must be transported in the carriers provided. They must not be carried on the staircases, but rather placed in the lift and sent *unaccompanied* to the appropriate floor. Toxic and other potentially dangerous compounds, such as solid carbon dioxide, may be transported in the lift, provided there are no passengers present. Be careful to prevent spillage and contamination. When carrying radioactive compounds, particularly when they are in solution, the vessel should be placed inside another, non-breakable container, preferably liquid proof and with a lid.

8.2 Storage

Four- or six-person laboratories must not contain more than 12 Winchesters of flammable solvents and smaller laboratories no more than 8. Winchesters must be stored in cupboards and duplications of solvents should be avoided. In laboratories where there are flameproof cabinets, the volume of flammable solvents allowed to be stored in the laboratory is determined by the capacity written on the cabinet door. In such cases, no flammable solvents should be stored outside the cabinet. Ethers should not be stored for long periods because of the potential for build-up of peroxides.

8.3 Distillation

All solvents, especially old stock and ethers, must be tested for peroxides before distillation. It is important to note that stabilisers will be removed by distillation and more rapid peroxide formation will occur during storage of distilled chemicals.

8.4 Toxicity

Some solvents, such as benzene and carbon tetrachloride, are very toxic (see Section 12). Fume cupboards must be used for the evaporation of aromatic solvents and for chromatographic separations involving solvents known or

suspected to be human carcinogens such as benzene. Always consider alternatives to these types of compound. For example, use toluene instead of benzene.

9. DISPOSAL OF HAZARDOUS AND OTHER LABORATORY WASTE

NOTE: For information on how to safely dispose of hazardous wastes consult the Hazardous Waste Officer **[Appendix B]**. The ANU policy and procedures on hazardous wastes can be found at:
http://policies.anu.edu.au/procedures/disposal_of_hazardous_waste/procedure#2_chemicalwastedisposal
The School's general procedures for disposal of laboratory wastes are outlined in **Appendix B**. Before discarding any chemicals, glassware or equipment the option of recycling, reuse or repair should be considered. If these options are not applicable, then the procedures for disposal are as follows:

9.1 Glassware

Winchesters and Reagent bottles. Empty reagent and solvent bottles must be washed out, drained and then placed in the yellow bins located in the loading bays of Buildings 35 or 33, or placed in the marked container in Room 208 on the top floor of Building 35. These will be sent for recycling.
ONLY BROWN GLASS IS ACCEPTABLE FOR RECYCLING.
***Damaged glassware*.** Items of glassware for repair or for the salvage of valuable components should be thoroughly cleaned and collected within each research group, then submitted for repair to the Glass Workshop.
***Broken glassware*.** Glassware beyond repair, plus empty reagent and sample bottles made from clear glass, should be cleaned and placed in the large hopper located in the Loading Bay.

9.2 Disposal of Solvent Wastes

Solvents must not be poured down the sink. They must be **acid-free** and segregated, where possible, into benzene, chlorinated and non-chlorinated and kept in labelled, clear glass bottles and emptied regularly into the appropriate drums located in the fume cupboard in Room 208 in Building 35 and in Room 1.22 in Building 33. Do not mix acetone and chloroform in the residue bottles; the resulting mixture may explode. Small quantities of acetone may be washed down the sink with large volumes of water. Potassium, or large quantities of sodium, must not be destroyed in the building.

9.3 Solid Waste

***Adsorbents*.** Alumina, silica gel, etc. should be stripped of any mobile chemical residues by flushing the columns with methanol or appropriate solvent and put in a separate labelled container (plastic bag or empty plastic chemical container). When full, these should be placed in the fume hood in Room 208 in Building 35 and Room 1.22 in Building 33.

***Pasteur pipettes, chromatography plates*.** Items for disposal must be placed in labelled containers **(not plastic bags)** in each laboratory. When full these should be given to one of the Technical Officers in charge of waste disposal **[see Appendix B]** or placed in the fume hood in Room 208 in Building 35 and Room 1.22 in Building 33.

***Needles, syringes, scalpel blades etc*.** Items for disposal must be kept separately in appropriately labelled containers **(not plastic bags)** in each laboratory. When full these should be placed in the yellow incineration bin in the Loading Bay.

***Contaminated tubing, tissues, gloves etc*.** Items for disposal must be placed in appropriately labelled containers (plastic bag or empty plastic chemical container) in each laboratory. When full these should be placed in the fume hood in the yellow bins in Room 208 in Building 35 and Room 1.22 in Building 33.

9.4 Other Waste

Used Oil. Drums for used vacuum pump oil and silicone oil are located beneath the fume hood in Room 216.

***Heavy metals*.** These should be recovered from residues wherever possible. Those not recovered should be collected and stored in labelled containers in each laboratory. These will be sent for disposal on an annual basis.

Radioactive waste. See Section 10.1 under Waste Disposal.

Biological waste. See Section 11.3.

10. RADIATION

NOTE: All users of radiation sources should refer to the ANU Procedures for Radiation Safety http://policies.anu.edu.au/procedures/radiation_safety/procedure

The Vice Chancellor is the official Licensee for all ARPANSA controlled radiation sources and apparatus in the University and he/she delegates certain of those responsibilities to Heads, Deans and Directors.

The list of names of Radiation Safety Officers for *all types* of radiation used in the School can be found in **Appendix A.**

10.1 Unsealed Radioactive Substances

All aspects of the handling of radioactive substances are now governed by ANU guidelines and the ANU takes its lead from the Australian Radiation and Protection and Nuclear Safety Act and associated regulations. These bodies impose statutory obligations on Radiation Safety Officers, Supervisors and Radiation Workers. The Act imposes heavy penalties for non-compliance. This has necessitated registration and documentation procedures with respect to radiation workers and to radioactive substances. All operations involving radioactive substances must be carried out in the appropriate laboratory and with prior approval of the relevant Radiation Safety Officer. **[See Appendix A]** It is mandatory for all proposed users of unsealed radiation sources to undergo the radiation safety course run by the ANU OHS & Injury Management branch prior to beginning such work. If the proposed user can satisfy the RSO that he/she has completed an equivalent course elsewhere, attendance at the ANU course may be waived.

User Registration. All Radiation Workers are registered with the Personal Radiation Monitoring Service (PRMS), ARPANSA. This includes some personal details, their history of exposure to ionising radiation, and documentation of any accidents in which they may have been involved. All intending users must complete a registration form, available from the RSO or PRMS. This form registers people to receive a TLD radiation monitor.

Submission of Protocols Before any radioactive material can be ordered or removed from storage, a comprehensive protocol *must* be written out and presented to the RSO for signed approval. It is important that the protocol include a risk assessment of all aspects of the proposed procedure, and a description of how the wastes will be treated. After a protocol has been approved, it will be so endorsed and given a Protocol Number. A copy will be returned to the applicant. Operations not explicitly described in the protocol are not permitted.
When the experiment is completed, an indication of the quantity of radioactivity contained in the wastes must also be recorded.
NOTE: The Radiation Safety Officer may insist that an experiment be first performed without radioactive reagents in order to check it is intrinsically safe.

***Ordering*.** Orders for radioactive substances require endorsement by the Radiation Safety Officer.

***Delivery*.** The radioactive material is delivered to the Radiation Safety Officer who will then notify the user of its arrival and location.

***Storage*.** Radiochemicals must be stored in the radiotracer Laboratories 232/236 in a locked refrigerator or cupboard. Radioactive materials may only be stored elsewhere in exceptional circumstances with the explicit written consent of the Radiation Safety Officer.

***Use and personal protection*.** It is the responsibility of the user to ensure that adequate precautions are taken to prevent hazards to personnel or contamination of the laboratories. The use of protective clothing is a key radiation protection measure in guarding against personal contamination and the spread of contamination to other persons and work areas. Therefore it is essential that such clothing is reserved strictly for work within the laboratory where the unsealed radioactive substances are kept and used. The coat must be kept within the laboratory or in the immediate vicinity of the laboratory e.g. at the entrance. Further, if contaminated, protective clothing must not be laundered with uncontaminated clothing.

Maximum quantities of isotopes that may be stored or used on the premises at any one time are specified on the Licence Schedule; use of greater quantities requires variation of the existing Licence or application for a new Licence. Normal chemical operations involving up
to 10 μCi (377 kBq) of isotopes of I.A.E.A. Classes III or IV (e.g , ^{3}H, ^{14}C, ^{32}P, ^{35}S) may be carried out in ordinary laboratories, using trays or plastic-backed absorbent paper (paper side up) to avoid contamination in the event of spillage. Operations involving larger amounts of such isotopes, and any operation involving isotopes of Classes I and II (e.g., ^{36}Cl), must be performed in the radiotracer laboratories; transfer of such materials to any other location requires the explicit written permission of the Radiation Safety Officer. **All operations with sources of radioisotopes are classified as Chemical Risk Control Category C.**

Permission to use the radiotracer laboratories 232/236 for any purpose must be obtained from the appropriate Radiation Safety Officer. **[See Appendix A.]** When the radiochemical laboratory is in use, a sign must be displayed on the door of Room 236 giving the user's name, starting date of the experiment, and isotopes and maximum quantities in use. The indicator light must be activated. Except with the written permission of the Radiation Safety Officer, experiments may only be carried out during normal working hours. A stock of glassware is available in Room 236, and should be used whenever possible. Contaminated glassware should not be returned to a normal laboratory.

***Waste Disposal*.** Solid waste *must* be placed in the special bins provided. At the completion of an experiment, an estimate of the quantity of isotope in the bins *must* be made and a note attached. Different isotopes must be disposed of in separate bins, so marked. The Radiation Safety Officer, Hazardous Waste Safety Officer or the Technical Manager, must be consulted about the disposal of radioactive liquid waste. Radioactive waste disposal must also comply with the ANU's Hazardous Waste Disposal guidelines:
http://policies.anu.edu.au/procedures/disposal_of_hazardous_waste/procedure#2_chemicalwastedisposal

The ACT Radiation waste disposal permit is held by the Technical Manager.

***Records*.** A record book for radioactive substances is kept in the Technical Manager's office. Each substance entering the School is recorded as a separate item. It is the responsibility of the user to maintain on the loose-leaf forms provided by the Radiation Safety Officer as an up-to-date record of the use of any radioactive substance. The record must include the date, the type of experiment, the amount of isotope used, the approximate amount discarded as solid and liquid waste, and the balance of the radioactive substance remaining in storage. The area is also required to maintain individual records of exposure of Radiation Workers to ionising radiation.

***Monitors*.** Portable monitors are available to survey radiation levels. TLD-badges must be worn when using *gamma* or hard *beta*-emitting isotopes (e.g., ^{32}P).

***Accidents or Spillage*.** The School's Radiation Safety Officer, or the Technical Manager must be notified *immediately* of any *accident* or *spillage* that occurs, however small, during the handling of a radioactive substance. The business and home telephone number for the Radiation Safety Officer can be found in **Appendix A.**

The ANU online Incident Notification form must also be completed as soon as practical. This is accessed via the Horus based website:

http://policies.anu.edu.au/procedures/death_injury_exposure_and_dangerous_occurrence_reporting_at_the_anu/procedure

10.2 X-ray Radiation

NOTE: No new source of X-ray radiation can be imported into the RSC without first informing the Technical Manager. Any transfers of X-ray radiation sources to

different locations within the RSC or transfers out of the RSC, or any sources that are retired, must be reported to the Technical Manager.

Before commencing work, persons working with X-rays are required to obtain a copy of the ANU booklet entitled "*Ionising Radiation Safety"* from the Technical Manager's office and to become familiar with the sections on the use of equipment generating ionising radiation. Prospective users of equipment will then have to be trained by an appropriate officer (X-ray service head, relevant group leader or nominee) and when that officer is satisfied that the user is competent, the user will be authorised to use the equipment unaccompanied.

***Monitors*.** All users of X-ray radiation must complete a registration form, available from the Technical Manager. This form registers people to receive a TLD radiation monitor.

10.3 Non-ionising Radiation

In the School there are many sources of radio-frequency and microwave fields with available power levels that exceed safe limits. The sources include microwave ovens, NMR and EPR spectrometers, a microwave source for generating plasmas, and induction furnaces.

Under normal operating conditions operators are protected from hazardous levels of radiation. Where it is possible for inexperienced operators to exceed safe limits of radiation with any of the sources available there is a staff member with the responsibility of ensuring that potentially hazardous procedures are understood. There is no internationally agreed safe level of exposure to non-ionizing radiation, but a consensus is emerging that a level of 1 mW cm^{-2} is safe for short periods of continuous radiation. Standards do not exist for pulsed fields; thus, the continuous wave safe level should be seen as an upper limit for exposure.

10.4 Lasers

NOTE: Before using lasers unassisted in the RSC, technical competency must be proved to the satisfaction of the group leader or the laser safety officer. **[See Appendix A]**

NOTE: No new laser source can be imported into the RSC without first informing the Technical Manager. Any transfers of laser sources within the RSC or out of the RSC, or any sources that are retired, must be reported to the Technical Manager.

Although the average power of lasers in the School is small, perhaps less than that of a small flashlight, laser beams are potentially dangerous for the following reasons:

(i) If a laser is focussed onto the retina of the eye, the damage caused can be much greater than that caused by looking at the sun;
Never look down a laser cavity.

(ii) If a laser is transmitting in the ultraviolet or infrared it will be invisible to the eye.
Always wear appropriate eye protection.

(iii) A small amount of laser energy can be concentrated into an extremely bright flash, perhaps brighter than the light from a thousand football field lighting systems.
Laser beams should not be directed above chest height.

