SCHOOL OF CHEMICAL SCIENCES

DUBLIN CITY UNIVERSITY

SAFETY HANDBOOK

(http://www.dcu.ie/safety/chemistry.php)

CONTENTS

SCHOOL OF CHEMICAL SCIENCES

HEALTH AND SAFETY POLICY

http://www.dcu.ie/safety/lab.html

1.

In accordance with the legislation enshrined in the Irish government's Safety**, Health and Welfare at Work Act –2005,** D.CU. has formed it's own Framework Safety Statement **http://www.dcu.ie/safety/pdfs/safety_statement.pdf** a document which is laid down and endorsed by the President of D.C.U.-**Prof. Ferdinand Prondzynski**, and the University Safety Officer**, Ms. Eileen Tully** ext.8896 Email: Eileen.tully@dcu.ie, It is the intention of the School of Chemical Sciences to improve health and safety whilst at work for all of its members. Consequently, the School complies with all current legal safety requirements as set down in the above statement, and applies other appropriate measures specific to the School to achieve a safe working environment. The intention to improve the health and safety at work of all members extends to all persons whilst engaged in School of Chemical Sciences, and to visitors, contractors and lessees of areas whilst on the School of Chemical Sciences premises. The School of Chemical Sciences Safety Policy is secondary to the Framework Safety Statement of Dublin City University, which applies to the D.C.U. campus as a whole. This policy is intended to provide accurate documentation of the health and safety arrangements currently in place at the School of Chemical Sciences.

2.

The Head of School has ultimate responsibility for the provision of a safe working environment within the School of Chemical Sciences. The current head of School is Dr. Brett Paull ext. 5060 Email: brett.paull@dcu.ie

The Head of School reports to the Dean of Faculty of Science and Health who has ultimate responsibility for the provision of a safe working environment across the various schools in the faculty of science and health.

The current Dean of Faculty of Science and Health is Prof. Malcolm Smyth ext. 7869 Email: malcolm.smyth@dcu.ie

3.

The Head of School delegates responsibility for day-to-day maintenance of safety to a School Safety Adviser (S.S.A.)/Assistant School Safety Adviser (A.S.S.A.) and responsibility for aspects of ionizing radiation safety to a Faculty Radiation Protection Supervisor, and Laser safety officer, where applicable.

The current School Safety Adviser is Dr. Michael Oelgemoller Ext. 5312 Email: Michael.Oelgemoller@dcu.ie

The current Assistant School Safety Adviser is Damien McGuirk Ext. 5111 Email: damien.mcguirk@dcu.ie

The current Faculty Radiation Protection Supervisor is Dr. Rosaleen Devery Ext. 5406 Email: rosaleen.devery@dcu.ie

The current Laser safety advisor is Dr. Paul Van Kempen Ext. 5023 Email: paul.van.kampen@dcu.ie

4.

Recognized Trade Unions are also entitled to appoint a Safety Representative from amongst School of Chemical Sciences members.

5.

Postgraduate students are entitled to nominate a laboratory representative for each research laboratory. Such representatives are entitled to bring any safety concerns to the Head of School as they arise.

6.

Members of the School have a duty of care to co-operate with the Head of School, the School Safety Advisor, Assistant School Safety Advisor, and Chief Technical Officer in any matters relating to health and safety. The Chief Technical officer is Veronica Dobbyn, ext. 5840 Email: veronica.dobbyn@dcu.ie

In particular, members of the Academic Staff, as research project supervisors and/or advisers of undergrad/postgraduate students, are expected to be responsible for the implementation of any recommendations of the Head of School or his or her representative in any matters relating to the health and safety at work of postgraduate students in their care.

Current members of school academic staff are listed in Appendix 11 of this handbook.

7.

The School of Chemical Sciences recognizes the importance of training its members in matters of health and safety and attempts to carry out such training at all levels. The School of Chemical Sciences looks to the University Safety Officer for assistance in such training.

8.

Any member of the School of Chemical Sciences or student