11. MICROORGANISMS & OTHER BIOLOGICAL MATERIALS

NOTE: The name of the Controlling Officer for the importation and use of biological material can be found in **Appendix B.**

There are three separate aspects of use of biological materials and living microorganisms in the School: their importation into RSC, their safe use within RSC, and their disposal following use. In each of these areas there are safe practices to be followed, together with some procedures that are governed by regulatory authorities. Microorganisms in use in the School, or that potentially contaminate biological materials used in RSC include viruses, bacteria, yeasts and fungi. There are no procedures in place for handling higher organisms in RSC.

11.1 Importation of biological materials.

All materials derived from living organisms, even if highly purified, should in the first instance be treated as being potentially infectious. It is of critical importance to the health of Australian residents, and to our primary industries, that infectious materials are not unknowingly imported, for example, as contaminants of other biological materials. Importation of biological materials from overseas is strictly controlled by the Australian Quarantine and Inspection Service (AQIS). Importation from other laboratories in Australia of materials derived originally from overseas sources is also subject to AQIS regulation. RSC is registered by AQIS for use of such materials, and they should not be passed onto other laboratories without approval. Procedures detailed below for their use and disposal must be adhered to strictly. AQIS Registration requires that a Controlling Officer be appointed, and that records be kept of the importation, use and disposal of certain biological materials. Purchase of materials that are subject to the regulations and are imported via

chemical and biochemical supply houses must be authorised by the Controlling Officer, who should be notified on arrival of the materials. Materials must be used and disposed of according to the regulations below (Sections 11.3-11.4). Users must notify the Controlling Officer in writing of their locations during storage and of their disposal.

Biological material imported directly from laboratories overseas will not be admitted into Australia without a "Permit to Import Quarantine Material", obtainable from AQIS. Application forms and advice on their completion are available from the Controlling Officer. A fee is charged, and granting of a permit may take as long as two weeks. Materials arriving without proper documentation may be held in quarantine or destroyed. Copies of all applications and permits must be lodged with the Controlling Officer or by gong to http://www.daff.gov.au/index.cfm . Imported materials must be used and disposed of in accordance with the conditions specified on the permit, and the regulations below (Sections 11.3-11.4). Users must notify the Controlling Officer in writing of their locations during storage and of their disposal.

11.2 Use of microorganisms and potentially infectious biological materials.

11.2.1 General safety aspects.

Microorganisms, particularly fungi and bacteria, are so commonly harmless that it is easy to forget that this is not always the case. Apart from dangerous pathogens that necessitate specialist handling, many microorganisms are potentially harmful or dangerous. These can cause infection (e.g., of eyes, ears, nasal passages, etc.), or if inhaled or ingested the metabolites in them may cause toxicosis. Powerful skin irritants and allergens are produced in some fermentations. It is the responsibility of the research worker to ensure that appropriate safety precautions are observed. All possible steps must be taken to protect technical staff, who should be instructed in the necessary safety precautions.

Unless the organism is known to be harmless, it is best to assume it may be infectious or toxic. A literature search should be carried out before working with any organism, and any toxic or infectious characteristics reported to the Controlling Officer **[see Appendix B]** for noting in the School's culture catalogue. Although *Escherichia coli* K12 strains may be assumed to be non-infectious, they should be handled carefully to avoid contact with skin or mucous membranes, or ingestion.

Use of bacteria containing recombinant DNA (r-DNA; e.g., plasmids, prophages) is also covered by regulations of the Institutional Biosafety Committee (IBC), and the Office of gene

Technology Regulator (OGTR). There are no facilities in RSC for culture of animal cells. Copies of the OGTR guidelines for recombinant DNA work may be borrowed from the RSC member of the IBC **[See Appendix B]** or by going to

http://www.health.gov.au/pubform/handbook.htm

These guidelines require that a protocol be prepared by the researcher and be approved (either by OGTR or the IBC) before r-DNA work may commence. In general, small-scale work with *E. coli* K12 transformed with DNA from species that naturally recombine with it (i.e., *E. coli* itself, coliphages and certain other bacteria) is exempt dealings with GMOs and is not subject to regulation, although normal safe practices in handling microorganisms are expected to be maintained (see below). Projects involving use of DNA from other species must be approved by the IBC, which will specify the required level of biological containment for the project or grant exemptions from those requirements. At present, no work requiring containment at level PC2 or above is permitted in RSC. Before commencement of work, all projects involving use of recombinant DNA should be discussed with the Controlling Officer who will advise on procedures for submitting proposals to the IBC.

For the purposes of AQIS regulation, all work permitted to be carried out at RSC is classified as being *in vitro* (i.e., higher organisms are not used for research purposes).

11.2.2 Recommended safety precautions

(i) If you are in doubt about possible safety problems associated with an organism, please check with the Controlling Officer **before** you handle it. **[See Appendix B.]**
(ii) Organisms which pose any toxic or infectious hazard should be clearly labelled "DANGER - toxic material" or "DANGER - infectious material" during both storage and growth.
(iii) General microbiological safety procedures can be demonstrated by the microbiologist.
(iv) Rubber gloves, laboratory coat, and safety glasses should be worn when working on preparative scales with cultures or culture liquors, or with materials classified as being potentially infectious.
When harvesting microorganisms, do not risk direct contact with the organism, its spores, or its culture liquor.
(vi) Avoid spreading the organism in the laboratory. Avoid forming aerosols - fine droplets of liquid culture, or clouds of spores from fungi or *Actinomycetes* - which can spread widely and may cause infections or allergic reactions. Cultures forming air-dispersed spores should be harvested in a fume-hood or biosafety cabinet, and procedures likely to generate aerosols should be carried out in a biosafety cabinet.

(vii) Hypochlorite solution (stored under the fume cupboard in Rooms E207, E208 and E3) should be on hand in anticipation of a spill of potentially-infectious material. In the event, hypochlorite solution should be poured carefully around the edge of the spill, and the microbiologist or research worker involved should be informed.
(viii) All waste materials from cultures of microorganisms or experiments with potentially infectious materials, should be returned to the autoclave Room E12 in covered containers for sterilisation prior to disposal by the approved method (Section 11.4).

11.3 Disposal of potentially infectious materials.

11.3.1 General biological material:

Waste disposal methods used by the Research School of Chemistry are covered in the ANU Occupational Health and Safety Manual, namely: “The guiding principle with all biological waste is that all biological material shall be rendered harmless (i.e., incapable of multiplying or transmitting genetic material) before leaving the control of the person who knows most about it. Generally, this means autoclaving or killing at the laboratory followed by transport of the dead material to the Health Services Supply Centre, Mitchell, for incineration.”

All potentially infectious biological material should be delivered in covered containers to the autoclave Room E12 for sterilisation. Materials that should be treated in this manner include disposable culture dishes, pipette tips and disposable test tubes, contaminated paper and tissues, etc., in addition to living cultures and culture liquors. Autoclaved solid or semi-solid (agar) waste should then be placed in the marked yellow Sulo bin in the Loading Bay, RSC, for weekly collection and incineration. Autoclaved liquid waste may be disposed of to the sewer system. Autoclaved glassware may be returned to the normal washup procedures. Contaminated sharps are incinerated directly in approved puncture-proof sharps containers following autoclaving.

When it is not possible to kill or inactivate infectious material by autoclaving, it should be treated with, or soaked in, dilute hypochlorite solution for 24 hr, prior to its disposal as above.

Non-contaminated waste materials will be generated in the laboratory as well as biologically contaminated material. It is essential that the two types of waste are kept separate.

Non-contaminated waste such as paper and plastic should be accumulated in separate bins (clearly distinct from containers used for biological waste) and disposed of as domestic waste.

Err on the side of caution. While some incineration of non-contaminated material is expected, it is imperative that domestic waste not be contaminated with potentially infectious materials.

11.3.2 Recombinant DNA (r-DNA) material:

Disposal of waste materials from r-DNA work shall be carried out in accordance with the protocol approved by OGTR or the IBC. Usually, this involves autoclaving or chemical killing of waste, followed by disposal by incineration (i.e., essentially as for general biological waste, above).

12. HAZARDOUS CHEMICALS

NOTE: **Appendix B** lists names of staff who are experienced in the handling of certain classes of hazardous materials. Reference should also be made to Section 7 in the main text, which lists the location of the High Hazard Laboratories and Section 9 which deals with risk assessments. If you are uncertain about the toxicity of any reagent, reference to Materials Data Safety Sheets (MSDS) can be made through the ChemWatch database. Conveniently, these can be found at the web sites http://sails.anu.edu.au/chemwatch/ or http://chemistry.anu.edu.au (then click on Chemwatch).

Many of the compounds in daily use in the laboratory have dangerous properties. They may be toxic, inflammable and/or explosive, may have unknown physiological effects, or may sensitise the skin. It is wise to assume that all chemicals are potentially dangerous. One should always be careful to prevent inhalation, skin contamination, fire and explosion.
The following is a list of some commonly encountered hazardous chemicals; comprehensive lists and references for these and many other compounds may be found in the books listed in the Bibliography.

NOTE: **Appendix C** contains useful practical tips for handling selected hazardous chemicals.

Aliphatic azo compounds are explosive; for example, azo-N-chloroformamidine decomposes explosively at 155 °C.

Aniline is very toxic. In severe cases of intoxication symptoms include marked cyanosis, nausea and vomiting, low blood pressure, sudden and extreme prostration, and sometimes convulsions.

Benzene and its homologues may be absorbed by inhalation or ingestion. A toxic dose will cause dizziness, headache, nausea, vomiting, pain in the chest, convulsions, coma and death from respiratory failure.

Delayed effects from chronic exposure are leukopenia and anaemia.

9-Bromofluorene causes severe dermatitis with a delayed reaction of three to four weeks.

Beryllium compounds are noted for a latent period between exposure and the onset of illness, and usually one or two weeks may elapse before an X-ray will show pneumonitis. Exposure to beryllium oxide has been known to cause a chronic lung disease as late as 25 years after the last exposure.

Carbon tetrachloride can cause nausea, dizziness, headache, blurred vision, fever and weakness with progression to coma and convulsions. Acute exposure will affect the central nervous system and then the liver and kidneys.

Diazomethane is both toxic and explosive. Exposure to diazomethane will cause severe headache, chest pains, aching muscles and an overwhelming fatigue; after sensitisation even traces of the gas will cause severe reactions. Even when diluted with nitrogen, the gas is liable to explode, e.g., above 100 °C, under high intensity lighting or in contact with ground glass joints.

Dioxane after 15 minutes' exposure at 300 ppm will cause mild transient irritation of the eyes, nose and throat. In large doses it is a weak anaesthetic and a liver and kidney poison.

Ethers have a long history of causing laboratory fires and explosions. These solvents are highly inflammable and readily form peroxides on exposure to air; di isopropyl ether is particularly prone to undergo peroxidation.

Ethylene diamine causes sensitisation of the skin and the respiratory system.

Mercury vapours are toxic. Globules of mercury spilled on benches and floors form large surfaces for evaporation. Some effects produced after repeated exposure to toxic or subtoxic concentrations are tremors, damage to kidneys, and opacity of the cornea.

Some metal hydrides, for example, sodium hydride, ignites and explodes in contact with liquid water or even high humidity. Other hydrides are less reactive but once ignited the fires are difficult to extinguish.

Osmium tetroxide causes irreversible eye damage and the vapour irritates all parts of the respiratory system. Osmium tetroxide must be used in a fume cupboard.

Peroxides as a group probably constitute the largest class of hazardous compounds. Many laboratory accidents have been ascribed to peroxide in solvents, usually ethers.

NOTE: Fluorine, hydrofluoric acid, perchlorates, anhydrous ammonia, liquid nitrogen, solid carbon dioxide, and alkali metals are discussed separately below.

12.1 Pressurised Toxic Gases

Anyone unfamiliar with the use of pressurised gases and, in particular, toxic gases, should consult someone with experience. A list of people with such experience can be found in **Appendix B** and written instructions for using pressurised gas cylinders safely can be found in **Appendix C (p12)**.

12.2 Warning Notice for Highly Toxic or Unpleasant Smelling Gases and Vapours

The warning notice attached to the Safety Notice Board outside Room 119A must be filled in when a toxic or "smelly" gas is to be discharged from a fume-hood so that maintenance workers will know to avoid the roof and the roof space for the duration of the experiment. *The notice must be updated daily.*

12.3 Fluorine (gas)

Special safety requirements are mandatory for the use of fluorine in the School. A sterile solution of calcium gluconate must be on hand for immediate use in the case of burns. **This will need to be injected under the affected area by a qualified medical practitioner.** The fluorine cylinder can only be delivered by special arrangement and the School Manager must be informed of its expected arrival time. The cylinder and fluorine reaction vessels must be clearly labelled DANGEROUS so that staff will be aware of a potential major hazard. The use of fluorine must be supervised and no more than two persons may be responsible for the cylinder and its use.

12.4 Hydrofluoric acid (solution and liquid)

For information on access to HF stocks, refer to **Appendix B.**
Calcium gluconate gel must be applied to the affected area if any HF comes in contact with the skin. In addition, in the case of more serious contamination, a sterile solution of calcium gluconate must be on hand for immediate use. This will need to be injected under the affected area by a qualified medical practitioner. Important. When fluorine gas or liquid hydrofluoric acid is ordered, the School Manager must be informed of its expected arrival time. The cylinder and any reaction vessels used in the experiment must be clearly labelled DANGEROUS so that staff will be aware of a potential major hazard. The use of fluorine must be

supervised and no more than two persons may be responsible for the cylinder and its use.

12.5 Liquid Nitrogen and Solid Carbon Dioxide

When liquid nitrogen is used to cool traps attached to vacuum pumps these traps must never be left immersed in the liquid nitrogen when the system is opened to the atmosphere, otherwise oxygen will condense from the air into the traps and the liquid oxygen **may explode** on warming. **(See Appendix C, p9.)** Always empty the cold traps immediately after use. Never pour liquid nitrogen into the sink.
Liquid nitrogen and solid carbon dioxide must be stored in well-ventilated areas, never in the cold room or in refrigerators.

When dispensing LN2 from a pressurised Dewar, a face shield, thermal gloves and lab coat or long sleeved shirt must be worn. Dispensing LN2 from the bulk container in the loading dock must not be carried out without prior authorisation from an authorised officer in the RSC Workshop. [See Section 16.]

12.6 Anhydrous Ammonia

When collecting ammonia as a gas, a direct flame or steam jet must never be applied against a cylinder of ammonia. If it becomes necessary to increase the pressure in a cylinder in order to promote more rapid discharge, the cylinder should be moved to a warm room. Only steel valves and fittings should be used on ammonia cylinders. Extreme care should be exercised to prevent the temperature of the cylinder from rising above 50 °C. Collect ammonia from the cylinder as a liquid and purify it by distillation in the laboratory with the aid of a dry ice - acetone condenser. It is convenient to dry the ammonia by the addition of a small quantity of sodium before the distillation.

Protect your eyes by wearing goggles when you handle ammonia.

Containers of anhydrous ammonia should be carried down the central stairwell. It is advisable to have a second person along when handling liquid ammonia. Supplies of liquid ammonia are kept on the Inorganic and Organic floors.

12.7 Liquid Helium

Liquid helium must not be handled by untrained staff. Before using liquid helium consult the School Manager or the Cryogenic Supervisor.

12.8 Oxygen

It is extremely important to note that an oxygen-enriched atmosphere can increase the risk of fire enormously. If the oxygen in the atmosphere is increased from 21% to 24% cotton and woollen clothing burns rapidly instead of smouldering. Under no

circumstances should oxygen be allowed to come into contact with oil or grease. Do NOT attempt to grease or oil gas regulators. These must be repaired and overhauled by trained personnel.

12.9 Cyanide

NOTE: Before any experiments involving cyanide can be carried out, the user must read and understand the RSC policy on its use. The policy and other relevant documents mentioned in the text below can be found in **Appendix B**.

Cyanide salts are on restricted access and are available from the Technical Manager.
Manipulations with cyanide salts must be carried out between 9.00 a.m. and 5.00 p.m., Monday to Friday when First Aid Officers certified to administer oxygen are available. At least two people must be present in the area when cyanide is being used. The "Oxy-Viva" kit, which is recommended for the immediate treatment of cyanosis, is located in Room 42. First Aid Officers qualified to administer oxygen therapy are listed in **Appendix A.**

Before using cyanide obtain a copy of *Cyanide Handling and Disposal Procedure* and read thoroughly. **[See Appendix B.]** Complete *Experiments with Cyanide* form and give a copy of *Cyanide Accident Procedures* to another person in the laboratory who will then be responsible for organising assistance in the event of an accident. All these forms are available from the Technical Manager.

Manipulations must be performed in a fume cupboard and an entry must be made on the "Roof Area" notice board outside Room 119 before commencing the reaction. If the reaction is to be left unattended, place a *Cyanide In Use* sign on the closed fume cupboard window.

12.10 Perchlorates

As perchlorates are classified as Class A explosives, all experiments with perchlorates must be treated as potentially hazardous. In the School there have been explosions of complexes of chromium, iron, osmium and ruthenium, and the rapid disintegration of many other perchlorate complexes has occurred, especially those of lower molecular weights, which are often the least stable.

Supervisors must ensure that only experienced staff or staff under direct supervision perform experiments involving the preparation and handling of perchlorates. To ensure that maximum care is taken when handling perchlorates the following rules and safety tests have been devised: the perchlorate ion should be used only if there is no other suitable ion; when handling perchlorates, plastic spatulas should be

used; perchlorates must never be scraped from sintered glass frits; and, perchlorates must never be heated or ground in the dry state. Whenever possible use perchlorates in aqueous solution; when this is not possible test the perchlorate in the organic solvent on a small scale (<100 mg) before employing the solvent for the reaction.

Before a perchlorate is prepared on a large scale (>100 mg), the sample must pass certain safety tests. The product (<100 mg), having been prepared behind a safety screen, must be subjected in <1 mg quantities to the hammer and anvil test, heating on a metal spatula, and mixing in an organic solvent (e.g., DMSO). If all of these tests have been satisfactory, that is, there have been no explosions, the experiment may be scaled up, to, say, 1g.

12.11 Alkali Metals and Highly Reactive Metal Hydrides

[See, also, Appendix C]

Sodium and potassium metal in contact with moist air will oxidise or peroxidise and may melt or ignite. Potassium is more reactive than sodium and the liquid sodium-potassium alloy is more reactive than either. *Alkali metals (including lithium) must on no account be used to dry chlorinated solvents such as dichloromethane, chloroform or carbon tetrachloride* (always check procedures for solvent purification and drying).

Lithium, sodium and potassium metal, sodium-potassium alloy, or sodium hydride, potassium hydride and lithium aluminum hydride, will release hydrogen rapidly when quenched. Prior to quenching, these substances should be covered with, or slurried in, a hydrocarbon solvent like toluene and *placed under a strong nitrogen or argon counter-stream*.

Quenching lithium and sodium metal and reactive metal hydrides: The quench should carried out by adding isopropanol drop wise followed by, cautiously, water. Finally, dilute sulfuric or hydrochloric acid is added until a neutral or slightly acidic pH is achieved. In all cases, when quenching a hydride or active metal, *the volume of hydrogen gas to be vented should be estimated* by recalling that 1 mole of gas occupies 22.4 L at standard temperature and pressure. Quenching rates should be chosen to allow enough time for gases and heat to be released in a controlled way. The quenching of potassium metal and sodium-potassium alloy requires extreme caution (see later).

Distillation Pots. When quenching distillation pots, one must exercise extreme care to ensure that lumps or domains of the reactive substance are not protected or

isolated from the quenching agent by other residues such as benzophenone. This is why *stirring is important, as it breaks up any protective coating, so exposing the fresh metallic surface*. Such mixtures must be fully quenched using the method described above and then pH-neutralized before transferring to waste containers.

Quenching potassium metal and sodium-potassium alloy: Fresh potassium or sodium-potassium alloy can be destroyed with dry tert-butanol or dry tert-amyl alcohol. *This procedure is, however, dangerous if the surface of the potassium or of the alloy has been exposed to air for any length of time* owing to the formation of peroxides which react explosively with alcohols.

WARNING! *If the residues contain potassium dioxide, $K^+O_2^-$, and tert-butanol is added to them, peroxidation of the solvent may occur. (Ethers and alcohols are both particularly susceptible to peroxidation in this way.) These types of peroxides are shock sensitive and disturbing them by swirling them in a beaker or scraping them with a spatula, may result in a violent explosion. As there is always uncertainty whether the metal residues contain dioxide or not, it is recommended that all potassium residues are destroyed by carefully adding them in small pieces to a large beaker of ice/water (not alcohol) kept behind a blast shield. To prevent ignition of the evolved hydrogen, the beaker could be placed under a nitrogen atmosphere.*

Alkali metals, especially sodium-potassium alloy, should be prepared fresh and any excess destroyed immediately. They should never be stored with an exposed surface for any period, even in closed vessels under argon or nitrogen, because joints, stoppers and taps are likely to leak.

12.12 Transport of Toxic Materials

(See Section 8.1)

12.13 "Smells"

A book is kept in the School Manager's office (Room 59) for the recording of smells that may be of concern. The School Manager, when notified of a smell will endeavour to determine the source of the smell and record findings in the book. It is School policy that if staff members are offended by a "smell" in their area they are free to vacate the area/building after notifying the School Manager.

12.14 Dealing with chemical spills

In each synthetic chemistry laboratory there is a bucket of soda ash and a bucket of vermiculite that can be used to absorb and/or neutralize spills. In addition to these, on the Top and Middle Floors (Birch Building), adjacent to the lift doors, there are

"spills" cabinets containing various items, including respirators, gloves and over suits that can be used when dealing with more serious spills.

13. AUTOMATIC CUT-OFF DEVICES

13.1 Smoke Detector Units

Time cut-out switches (60 minutes) have been fitted to the smoke detector units in Rooms 5, 6, 8, 16, 28, 34, and 238. Red warning lights by the door, in the room or in the corridor, indicate that the smoke detector has been cut out by the time switch.

14. OCCUPATIONAL STRAIN INJURY

The School has staff designated as Occupational Strain Liaison Officers (OSLOs). **[See Appendix A]** Members of the School should consult with the OSLOs about repetitive strain injury matters; OSLOs attend Safety Committee meetings for discussion of this subject.

15. ADDITIONAL RULES AND INFORMATION

15.1 Minor Maintenance

Minor maintenance jobs, such as leaking taps, faulty lights, faulty electrical switches, etc., should be logged in the Workshop Job Request System under 'Urgent and someone in the Workshop informed personally.

In cases where a potential hazard is involved the Workshop Manager or the Facilities Officer or the Mechanical Workshop Supervisor should be notified as soon as possible.

15.2 Cleaning of Glassware

NOTE: **See Appendix C**
Open "acid-baths" (sulphuric, sulphuric-chromic acid) are not permitted in laboratories. In appropriate cases these solutions may be used in small quantities to clean glassware such as burettes and pipettes. The acids must not be allowed to come in contact with the benches.

Buckets of Soda Ash are kept in laboratories for neutralisation of spilled acids. Caustic solution (ethanol or *iso*-propanol/KOH) in a polythene tank with a lid should

be used for removing silicon grease from glassware. (NB Caustic baths will not remove Apiezon grease.) The tank should stand on a sink, not on the bench. Glassware for repair must be thoroughly cleaned before it is sent to the glassblowing section of the workshop.

15.3 Disposal of Hazardous Waste

Consult the Technical Officer in charge of waste management. **[See Appendix B.]** Further information on the disposal of hazardous wastes can be found at the ANU OHS website listed in Section 20. For information on segregating wastes prior to disposal, see Section 9.

15.4 Good Laboratory Practice

Good housekeeping is essential to minimise toxic hazards to oneself and to other workers and to keep equipment in working order. Spillages, particularly on balances and instruments, should be cleaned up immediately. Fume cupboards must be cleaned regularly and surplus chemicals returned to the appropriate store. Because of possible contamination, books should not be kept on laboratory benches or in the drawers underneath.

Please ensure all laboratory corridors, walkways and fire extinguisher locations are not cluttered with equipment and furniture. The corridors are essential escape routes.

15.5 Electrical Equipment

The School has licensed staff that test, approve and tag all electrical and electronic appliances and equipment with a BLUE label before releasing them for use. Faulty equipment or switches should be reported as soon as possible to the Workshop. In the first instance, the equipment should be labelled: DO NOT USE to warn others of the potential danger. *Only authorised personnel may carry out repairs, alterations and maintenance of electrical and electronic equipment. Never use electrical equipment that has been tagged with a RED - 'Do not use' - label.* Isolation and danger tagging of equipment may only be done by an electrician or other appropriately qualified person. School personnel must comply with the instructions written on the tag. In addition, all portable appliances must be tested every 12 months.

http://policies.anu.edu.au/procedures/electrical_safety/procedure

Ensure that electrical cables are kept off floors where possible to minimise hazards and to assist the cleaners. All electrical equipment must be purchased with appropriate circuit diagrams and service manuals.

15.5.1 Use of Heat Guns

Heat guns are a potential source of fire in a laboratory. If used incorrectly, they can overheat and ignite the motor casing and any other flammable materials near by.

Heat guns must be operated using the following standard procedures:

- **Do not use a heat gun near flammable materials/atmospheres.**
- **Never touch the hot metal nozzle with clothing or skin.**
- **Always hold heat guns in fixed and permanent positions when in use.**
- Ring clamps are ideal for this purpose. Sometimes, when performing tasks other than drying tlc plates, this may not be possible, but, where practicable, always bring the job to the heat gun, never the other way round.
- **Never confine the hot air outlet by clamping the heat gun close to a work surface or wall.**
- **Always use heat guns on the minimum setting necessary to do the job.** Most heat guns have a very large potential heat capacity (2kW), because they are designed to act as paint strippers. On maximum setting, temperatures up to 700 deg C can be reached, which far exceeds any temperature a laboratory worker would normally have need for.
- **Never lay a heat gun on its side, whether it is in use or not.** The air intakes are often located in the sides of the motor housing and reducing the airflow over the heating elements will increase the temperature dramatically.
- **Never leave the mains switch turned on after use, even if the appliance is turned off at the motor housing.** If the mains switch is left on, the power cord is still energized up to the appliance. Best practice is to pull the plug out from the power point after use.

15.6 Vacuum Pumps

All vacuum pumps that require servicing by the workshop must first have been flushed with clean oil before transporting to the workshop. Regular servicing will increase the life of the pumps.

15.7 Observation Windows and Laboratory Doors

The wired glass windows in laboratory and instrument room doors are installed for safety reasons. These windows may be covered when a “dark room” is required, but when the experiment is completed the window must be uncovered. *Laboratory doors must never be locked without prior consultation with the Technical Manager, School Manager or Area Safety Officer.*

16. REGULATIONS FOR RSC WORKSHOP STAFF

NOTE: Before starting work for the first time, all new RSC Workshop staff must be inducted by the Workshop Manager. They must also familiarize themselves with the Workshop Safety Manual for information on ANU policies and procedures.

Suitable eye protection: This must be worn whilst using machine tools or carrying out hazardous operations. All machines must be fitted with appropriate guards. Guards must be in position when the machine is in use. Loose clothing or long hair must be restrained when machine tools are being used. Suitable ear protection must be worn as required.

Flammable solvents: These must not normally be used for cleaning purposes. If the use of a flammable solvent is unavoidable, a risk assessment must be carried out prior to its use with reference to available MSDS, Chemwatch, for example: http://sails.anu.edu.au/chemwatch/ and/or by consulting a senior technical or research officer.

Risk Assessments for chemicals and chemical products: Risk assessments must be carried out before using chemicals or chemical products. **[See Appendix B]**

Dispensing cryogenics:
The authorised officer with responsibility for cryogenic liquids can be found in the room adjacent to the main LN2 container in the RSC loading dock, Building 35. This officer will run through the Standard Operating Procedures for dispensing cryogenic liquids with first time users and decide when those users are competent to use the equipment unassisted. The dispensing outlet is locked and requires a key.

17. REGULATIONS FOR RSC STORES STAFF

NOTE: Before starting work for the first time, all new RSC Stores staff must be inducted by the Head Stores Officer. It is expected that all RSC Stores staff will complete an appropriate course or courses on handling hazardous materials. The School has prepared its own Protocols for Handling Dangerous Goods:

- Assume all goods are dangerous.
- When receiving chemical deliveries always check their Material Safety Data Sheets using the link in the Chemical Inventory System. (Instructions on how to use the MSDS link are included in the CIS guide.)

- If a vessel containing a chemical has been packed inside a secondary container, do not open the secondary container to access it.
- If any container – primary or secondary – is damaged or distorted: DO NOT TOUCH IT. Contact the end-user, a senior academic or a senior technical officer.
- If there is a major chemical spill during a delivery:
  - YOUR SAFETY IS THE FIRST PRIORITY.
  - Call out for help.
  - Call the RSC Emergency telephone number (Extension 53636).
- If, after assessing the risk, **you consider it safe** to do so:
  - Turn off the air intakes to the building using the timer switch located adjacent to the steel loading dock ramp.
  - Use the bunding and absorbent kept in the spills containment kit located in the loading dock to prevent liquids entering the drainage system.
- If the situation is considered highly hazardous:
  - Activate the fire alarm located adjacent to the liquid nitrogen area, which will summon the Fire Brigade and the School's Emergency Response Team.
- Before transporting large volumes of chemicals and solvents in a trolley, always check with the Dangerous Goods compatibility chart to ensure the items are compatible.

18. MONTHLY SAFETY INSPECTIONS

Once a month, safety inspections are carried out. A senior member of the academic staff is included in each inspection team, along with the Technical Manager and the Director and/or the Chair of the Safety Committee. In addition to checking on good laboratory practice, notebooks are also checked to see if risk assessments are being done. As part of the requirements for a satisfactory report from the inspection team, laboratory workers are expected to clear and clean the surface of their benches. The inspection reports are circulated to Group Leaders, who are then responsible for correcting any deficiencies.
NOTE: Occasional spot checks are also carried out.

19. ANNUAL CLEAN-UP

A thorough clean-up of all laboratories and instrument rooms in the School is arranged towards the end of each year. Each group is required to cease work for at least one full day in order to carry out the clean-up. The date of the clean-up is arranged in conjunction with the group technical staff, who will then be available to supervise the return of equipment and chemicals to the stores and to arrange for the repair of broken equipment and laboratory fittings and disposal of chemicals.

Group leaders are asked to ensure that the following points, as far as they are relevant to their group's work environment, receive close attention:

1. A stock take of all chemicals must be carried out and their locations recorded in the chemical inventory system. Those not already in the system must be bar coded and entered.
2. Each bottle of reagent must be examined and a decision made as to whether it is to be kept, relocated, combined, re-bottled, or returned to store, remembering to record all changes in the chemical inventory system. A list of any chemicals for disposal, with quantities, must be given to Stephen Lee.
3. All shelves, cupboards, drawers and fume cupboards must be thoroughly cleaned.
4. Refrigerators must be cleaned out and defrosted.
5. Arrangements must be made for the recovery or disposal of all residues.
6. Surplus glassware must be thoroughly cleaned and returned to the store or, if broken, submitted to the glassblowers for repair.
7. Electrical and other general items of laboratory equipment must be thoroughly cleaned and examined for faults, and the necessary action taken for repair.
8. Faulty switches, power points, light fittings etc., as well as any other laboratory fitting in need of maintenance, must be reported to the Workshop via the on-line Job Request System.
9. Remove all superfluous materials from floors and benches.

An inspection by the Director and representatives of the Safety Committee of **ALL LABORATORIES** will be carried out the week following the clean-up.

CARRYING OUT A STOCK TAKE USING THE CHEMICAL INVENTORY SYSTEM

Beginning the stock take:

- Click on **'Room Inventory'** from the boxed menu.
- Click on the **'Take inventory'** button.
- From the drop-down boxes, select Building, Room and Location where the inventory is to be taken, then click **'Submit'**.

Scanning bar codes:

- The bar code readers are programmed to automatically enter **[Submit]** after each scan allowing for consecutive scans to be made within the same location. However, a pause of about one second between scans is recommended or the bar code numbers could double up.

Completing location inventory:

- At the completion of the inventory click the **'Finish'** button.

To store the data scanned for that location:

- Click **'Store scans'** and the inventory for that location is updated.

20. BIBLIOGRAPHY

ChemWatch
ChemWatch is a networked database that contains the so-called Material Safety Data Sheets (MSDS) of a vast range of chemicals. Access to Chemwatch:

http://sails.anu.edu.au/chemwatch/

http://chemistry.anu.edu.au (via RSC Homepage and/or the chemical inventory system)

http://chemgold.anu.edu.au

The following list contains the websites of relevant ANU Policies and Procedures:

List of all ANU OHS Policies
http://search.anu.edu.au/search/search.cgi?collection=policies&query=ohs%20policies
Hazardous waste
http://policies.anu.edu.au/procedures/disposal_of_hazardous_waste/procedure

Radiation
http://policies.anu.edu.au/procedures/radiation_safety/procedure

Risk management for chemicals (see also RSC Safety Regulations)

Policy http://policies.anu.edu.au/policies/chemical_management/policy

Procedure http://policies.anu.edu.au/procedures/chemical_management/procedure

Manufacture and supply of chemical materials
http://policies.anu.edu.au/procedures/ohs_requirements_for_the_manufacture_and_supply_of_chemical_materials/procedure

Incident Notification Form
http://policies.anu.edu.au/procedures/death_injury_exposure_and_dangerous_occurrence_reporting_at_the_anu/procedure

Workshop safety (safety course to be completed)
http://policies.anu.edu.au/procedures/workshop_safety_procedures/procedure

Isolation and Danger Tagging
http://policies.anu.edu.au/procedures/isolation_and_danger_tagging_procedure/procedure

The following books are in Room 131A:

"Handbook of Reactive Chemical Hazards" L. Bretherick

"Prudent Practices for Handling Hazardous Chemicals in Laboratories" National Research Council, U.S.A.

"Toxicology of Drugs and Chemicals" W. B. Deichmann & H. W. Gerarde

"The Care, Handling and Disposal of Dangerous Chemicals" P. J. Gaston

"Laboratory First Aid" K. Guy

"Laboratory Handbook of Toxic Agents" Royal. Inst. Chem.

"Dangerous Properties of Industrial Materials" N. I. Sax

"Safety in the Chemical Laboratory" J. Chem. Ed.

Appendix A

OHS PERSONNEL & EQUIPMENT

- Emergency response team
- First Aid Certificate holders
- First aid cabinets
- Resuscitation equipment

(April 2012)

Appendix A

RSC Staff and Student contact details:
http://rsc.anu.edu.au/internal/index.php?option=com_wrapper&Itemid=74

RSC SAFETY COMMITTEE

Prof Tony Hill (Room 136)

Prof Martin Banwell (Room 201A)

Ms Tracy Murray (Room E207)

Mrs Viki Withers (Room 241)

Mr Paul Gugger (Room 1.83)

Dr Nick Kanizaj (Room 123)

Mr Geoff Deeble (Room 59)

A/Prof Geoff Salem (Room 2.2)

Mr Hugh McGlinchey (Room W3)

Mr Bill Speed (W/S)

Mr Lee Welling (Room 131)

Dr Mal McLeod (Room 118)

Mr Kevin Cooper (Room 59)

Vance Lawrence (Room 2.3)

Mr Hendrik Maat (W/S)

Occupational Strain Liaison Officers

Mr Graeme Lindsell (Room E101)
Mr Gavin Perri (Room 136)

Area Safety Officers

Building 35

Top Floor	Nick Kanizaj (Room 123)
Middle Floor	Daniel Bartkus (Room 109)
Ground Floor	Aidan Heerdegen (Room 39)
Workshop	TBA (Workshop)

Building 35A

Biological chemistry	Tracy Murray (Room E207)
Building 33	Paul Gugger (Room 1.83)
Building 136 (Teaching Division)	Vance Lawrence (Room 2.3)

Appendix A (cont.)

AFTER HOURS TELEPHONE NUMBERS

ANU SECURITY 52249

DIAL '0' FOR OUTSIDE LINE

	EMERGENCY	NON-EMERGENCY
FIRE BRIGADE	000	6247 0358
HOSPITAL	000	6243 2111
AMBULANCE	000	6249 8133
POLICE	000	6249 7444

MR LEE WELLING	(Technical Manager)	6242 8420 or 0404 823 154
MR KEVIN COOPER	(Facilities Manager)	6292 5446 or 0404 823 152
MR GEOFF DEEBLE	(School Manager)	0416 249 987
MR VANCE LAWRENCE	(STO, Teaching Division)	0410 424 483
PROF. TONY HILL	(Chair, Safety Committee)	040 654 6874
MR HUGH MCGLINCHEY	(Head Security Officer, RSC)	6231 9008

The DUTY SECURITY OFFICER should be informed immediately of any **emergency** occurring after hours by ringing the reception desk (Ext. **53636**) or by pressing the PRESS IF DESK UNATTENDED button on the reception counter.

Appendix A (cont.)

Emergency Response Team – Buildings 35/35A/36

			Room	Phone
House Warden:		Geoff Deeble	59	0416 249 987
Deputy House Wardens:		Kevin Cooper	59	0404 823 152
		Lee Welling	131	0404 823 154
EWIS		Hamish Onslow-Macarthur	11	51557
Wardens: ***(Birch Bld.)***				
Top Floor	A	Tony Herlt	103	0404 823 159
	B	Nick Kanizaj	123	0404 823 165
Middle Floor	A	Daniel Bartkus	109	54207
	B	Hideki Onagi	125	54334
Ground Floor	A	John Allen	23	53570
	B	Aidan Heerdegan	39	53579
Workshop	A	Mike Hill	W/S	53494
	B	Bob O'Brien	W/S	53494
Purchasing & Stores	A	Barry Scarr	Store	53499
	B	Kurt Russell	Store	55524
Wardens: ***(Craig Bld.)***				
Top Floor/Middle Floor		Tracy Murray	E207	54181
Ground Floor		Lasse Noren	E8	55408
General (Disabled Assistance):		Duty Security Officer		53636
First Aid Coordinator:		Paul Gugger	1.83	0404 823 164
Plant and Services:		Kevin Cooper	59	0404 823 152
		Mike Hill	W/S	50631/53494

Appendix A (cont.)
Emergency Response Team – Buildings 33/34

			Room	Phone
House Warden/EWIS:		Paul Smith	ESR Room	61253074
Deputy House Warden/EWIS:		Paul Gugger	1.83	0404 823 164
Wardens: (Link Bld 33)				
Top Floor	A	Rob Stranger	1.44	52934
	B	Mark Humphrey	1.68	52927
Ground Floor	A	Chris Blake	G48	58074
	B	Peta Simmonds	G44	53701
Wardens: (Teaching/Research Bld 33)				
Top Floor	A	Russell Barrow	2.29	53419
	B	Geoff Salem	1.24/2.20	53043
Middle Floor	A	Ron Pace	1.18	54546/54962
	B	Mark Ellison	1.33	54398
Ground Floor	A			
	B			
General:		Duty Security Officer		53636
First Aid Coordinator:		Paul Gugger	1.83	0404 823 164
Plant and Services:		Kevin Cooper	59	0404 823 152
		Mike Hill	W/S	50631/53494

Appendix A (cont.)

First-Aid Certificate Holders

NOTE: *Denotes personnel trained in administering oxygen.

BIRCH BUILDING

Ground Floor		**Phone**
Mr Bob O' Brien	Workshop	53494
*Mr Kevin Cooper	Room 29	50631 or 0404 823 152
Mr Kurt Russell	Room 30A	55524
Middle Floor		
Mr Gavin Perri	Room 136	54401
Top Floor		
*Mr Tony Herlt	Room 103	59765 or 0404 823 159
Ms Viki Withers	Room 241	53730

CRAIG BUILDING

Mr Hamish MacArthur-Onslow	Room E14	51557

LINK BUILDING

*Mr Paul Gugger	Room 1.87	54165 or 0404 823 164

TEACHING (BUILDING 136)

*Mr Vance Lawrence	0410 424 483
Mrs Bozena Belzowski	0404 823 168

Outside Business Hours: Phone 52249 (Facilities and Services Security) and ask for First Aid assistance.

Security Officer qualified to administer oxygen: N/A

Appendix A (cont.)

First Aid Cabinet Locations

Birch Building F035

Ground Floor

Main Reception (Portable first aid kit, portable oxygen and portable Defibrillator).
Workshop, Joint workshop, Glass Blowers Workshop, Room 18 and First Aid Room 42.

Middle Floor

Outside lift in main corridor and Room 110.

Top Floor

Room 210 and room 234.

Craig Building (F035A)

Middle Floor

Room E102

Top Floor

Room E205/E207

Link Building (F033 Stage 2)

Ground Floor

Room G42 (NMR)

Top Floor

Room1.87 and Room 1.47

Teaching/Research (Building F033 Stage 1)

Ground Floor

Room G.1 and Room G.10 (Room G.10 includes portable first aid kits)

Middle Floor

Main Reception room 1.28 (Portable first aid kit and portable oxygen)
Room 1.12, Room 1.3 and Room 1.21

Top Floor

Room 2.3, Room 2.8 (portable first aid kit), Room 2.28, Room 2.21 and Room 2.16

Appendix A (cont.)

SELF CONTAINED BREATHING APPARATUS

PERSONNEL TRAINED IN THEIR USE

Xing Hua Ma (R 237, x50793)

Paul Gugger (R 1.83, 0404 823 164)

Lee Welling (R131, 0404 823 154)

Aiden Heerdegan (R 39, x53579)

Kevin Cooper (R59, 0404 823 152)

Hugh McGlinchey, Stephen Jamieson, Don Smith (0404 823 158)

LOCATION OF SELF-CONTAINED BREATHING APPARATUS

Ground Floor: Wall adjacent to RSC Main Stores service counter.

- 2 x 45-minute rescue units with positive-pressure face masks

RESUSCITATION APPARATUS

Building 35 (Birch)	Oxyviva unit (Reception Desk, Foyer, Birch Bld.) Defibrillator (Reception Desk, Foyer, Birch Bld.)
Building 33 (Link)	Oxi-sok unit (Room 1.83)

Appendix A (cont.)

RADIATION SAFETY OFFICERS

Budget Unit RSC	Person	Room	Area of Expertise *
	Prof E. Krausz	40	3
	Prof L. N. Mander #	244	1
	Dr D. Ollis	E214	2
	Prof T R. Welberry	43	2
	Mr L. L. Welling	131	4
	Prof J. White	13	2
	Mr Hendrik Maat	W/S	3

*****

1. RADIOISOTOPES
2. MACHINES PRODUCING IONIZING RADIATION
3. LASERS
4. NON-IONIZING RADIATIONS

 # RSO who authorizes experiments that require radioisotopes
Prof L. N. Mander: Room 244; Phone (home): 62511361; (work): ext. 53761

BIOLOGICAL SAFETY OFFICERS

Budget Unit	Person	Room
RSC	Prof G. Otting	E4
RSC	Ms Tracy Murray	E207

Appendix B

USE OF HAZARDOUS MATERIALS

- **Safe handling of hazardous materials**
- **High hazard laboratories**
- **Location of panic buttons**
- **Risk assessment guidelines**
  - **Fine chemicals**
  - **Chemical products**
- **Use of cyanide**
- **Classification of hazardous chemicals**

(April 2012)

Appendix B

USE OF HAZARDOUS MATERIALS

RSC Staff and Student contact details:
http://rsc.anu.edu.au/internal/index.php?option=com_wrapper&Itemid=74

PYROPHORIC & OTHER AIR-SENSITIVE COMPOUNDS

The following officers are experienced in the handling of air and moisture sensitive compounds and in the safe destruction of their residues:

Lee Welling	Room 131
Paul Gugger	Room 1.83

PRESSURISED TOXIC GASES

Anyone unfamiliar with how to use and fit a regulator valve to a pressurized gas cylinder, should seek advice from the following officers:

Lee Welling	Room 131
Paul Gugger	Room 1.83

NB Where possible, only cylinders small enough to fit into a fume cupboard should be used.

NOTE: for guide in how to use a pressurized gas cylinder safely, see Appendix C, p12

MICROORGANISMS & OTHER BIOLOGICAL MATERIALS

The Controlling Officer for the importation of biological materials is:

Gottfried Otting	Room E4

The following officer will provide advice on the use of microorganisms and potentially infectious materials:

Tracy Murray	Room E207

LIQUID NITROGEN

Low or high pressure dewars must not be filled from the bulk reservoir of liquid nitrogen without prior authorization and induction from a member of the RSC Workshop staff.

RADIOACTIVE MATERIALS

The Radiation Safety Officer authorized to approved the use of radioactive substances is:

Lew Mander	Room 244 [Phone 62511361 (home); ext 53761 (work)]

CYANIDES AND CARCINOGENS

The following officers have access to these restricted compounds:

Lee Welling	Room 131
Paul Gugger	Room 1.83

HYDROFLUORIC ACID

The following officer has access to this restricted compound:

Lasse Noren	Room E8

NOTE: Prospective users of HF must present a signed Category C risk assessment form, in order to receive the acid. HF burns kits are kept in Room 127 (see Lasse Noren).

DISPOSAL OF HAZARDOUS WASTES

The following officer will provide information concerning procedures for the safe segregation and disposal of hazardous wastes:

Stephen Lee	Room 114

http://policies.anu.edu.au/procedures/disposal_of_hazardous_waste/procedure

Waste solvents must be emptied into the appropriate drums kept in Room 208 in Building 35 and in Room 1.22 in Building 33, which are then collected by designated support staff and taken to the chemical wastes store in the loading dock of Building 33.

PROCEDURES FOR COLLECTION AND DISPOSAL OF LABORATORY WASTE

Before discarding ANY chemicals, glassware or equipment the option of recycling, reuse or repair should be considered. (For more details, refer to Section 9, page 11 of Safety Regulations.)

Empty Winchesters and Reagent Bottles MUST be rinsed out and placed in the marked trays on each floor. On the top floor these are in Rm208 and Rm230.
The empty bottles are collected by the Security Officers for recycling.
ONLY BROWN GLASS IS ACCEPTABLE FOR RECYCLING.

Repairable Glassware, including useable ground glass joints, MUST be THOROUGHLY CLEANED before being given to the glassblower.

Clean Broken Glass, including rinsed reagent and sample bottles, may be placed in the large hopper located in the Loading Bay.

Broken Thermometers MUST have the Hg removed before discarding the glass.

Non-biological sharps, including glass Pasteur pipettes and small TLC plates, should be put in labelled containers in each laboratory. When full these should be placed near the large hopper located in the Loading Bay. Empty containers are available from Stephen Lee (Rm114).

Needles, Syringes, Scalpel Blades, etc. MUST be kept separately in labelled containers which, when full, are to be placed in the yellow incineration bin in the Loading Bay.

Inorganics/Organics Immobilised on Adsorbents (used Silica Gel etc.):
After stripping mobile chemical residues from the adsorbent with a suitable solvent, the adsorbent should be put into labelled containers and placed in Room 208 in Building 35 and Room 1.22 in Building 33.

Solvents MUST be acid free and segregated into benzene, halogenated and non-halogenated in labelled, clear, colourless bottles in each laboratory.

Used Oil: There are drums for used pump oil and silicone oil on the top floor in Rm 216.

Heavy Metals are to be recovered from residues wherever possible. Those not recovered are to be sent for disposal on an annual basis.

SPECIAL LABORATORIES FOR HAZARDOUS EXPERIMENTS

MICROBIOLOGICAL HAZARDS LABORATORY (Room 234)

ALL EXPERIMENTS CARRIED OUT IN THIS LABORATORY ARE CATEGORY C

This room is setup as a PC2 microbiological hazards laboratory and houses a Braun Biostat C Reactor. Users of this apparatus **must** be familiar with the protocols and regulations that govern the use of genetically modified organisms. The publication, "Handbook on the Regulation of Gene Technology in Australia," along with the ANU OH&S Unit's own publication, "Biological Safety," are kept on the bookshelves adjacent to the apparatus.

All users of this facility should see Martin Banwell (Room 201) before starting an experiment.

RADIO-ISOTOPE LABORATORY (Room 232/236)

ALL EXPERIMENTS CARRIED OUT IN THIS LABORATORY ARE CATEGORY C

This laboratory is designed for all experiments involving the use of radioisotopes. Requests for the use of this laboratory must be made to one of the following people:

Lew Mander	Room 244
Lee Welling	Room 131A

HIGH-PRESSURE LABORATORY (W12)

ALL EXPERIMENTS CARRIED OUT IN THIS LABORATORY ARE CATEGORY C

This laboratory is designed for operations involving high-pressure equipment or for potentially explosive reactions, e.g., bomb or large scale sealed reactions. It consists of an antechamber and a reaction chamber. The antechamber contains a fume cupboard and benches for the preparation of materials for experiments and contains control systems for apparatus being used in the reaction chamber. Requests for use of the laboratory must be made to one of the following officers:

Lee Welling	Room 131A
Nick Kanizaj	Room 123

In all cases, Lee Welling or Nick Kanizaj must be notified before and after the use of this room.

Notices containing the following information must be hung on the outside of the laboratory door:

NAME, TELEPHONE NUMBER (WORK & HOME), TIME AND DATE OF START, EXPECTED TIME AND DATE OF FINISH, TOGETHER WITH APPROPRIATE DATA ON REACTION, e.g., HAZARDS, TEMPERATURES, PRESSURE, ETC.

Additional rules for use of high-pressure laboratory:

1. Users may enter the antechamber at any time unaccompanied, **EXCEPT** when the fume hood in the antechamber contains an active experiment, in which case the user must be accompanied by another person.

2. Users **MAY NOT** enter the reaction chamber when there is an experiment in progress. The sole exception to this is when the rocking autoclave needs to be re-pressurised. However, even in this case, entry is not permitted if there is another experiment active in one of the other bays.

3. Inexperienced Users must **ALWAYS** be accompanied by someone familiar with the equipment, whether setting up, or monitoring an experiment. (The competency of a User will be determined by the Group Leader, or nominee).

4. The door between the reaction chamber and the antechamber must be kept closed whenever an experiment is active in one of the bays.

5. When gases under high pressure are being used, the outer glass door of the reaction chamber should be open and the fume extraction system in the bays should be on.

6. Whenever someone enters the laboratory, the front door must be latched wide open and the sign **STAFF INSIDE** displayed. The door must be shut and locked as soon as the laboratory is vacated. Staff in the area (Workshop/Stores) must be informed when ammonia or other reactive gases are in use.

There are four bays in the reaction chamber.

Bay A contains a rocking high-pressure autoclave (400 BAR). Paul Gugger will determine the competency of Inexperienced Users.

Bay B is available for experiments not involving fixed equipment.

Bay C is available for experiments not involving fixed equipment.

Bay D contains a high-pressure reactor (20 KBAR). Before this is used, you must obtain the permission of Nick Kanizaj (Room 123) or, in his absence, Lee Welling (Room 131).

TOXIC CHEMICAL "STINKS" LABORATORY (Room 216)

ALL EXPERIMENTS CARRIED OUT IN THIS LABORATORY ARE CATEGORY C

No permission is required to use this room, however, when using thiols or similar noxious compounds, the scrubbers must be bleached. The officer to consult is Paul Gugger (Room 1.83) or Kevin Cooper (Room 59).

DETECTORS AND ALARMS

RED PANIC BUTTONS

	Hazardous goods stores	
Ground Floor:	Room W10	Organic chemicals store
	Room W12	High pressure laboratory
Middle Floor:	Room 108	Fire protected laboratory
	Room 112	Fire protected laboratory
	Room 124	Toxic chemical laboratory
Top Floor:	Room 208	Fire protected laboratory
	Room 216	Toxic chemical laboratory
	Room 232	Radio chemical laboratory
	Room 234	Bioreactor laboratory
Craig Building	Room E3	Cold laboratory
	Room E206	Cold laboratory
	Room E207(A)	25 ºC Room
	Room E207(B)	28 ºC Room

There are monitors for these rooms at the front desk that are linked to the group alert (mobile phone) system.

RISK ASSESSMENT GUIDELINES FOR EXPERIMENTAL CHEMISTS

NOTE: These guidelines should be printed then attached to the inside front cover of your notebook.

- EYE PROTECTION MUST BE WORN AT ALL TIMES IN LABORATORIES
- APPROPRIATE BARRIER PROTECTION (COATS, GLOVES, ETC.) IS ESSENTIAL
- APPROPRIATE VENTILATION FOR VOLATILE SUBSTANCES IS ESSENTIAL
- CONSUMPTION OF FOOD AND BEVERAGES IN LABORATORIES IS FORBIDDEN

EXPERIMENTAL PROTOCOLS AND RISK ASSESSMENTS

If the experiment is rated as Category C (see below), the Group Leader or nominee must sign and date the pro forma prior to the experiment being carried out.

The risk assessment would normally be based on:

1. The hazardous properties of the reagents (flammable, pyrophoric, toxic, biological, etc.);
2. The quantities of those reagents used (small scale/large scale);
3. The physical environment where the experiment should be carried out (eg. high hazard laboratories).

Note: For assessing hazardous properties, the material safety data sheets (MSDS) should be consulted. Conveniently, these can be found at the web site for Chemwatch http://sails.anu.edu.au/chemwatch/. Note should also be taken of the reagent's Dangerous Goods Class and its compatibility with other reagents of different classes. (See Table below.) This information is also available from Chemwatch.

RISK ASSESSMENTS AND ACCESS HOURS

Normal access hours to the School for academic staff and students are from:

- Monday to Friday: 8.00 am to 9.00 pm
- Saturday/Sunday: 8.00 am to 6.00 pm

Normal business hours in the School are from:

- Monday to Friday, 8.00 am to 6.00 pm, excluding Public Holidays.

RISK CATEGORIES

Category A: (minimal risk) **[Normal Access Hours. Work can be carried out alone.]**

Library work, keyboard work, or laboratory work not involving chemicals or foreseeable hazards. Samples for measurements can be made up provided the quantities of materials are small. Work in instrument rooms falls within Category A provided high pressure equipment is not in use.

Note: Keyboard work is permitted outside Normal Access Hours, but *only* in the Library, Room 119 ('write-up' room) or on the Middle Floor of the Craig Building.

Category B1: (low risk) **[Normal Access Hours. Work can be carried out alone.]**

Laboratory work involving small-scale reactions (<100 mL) and using low-risk substances. (Refer to B2 for substances considered moderate risk.) Procedures, such as solvent transfers, distillations and storage, drying and extraction, chromatography and cleaning, where volumes of flammable solvents used *do not exceed* 500 mL.

Category B2: (moderate risk) **[Normal Access Hours. Another chemist must be within calling distance.]**

Laboratory work involving moderate scale reactions (<500 mL) using substances that are known to be moderately toxic, corrosive, allergenic, etc. (consult MSDS); procedures such as solvent transfers, distillations and storage, drying and extraction, chromatography and cleaning, where volumes of flammable solvents used *do not exceed* 2.5 L.

Category C: (significant risk) **[Normal Business Hours only. Must be authorised by Group Leader or nominee.]**

Procedures as for *Category B2* when scale >500 mL **plus** reactions where special precautions need to be applied according to the nature of the hazard (special eye protection - *e.g.,* for UV or laser radiation, face shield, safety shield, respirator, experienced colleague in attendance, *etc.*). All reactions carried out in designated High Hazard Laboratories are deemed to be Category C.

C1: Procedures involving chemicals with the following properties:

- strongly corrosive, irritant, pungent,
- mutagenic, teratogenic, carcinogenic,
- oxidising, pyrophoric, highly flammable,
- react violently with water,
- non-commercial compounds (high risk based on generic assumptions, no data available)

C2: Procedures/chemicals that require special location and/or facilities

- potentially explosive (including sealed tubes),
- high pressure reactions,
- radioactivity above specified levels
- other radiation sources (ionising, laser, RF),
- large scale reactions (including solvent distillation),
- highly toxic, stench.

C3: Work involving the use of naked flames associated with flammable solvents as used in the biological laboratories. Prior arrangements must be made with group leaders to ensure two members of staff are present on such occasions.

Note: It is forbidden to leave naked flames unattended in any laboratories.

WORKSHOP RISK ASSESSMENT GUIDELINES FOR CHEMICAL PRODUCTS

For full MSDS go to ChemWatch

CHEMICAL PRODUCT	HAZARD RATING	HAZARD TYPE	HAZARD CONTROLS
Powders & Abrasives	MODERATE		  
Petroleum oils & spirits (lubricants, petroleum ethers, kerosene, alkanes)	MODERATE		   
Silicon oils (+ solvents)	MODERATE		  
Solvents & Cleaners (turpentine, alcohol, paint thinners)	MODERATE		   
Cleaning agents (bleach, ammonia solutions, disinfectants)	MODERATE		 
Acids & Caustics (hydrochloric acid, sodium hydroxide)	HIGH		  
Insecticides & Herbicides	MODERATE		  

	Eye protection must be worn.			Harmful and/or Irritant
	Hand protection must be worn.			Highly flammable
	Dust mask must be worn.			Toxic or Very Toxic
	Half face respirator must be worn.			Corrosive
	Fume extraction recommended.			
	Full-face shield must be worn.			

GUIDE TO CHEMICAL INCOMPATIBILITIES

Incompatible
Avoid storing together
Compatible

DG C	2	3	4.1	4.2	4.3	5.1	5.2	6	8
Flammable, non-flammable gases (Do not store in labs) **2**									
Flammable liquids 3									
Flammable solids (E.g. powdered magnesium) **4.1**									
Spontaneously combustible (E.g. sodium sulphide) **4.2**									
Dangerous when wet (E.g. organolithiums) **4.3**									
Oxidising agent (E.g. conc nitric acid, sodium peroxide) **5.1**									
Organic peroxide (E.g. benzoyl peroxide) **5.2**									
Toxic 6									
Corrosive[!] Keep acids and bases apart **8**									**[!]**

REGULATIONS FOR THE USE OF CYANIDE

The RSC Safety Committee has formulated the following policy for the use of cyanide compounds:

1. All experiments using cyanide compounds are considered to be Category C (High Risk), therefore a risk assessment sticker countersigned by a group leader or other officially nominated person must be attached to the relevant page of the laboratory notebook.

2. At least two people must be present when cyanide is being handled.

3. Work with cyanide can only be carried out between 9.00am and 5.00pm, Monday to Friday when First Aid Officers certified to administer oxygen therapy are available. The Technical Manager must be notified if a reaction is to be left running overnight.

4. The Cyanide Handling and Disposal Procedures must be read and the Experiments with Cyanide form completed prior to commencement of the experiment. Both are available from the Technical Manager's office (Room 131A in Birch Building). The Technical Manager will distribute the cyanide only after receiving a completed 'Experiments with Cyanide' form, countersigned by the Group Leader.

5. Co-workers in the laboratory must be informed of the intended work and a copy of the Cyanide Accident Procedure given to another person in the laboratory, who will then be responsible for organising assistance in the event of an accident.

6. Before beginning work, an entry must be made on the 'Toxic Emissions Board' located outside Room 119 in the Birch Building. All equipment used in the reaction must be placed in shallow trays so that any spills or leaks will be contained. Work must be carried out in a fume cupboard that has been cleared of acids, as well as unnecessary items. A copy of the 'Experiments with Cyanide' form must be taped to the fume cupboard window.

7. Waste solutions containing cyanide *must not* be left in the fume cupboard to evaporate, nor should they be emptied down the sink. They should be treated to make them safe, as soon as possible. (See section on Disposal, below.)

NOTES ON HANDLING CYANIDE

Entry into the body can be from ingestion, inhalation and absorption through the skin.

To avoid accidental ingestion:

- Wash your hands thoroughly before eating, drinking or smoking.
- Never, under any circumstances, bring food or drink into the laboratory.

To avoid inhaling cyanide gas or dust:

- Whether setting up and carrying out an experiment or treating the residues after an experiment, always keep cyanide inside a fume cupboard.
- Ensure that acids cannot come into contact with cyanide.

To avoid cyanide being absorbed through the skin:

- Wear gloves, lab coat and safety spectacles. Note: Make sure your gloves are impervious to the solvent being used. **[See Appendix C.]**
- Where there is even a remote chance of 'splash', use a face-shield.
- Use 12% bleach solution to rinse gloves before disposal and to wipe down the face-shield after use.

DISPOSAL OF CYANIDE WASTES

Waste solutions containing cyanide must not be left in the fume cupboard to evaporate, nor should they be emptied down the sink.

The pH of a dilute solution should be checked and, if necessary, adjusted to pH 10-11 with NaOH solution. This is then treated with an excess of 12% bleach. (Test for excess hypochlorite with starch-iodide paper.) Note: Control the temperature by the addition rate. Let the solution stand overnight and then cautiously adjust to pH 7. If there are no environmentally damaging species present, such as metal complexes, the neutralized residue can be flushed down the sink with excess water.

CYANIDE ACCIDENT PROCEDURE

- SHOUT FOR HELP.

- IF YOU ARE NOT IN ANY DANGER YOURSELF, REMOVE THE VICTIM FROM POSSIBLE FURTHER EXPOSURE.

- IF APPROPRIATE, PUT VICTIM UNDER SAFETY SHOWER, BUT DO IT BEFORE REMOVING ANY CONTAMINATED CLOTHING.

- IF THE VICTIM IS IN DISTRESS OR UNCONSCIOUS, CALL, OR GET SOMEONE ELSE TO CALL: **Ph: 0 000** AND ASK FOR AN **AMBULANCE**.
    - TELL THE OPERATOR:
        - IT IS POSSIBLE CYANIDE POISONING.
        - THE ADDRESS IS: Research School of Chemistry (Building 35), Science Road, ANU, Barry Drive entrance.

- CALL THE RSC EMERGENCY TELEPHONE NUMBER **(Ph: 53636)** TO ALERT THE EMERGENCY RESPONSE TEAM.

- ASK FOR A FIRST AID OFFICER WHO HAS OXYGEN THERAPY TRAINING.
    - Mr Kevin Cooper Room 29 50631 or 0404823152
    - Mr Paul Gugger Room 1.87 54165 or 0404823164
    - Mr Vance Lawrence Room 2.3 52019 or 0410424483

- WARN ANYONE IN THE AREA NOT TO ENTER THE LABORATORY WHERE THE ACCIDENT OCCURRED.

Classification of Hazardous Chemicals

Class 1 - Explosives

Class 2 - Gases

Dangerous goods Class 2 is divided into four sub-classes -

Division 2.1 - Flammable gases

Examples of flammable gases are hydrogen, methane, acetylene

Division 2.2 - Non-flammable, non-toxic gases

Examples of *Division* 2.2 gases are nitrogen, compressed air, helium, argon.

Division 2.3 - Toxic gases .

Toxic gases include carbon monoxide, chlorine, phosgene

Division 2.2 - Subsidiary Risk 5.1 (Oxidising Gases)

Two oxidising gases are oxygen and nitrous oxide

Class 3 - Flammable Liquids

Class 4 - Flammable Solids

Class 4 is divided into three divisions.

Division 4.1 - Flammable solids

Division 4.2 - Substances liable to spontaneous combustion

e.g. white phosphorus.

Division 4.3- Substances that in contact with water emit flammable gases

These are substances that, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities. e.g. sodium metal.

Class 5 - Oxidising Substances and Organic Peroxides

Class 5 dangerous goods are divided into two divisions.

Division 5.1 - Oxidizing Substances

Examples of oxidising agents are hydrogen peroxide, copper chlorate and fluorine.

Division 5.2 - Organic Peroxides

Examples of organic peroxides are dibenzoyl peroxide, peracetic acid and perbenzoic acid.

Class 6 – Toxic and Infectious Substances

Class 6 is divided into two divisions.

Division 6.1 - Toxic Substances

These are substances that if swallowed, inhaled, come into contact with skin are liable to cause death, serious injury, or to harm human health.

Division 6.2 - Infectious Substances

Infectious substances are materials known, or reasonably expected, to contain pathogens.

Class 7 - Radioactive Substances

Class 7 dangerous goods spontaneously emit ionizing radiation.

Class 8 – Corrosives

Class 8 dangerous goods are corrosive substances, such as strong acids and bases.

European Union Hazard Symbols

Explosive Hazard

Harmful (X_n)

Extremely Flammable (F+) or

Highly Flammable (F)

Corrosive

Oxidising

Irritant (X_i)

Very Toxic (T+) or Toxic (T)

Radioactive

Appendix C

BENCH CHEMISTS' BUMPER BOOK OF REALLY USEFUL THINGS TO KNOW

(April 2012)

BENCH CHEMISTS' BUMPER BOOK OF REALLY USEFUL THINGS TO KNOW

The primary purpose of this booklet is to make life safer for bench chemists when they are carrying out activities associated with synthetic chemistry. Various topics are included in the text such as, how to choose, prepare and dispose of cleaning mixtures, how to handle alkali metals and their compounds and treat their residues, how to choose gloves appropriate for use with a particular solvent or corrosive mixture. (The pretty pink latex gloves are next to useless in a most cases). The booklet should also provide some useful tips on how to make the prosecution of certain tasks in chemistry more efficient.

PLEASE NOTE: It is intended that this site should be continually updated and/or added to a-la-Wikipedia, so should you feel the urge to write something relevant, or whether you want someone else write it for you, please contact the RSC Technical Manager.

CONTENTS

CLEANING MIXTURES

BASE BATHS

POTASSIUM HYDROXIDE AND ALCOHOL (ISO-PROPANOL OR ETHANOL)

$$KOH + ROH = K^{+} [^{-}OR] + HOH$$

Uses
Hydrolyzes functional groups of many compounds making them soluble. Dissolves silicone grease from contaminated ground-glass joints. These baths will not dissolve Apiezon grease.

NOTE: Ground-glass joints and particularly sintered glass will dissolve if left in the bath too long.

Preparation
The choice of alcohol appears to make no difference to the potency of the mixture. However, iso-propanol is preferred, because ethanol with KOH gives a dark purple solution making it difficult to see the submerged glassware.

WARNING! *Adding KOH to water is an extremely exothermic reaction that generates a caustic aerosol, so the equipment must be set up in fume cupboard.*

To make ~ 10 litres of KOH/alcohol solution, first pour 10L of alcohol into an appropriate container. (The best containers are those made from HDPE and moulded, not sealed, at the edges.) Next place a clamped 3L conical flask containing a straight (not ovate) stirring bar, in a large plastic bowl and put them both on a magnetic stirrer. (The plastic bowl is for protection should the beaker break.) Pour in ~ 1L of water and begin stirring. Tip KOH pellets into the water at such a rate that they dissolve easily. If too many are put in at one time, the stirring bar may start to jump around and break the beaker. When the solution starts to get hot, place a watch glass over the top of the beaker to prevent the aerosol from escaping. After ~ 400 – 500 gm of KOH have been added, pour the hot solution into the alcohol, stirring well with a glass rod. If the basic solution is made too concentrated, two layers will result. A freshly made bath should first be left for 24 h to equilibrate after which it should be ready for use. (Average cleaning time for glassware is ~ 20 mins.) When the glassware is removed from the bath, dunk it in a beaker of dilute HCl before rinsing with water. KCl is far easier to rinse off than KOH.

Use-by date
If glassware is pre-washed with solvent to remove gross amounts of contaminants, including silicone grease or oil, before placing it in the bath, the KOH/alcohol mixture should last up to 12 months. The bath should be topped up with alcohol during its lifetime to make up for evaporation.

Disposal
Provided high quantities of toxic or noxious materials have not been put into the bath, the contents can be carefully emptied into the sink accompanied by a large volume of water.

ACID BATHS

Mineral acids:
When making up aqueous solutions from concentrated mineral acids (sulphuric, nitric and hydrochloric) always add the acid to the water. This is particularly important with sulphuric acid.
Remember: if you spit into acid, it will spit back at you.

Chromic acid:
Chromic acid baths are forbidden in the RSC for a variety of reasons.

Caro's Acid: H---O---O---SO_3H
Uses
Caro's acid is a mixture of hydrogen peroxide and sulphuric acid (typically 5 : 1) and can be used for cleaning intractable carbonaceous material or heavy metal contamination from glass sinters. The benefit of using it is that expensive sintered funnels that might otherwise be discarded because they are clogged with intractable residues, can be resurrected. Other uses of Caro's Acid include oxidizing primary aromatic amines to nitroso compounds and oxidizing tertiary amines to amine oxides.

Preparation
Concentrated sulphuric acid is added drop-wise to a stirred volume of hydrogen peroxide (30%) behind a safety shield.
The wearing of a face shield is advisable during the preparation and use of Caro's Acid.

WARNING! *Caro's acid is a powerful oxidant and can form dangerously explosive mixtures with certain organic compounds and so should be used only on a very small scale.*

***

GLOVES

TYPES

The RSC maintains stocks of three types of gloves, two of which are made from latex rubber, the third from nitrile.

1. Latex – pink. Come in pairs and are semi-disposable.
2. Latex – white. Are ambidextrous and disposable.
3. Nitrile – green and blue. Are ambidextrous and disposable.

Other types of gloves are available on request.

RATINGS FOR SOME SELECTED SOLVENTS

SOLVENT	BEST	AVOID
ACETONE	LATEX	NITRILE, PVA
BENZENE	PVA	LATEX
CAUSTIC SOLUTIONS	LATEX, NITRILE	PVA
CHLOROFORM	PVA	LATEX
DICHLOROMETHANE	PVA	LATEX
DIETHYL ETHER	NITRILE, PVA	LATEX
DMSO	LATEX, NITRILE	PVA
ETHYL ACETATE	LATEX	NITRILE
HEXANE	NITRILE, PVA	LATEX
HYDROFLUORIC ACID	NITRILE	PVA
MINERAL ACIDS	LATEX	PVA
PETROLS	NITRILE, PVA	LATEX
TOLUENE	NITRILE, PVA	LATEX

The list shows the most and least effective gloves to wear when handling selected solvents. The ratings are based primarily on permeation rate, that is, the time it takes for the solvent to pass through the membrane. The best gloves are those through which the solvent takes a long time to permeate. *However, any gloves are more effective than no gloves at all.*

It is not just the type of material that determines the rate of solvent permeation, the thickness of the gloves is also a factor. Generally it can be said that the thin, disposable type, are less effective in preventing solvent permeation.

A useful website to consult when choosing the correct gloves for the job is: http://ansell.com.au/chemical-glove-guide where the list is more comprehensive and the permeation parameter quantified.

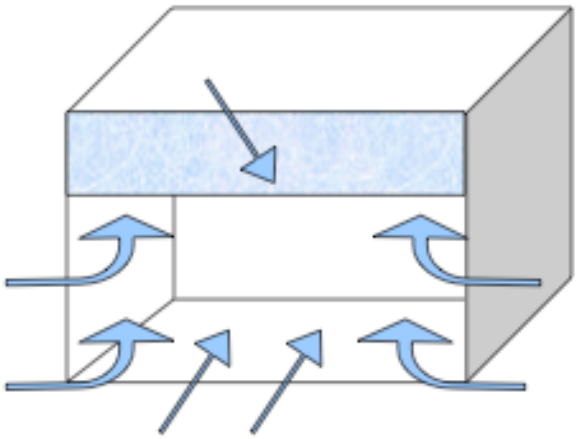
***

FUME CUPBOARDS

GUIDELINES ON THE SAFE USE OF A FUME CUPBOARD

The fume cupboard is a major means of controlling your exposure to chemicals and other airborne hazardous materials.

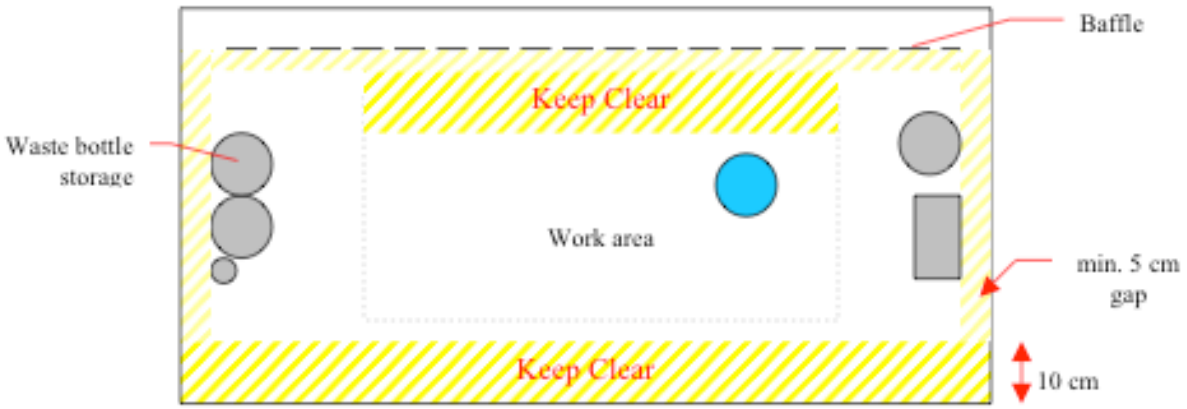
Operation - A fume cupboard is basically a ventilated box with an adjustable work opening (sash). A moving curtain of air (at 0.5 ±0.1 m/s) being drawn past the operator, through the opening, over the work, then up the exhaust stack reduces your exposure. A fume cupboard used properly provides adequate protection. However, incorrect use a fume cupboard may result in dangerous material escaping from the cupboard. A fume cupboard is designed to have a smooth airflow through the front opening –



Normal airflow into a fume cupboard

The fume cupboard draws air out of the laboratory. Therefore at least an equal amount of air must be brought into the room to replace it. Please ensure that there is an adequate amount of make-up or supply air into the room before using an exhaust system. Baffles or slots at the back of cupboard achieve an even airflow through the face of the cupboard. If the baffles or slots are blocked or restricted, then the air distribution can become uneven or unsafe. Avoid blocking or placing large items near the baffles.

Items placed in or in front of the fume cupboard creates air turbulence. This may affect the capture of contaminants, and in some instances vapours may escape from the cupboard towards the user. To limit this, ensure that work is conducted in the middle of the bench space, avoiding work and items within 10 cm of the front edge or at the back of cupboard obstructing the baffles.



Fume cupboard bench layout

Hints –
To achieve optimum performance from your fume cupboard ensure:
- That work is conducted in the middle of the bench space.
- Minimise the amount of items in the fume cupboard.
- Minimise traffic passing in front of the fume cupboard.
- Avoid open doors or opens in the vicinity of the fume cupboard.
- Ensure adequate make-up air into the room.
- Larger items may need to be placed further back from the front edge.
- Do not place storage items behind where you are working, as this affects airflow.
- If you are using a radiation shield or blast shield, there is a potential for a dead spot to be created.
- Try to minimise this by limiting items to the side and behind the shield.

***

RISK ASSESSMENTS (Chemwatch)

The most convenient way to carry out a chemical risk assessment is to use the Chemwatch database. It can be found on the website http://sails.anu.edu.au/chemwatch/.

When a search is made on a substance the first page to open contains a brief **Summary** of the hazards associated with the chemical concerned. If you then click on **Sections** in the left-hand column a list will appear on the right-hand side giving options for information. For example, if you click on the heading, **Personal Protection**, details will be given of what protective measures you should take when handling the chemical in question: the type of gloves you should wear, whether you need a mask or safety shield, that sort of thing. Other headings under **Sections** provide safety information such as what to do in the event of a spill, or what sort of fire fighting procedures to employ.

***

WORKING WITH VACUUMS

CRACKS IN GLASSWARE

Any glassware placed under vacuum has the potential to implode. Before evacuating glassware *always check thoroughly for cracks*.

Some cracks are difficult to see. Star cracks, for instance, are a common cause of implosions in round bottom flasks and are often difficult to detect with the naked eye. If in doubt, take the flask to the glassblower for an expert opinion.

Star cracks usually form when RB flasks roll and bump together in the drawer, when the drawer is being opened and closed. Getting the carpenter to install horizontal drawer dividers will prevent this.

*

LIQUID OXYGEN

After evacuating the pump trap assembly and (if used) Schlenk line, always place a dewar containing liquid nitrogen under the trap. If solvents are not trapped before entering a rotary vane, high vacuum pump they will either dilute the oil in the pump, thereby reducing its viscosity and effectiveness, or, in some cases, they will polymerize the oil making it so viscous the pump will seize.

WARNING! *After releasing the vacuum in the pump trap assembly, always remove the liquid nitrogen dewar to prevent liquid oxygen condensing from the air into the trap. Liquid oxygen can react violently with some organic materials.*

*

LIQUID ARGON

Similarly, argon can be liquefied at atmospheric pressure when cooled in liquid nitrogen. It is fairly common practice to remove air from deuterated solvents using the freeze-thaw method. The solvent is first frozen in a Schlenk flask using liquid nitrogen and then the air is removed under vacuum. Argon gas is then allowed into the flask.

WARNING! *The tap on the Schlenk flask must not be closed at this point, as there may be some liquid argon condensed within and when the contents warm to room temperature the build up of pressure will shatter the flask. Always keep the flask at atmospheric pressure when warming to room temperature.*

***

ALKALI METALS

WARNING! *Alkali metals must never be used with chlorinated solvents.*

LITHIUM METAL

Weighing
Lithium is usually supplied as wire wrapped around a metal spool and immersed in mineral oil. Weighing is best done using two beakers, one filled mineral oil the other with pentane, and then tare weighing the beaker containing the less-volatile mineral oil. The lithium is then rolled out from the spool and cut with scissors, the pieces being washed in pentane before being placed in the oil on the balance. For large-scale reactions, lithium can be conveniently 'weighed' by estimating the mass of a unit length of clean metal and then measuring the required amount with a ruler. Surface impurities can be scraped off with a scalpel.

NOTE: lithium is the hardest of the alkali metals (Gr. lithos, means stone!). It cannot be cut with a scalpel and *making lithium wire from rods or sticks of the metal using the sodium press should never be attempted*, as it will break the press.

Use
For metal/ammonia reductions, reaction time with the ammonia can be improved by increasing the surface area of the metal. This can be achieved by placing the lithium pieces between a few sheets of weighing paper soaked in mineral oil and then striking the top sheet of paper with a pestle.

NOTE: when preparing organo-lithium compounds from organo-chlorides, always use sodium doped lithium metal or the reaction will not proceed.

Storage
Lithium has a low density (specific gravity 0.534) and pieces not wrapped around the spool will float in mineral oil allowing the metal to react with the air and any moisture present. For this reason, after weighing out the lithium, destroy any small pieces of the metal remaining, rather than try to store them.

NOTE: mineral oil has low volatility, but is still volatile. If lithium wire is left in a container with a loose fitting lid, the oil will slowly evaporate and expose the metal to the air.

Impurities
If stored inappropriately, lithium can react with air and moisture forming oxide, carbonate and hydroxide.

WARNING! *Lithium can also react with nitrogen forming the pyrophoric complex, lithium nitride, $[(Li^{+})_3N^{3-}]$. Finely divided lithium is particularly susceptible to this process. Experiments that employ finely divided lithium represent one of the few air sensitive reactions where the use of argon as an inert gas is necessary.*

*

SODIUM METAL

Weighing
Sodium is usually supplied as sticks or rods in mineral oil. The metal is soft and easily cut with a scalpel or scissors and the pieces can be weighed in much the same way as lithium, using beakers of mineral oil and pentane.

Sodium wire can also be prepared by extruding pieces of it through the die of a sodium press. The rod form of the metal is the most convenient type to use, as the diameter of the rod fits best in the die.

Use and Storage
See under *LITHIUM*. (Specific gravity of sodium 0.971.)

Impurities
Exposure to air forms mainly the mono oxide, although peroxide can form in smaller amounts. Moist air produces hydroxide.

WARNING! *Sodium peroxide, Na_2O_2, reacts violently with iron metal.*

*

POTASSIUM METAL

Weighing
Potassium metal comes in sticks and is soft enough to cut with a scalpel. It is highly reactive and should not be weighed out on the open bench. The safest way to weigh out potassium is in a nitrogen dry box equipped with a balance. Except in specific cases, ultra dry glove boxes are unnecessary for this purpose. The best dry boxes to use are those fabricated from Perspex in the School's workshop. These nitrogen boxes, unlike the ultra dry glove boxes, do not have vacuum entry ports, but rather rubber irises through which users can simply and quickly slip their hands, glassware and reagents.

Use
Anyone planning to use potassium for the first time should read the RSC Safety Regulations and consult the relevant officers listed in Appendix B(i).

Storage
Potassium metal is particularly prone to oxidation. Old samples of metal are commonly coated with potassium oxide and dioxide. This latter species is the so-called 'superoxide'. To prevent oxidation of a new sample, the clean metal should be kept submerged in mineral oil that has been saturated with argon. The container should have a screw top cap to maintain the argon atmosphere and prevent evaporation of the oil. Alternatively, small amounts of dry potassium, or potassium under mineral oil can be stored in a Schlenk flask under nitrogen or argon.

Impurities
Oxides and hydroxides are common impurities, along with smaller amounts of dioxide.

WARNING! *Potassium dioxide can form highly explosive peroxide species with alcohols and ethers. Do not use potassium metal in these types of solvents unless the metal is of a guaranteed high purity.*

Destruction of Alkali Metal Residues

LITHIUM and *SODIUM*

Lithium and sodium can be destroyed by reacting them with isopropanol and when the reaction is complete, adding the resulting isopropoxide to a large excess of water.

WARNING! *It is particularly important when destroying larger pieces of metal residues to make sure they have completely reacted with the isopropanol and that there is no fresh metal being protected by an isopropoxide coating. This commonly occurs when lithium or sodium residues are left in a beaker of isopropanol and the isopropanol evaporates before the reaction has finished. Residues of this type when washed down the sink will react violently with the water and any hydrogen produced will burn from the heat of reaction. Any flammable solvent present may also ignite.*

POTASSIUM

Residues of pure potassium can be destroyed by careful addition of *tert*-butanol and when the reaction is complete, adding methanol, before pouring the butoxide/methoxide mixture into a large excess of water.

WARNING! *If the residues contain potassium dioxide, $K^+O_2^-$, and tert-butanol is added to them, peroxidation of the solvent may occur. (Ethers and alcohols are both particularly susceptible to peroxidation in this way.) These types of peroxides are shock sensitive and disturbing them by swirling the beaker or scraping them with a spatula, may result in a violent explosion. Because of the uncertainty of whether the metal residues contain dioxide or not, it is recommended that all potassium residues are destroyed by carefully adding them in small pieces to a large beaker of ice water (not alcohol) kept behind a blast shield. To prevent ignition of the evolved hydrogen, the beaker could be placed in a nitrogen box.*

WARNING! *CO_2 fire extinguishers SHOULD NOT BE USED on any fires associated with alkali metals. USE DRY POWDER.*

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ALKALI METAL COMPOUNDS

ORGANOLITHIUM SOLUTIONS

Preparation

Prepared as solutions in hydrocarbons, under nitrogen. Reaction temperature is typically 25 – 70°C.

$$2Li(Na) + RX \rightarrow RLi + LiX$$

(0.5 – 2% Na accelerates reaction)

Use and Storage

Alkyl and aryl lithium complexes are air, water and temperature sensitive. A partially decomposed sample of RLi solution is usually indicated by precipitation of LiX, LiOMe and LiOH all of which are insoluble in hydrocarbon solvents. The presence of these precipitates means the solution will need to be titrated before any stoichiometric work is attempted. To avoid this time consuming chore some simple precautions can be taken:

***Store solutions in a Schlenk flask**

Commercial samples are supplied in bottles that have a plastic seal under a crimped cap. On a new bottle, the crimped cap is first removed to expose the seal. *These seals are useless* and after puncturing them only a couple of times with a needle or canula, a permanent hole will be made allowing air in. Best practice is to transfer the fresh solution into a Schlenk flask via a canula using positive nitrogen pressure. To remove the problem of the solvent leaching grease into the solution, use a flask with a single plunger/'O'-ring type tap and no ground glass joint. Transfers to and from the flask are made by removing the plunger and replacing it with a septum through which a needle or canula can be passed. If these practices are strictly adhered to, titration of the solution should be unnecessary throughout the life of the reagent.

***Store solutions under dry nitrogen**

RLi reacts with atmospheric oxygen:

$$2MeLi + O_2 \rightarrow 2LiOMe$$

RLi reacts with moisture in air:

$$BuLi + HOH \rightarrow C_2H_2 + LiOH$$

***Store solutions in fridge**

RLi is thermally unstable in the presence of RX and coupling can occur:

$$RX + RLi \rightarrow R_2 + LiX$$

NOTE: When quantitatively transferring organolithium solutions *always use a gas tight syringe.* This prevents the solution from dripping out of the needle tip when it is removed from the nitrogen pressurised Schlenk flask.

NOTE: Always wash syringes and canulas immediately after use by drawing water through them. If they are left on the bench, plugs of hydroxide and alkoxide will form inside the bore, which are extremely difficult to shift.

WARNING! *Never mop up drips or spills of organolithium solutions, particularly alkyl lithium solutions, with tissues, because their large surface area and combustible nature will make them burst into flames.*

WARNING! *Should a fire result from a dropped flask of organolithium solution, DO NOT USE A CO_2 EXTINGUISHER. USE DRY POWDER. Fires that are contained in a flask can usually be extinguished by placing a loose fitting stopper in the neck.*

Destruction of Organolithium Residues

The safest way to destroy RLi residues is to carefully pour them into a large volume of stirred ice water behind a safety shield.

*

ALKALI METAL HYDRIDES

These are purchased as finely divided compounds suspended in an inert medium such as wax, or mineral oil. The concentration of the suspension is usually < 60% by weight, although sodium hydride can be bought dry at nominally 95%. *It is unsafe and unnecessary to use such a concentrated sample of metal hydride.* Washing out the support medium from a hydride suspended in wax or oil with dry hexane under Schlenk conditions and then removing the residual solvent from the pure compound under vacuum is a safe and simple alternative.

WARNING! *Weighing out 95% NaH in air can result in a reaction with atmospheric moisture, liberating hydrogen, which the heat of reaction may then ignite. All alkali metal hydrides should be weighed out in a nitrogen box.*

Destruction of Alkali Metal Hydride Residues

The safest way to destroy alkali metal hydride residues is to carefully pour them into a large volume of stirred ice water behind a safety shield in a fume cupboard.

***

PRESSURISED GAS CYLINDERS

Protocols for the use of pressurized toxic gases

1. Contain the cylinder inside a fume cupboard.

2. Secure the cylinder in an approved clamp/cradle.

3. Before attaching the it to the cylinder, test the regulator for faults by passing compressed air through it whilst operating the regulator valve.

4. Ensure the regulator valve is fully closed.

5. Attached the regulator firmly to the cylinder. (There should be no free movement between the locking nut that attaches the regulator to the cylinder, and the stem of the regulator.)

6. Before opening the cylinder valve, and before attaching the gas delivery tube to the experiment, clamp the tube so its end is directed towards the rear of the fume cupboard.

7. First open the cylinder valve, then open the regulator valve and test for leaks with leak detector solution.

8. Before attaching the gas delivery tube to the experiment, adjust the gas flow rate to the required level by bubbling the gas through a suitable solvent contained in an open beaker.

Appendix D

PROTOCOLS FOR EMERGENCY RESPONSE TEAM

- **Building evacuation**
- **Accident victim assistance**
- **Cyanide poisoning – emergency response**
- **Dealing with uncontained emissions of toxic gases and vapours**

(April 2012)

EVACUATION PROCEDURES FOR EMERGENCY RESPONSE TEAM

During Business Hours

ALERT TONE – Amber Lights – Fire/Smoke Warning

Triggered by heat and smoke detectors: ***Attention Emergency Response Team*.**

FIRE WARDENS:

- PICK UP DESIGNATED RED PHONES AND AWAIT INSTRUCTIONS FROM HOUSE WARDEN

HOUSE WARDEN, 1ST AID OFFICER, PLANT MANAGER/OFFICER:

- IDENTIFY LOCATION OF FIRE FROM FIRE PANEL
- *TURN OFF ALERT TONE*
- DIRECT APPROPRIATE FIRE WARDEN BY PHONE TO INVESTIGATE
- UPDATE BUILDING OCCUPANTS OF SITUATION via PA
- ACTING ON WARDEN'S ADVICE, DECIDE WHETHER TO EVACUATE OR NOT

EVACUATION TONE – Red Lights - Evacuation
Operated manually or by time default (3 minutes): ***Attention Emergency Response Team*.**

FIRE WARDENS

- HANG UP RED PHONES
- CLEAR DESIGNATED AREA
- REPORT TO HOUSE WARDEN NEAR FIRE PANEL

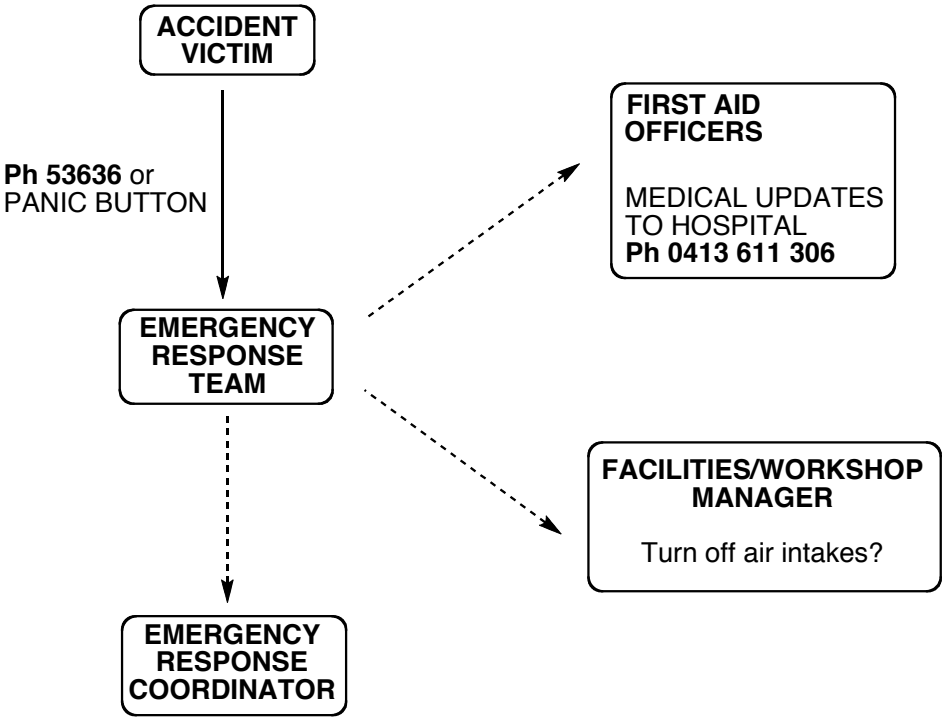
After Hours

- ALERT TONE WILL DEFAULT TO EVACUATION AFTER 3 MINUTES, IF NOT STOPPED MANUALLY
- BEST PRACTICE IS TO ALLOW THE ALERT TONE TO DEFAULT TO EVACUATION IF ACTIVATED AFTER HOURS

PANIC BUTTONS
Operated manually: ***Attention Emergency Mobile Phone Holders*.**

- BE GUIDED BY MOBILE TELEPHONE INSTRUCTIONS
- INVESTIGATE
- REPORT TO HOUSE WARDEN IN FOYER

ACCIDENT VICTIM ASSISTANCE



1. EMERGENCY SERVICES: **Ph 0 000**

2. HOSPITAL: **Ph 0413 611 306** (Casualty Department's priority mobile number)

3. Send GUIDES to road junctions to meet emergency service vehicles

4. MSDS from Chemwatch (RSC Homepage or http://chemistry.anu.edu.au)

   Under "Sections" print:

   * For First Aid Officers (First Aid Section)

   * For Ambulance (First Aid; Advice to Doctor; Toxicological Sections)

   * For Fire Brigade (First Aid; Fire Fighting; Spills/Accidents Sections)

5. CHEMICAL INVENTORY SYSTEM: Assess potential risk in area affected

6. FACILITIES AND SERVICES (ANU SECURITY): **Ph 52249**

7. VICTIM'S EMERGENCY CONTACT

CYANIDE ACCIDENT PROCEDURE

- SHOUT FOR HELP.

- IF YOU ARE NOT IN ANY DANGER YOURSELF, REMOVE THE VICTIM FROM POSSIBLE FURTHER EXPOSURE.

- IF APPROPRIATE, PUT VICTIM UNDER SAFETY SHOWER, BUT DO IT BEFORE REMOVING ANY CONTAMINATED CLOTHING.

- IF THE VICTIM IS IN DISTRESS OR UNCONSCIOUS, CALL A FIRST AID OFFICER WHO HAS OXYGEN THERAPY TRAINING.

o Mr Kevin Cooper	Room 59	**50631** or **0404823152**
o Mr Paul Gugger	Room 1.87	**54165** or **0404823164**
o Mr Vance Lawrence	Building 136	**0410424483**

- CALL, OR GET SOMEONE ELSE TO CALL AN AMBULANCE: **Ph 0 000**
    - TELL THE OPERATOR:
        - IT IS POSSIBLE CYANIDE POISONING.
        - THE ADDRESS IS: Research School of Chemistry, Science Road, ANU, Barry Drive entrance.

- CALL THE RSC EMERGENCY TELEPHONE NUMBER **Ph 53636** TO ALERT THE EMERGENCY RESPONSE TEAM.

- WARN ANYONE IN THE AREA NOT TO ENTER THE LABORATORY WHERE THE ACCIDENT OCCURRED.

- REFER TO “ACCIDENT VICTIM ASSISTANCE” PROTOCOLS IN THIS FOLDER (see previous page).

DEALING WITH UNCONTAINED EMISSIONS OF HAZARDOUS GASES OR VAPOURS

When reported by the person responsible:

Should anyone be using a gas or vapour that is known to be hazardous and they unintentionally vent it into the atmosphere, it should be reported to the local Building/Operations Manager or Safety Officer or senior academic staff member immediately. (This is particularly important when the gas or vapour does not have an odour.)

When reported by a third party:

Should anyone detect an odour in the atmosphere coming from a gas or vapour, which they suspect might be hazardous, they should report it to the local Building/Operations Manager or Safety Officer or senior academic staff member immediately. The source and nature of the emission is then investigated. Designated officers (Emergency Response Team) can be asked to assist.

Building/Operations Manager:

When the source and nature of the emission is known:

1. Make an initial risk assessment to determine if the source can be shut off.
2. Make a further risk assessment as to whether to trigger an evacuation of the building using the EWIS.
3. Make a final risk assessment whether the occupants of neighbouring buildings need to be warned of the potential risk.

Warning occupants of neighbouring buildings:

Contact ANU Security and/or HSWE Branch who will then liaise with designated officers in neighbouring buildings (Building/Operations Manager or Safety Officer or senior academic staff members). An electronic list of contact details should be kept on the Home pages of all area websites, as well as a hard copy list at building reception/entry points.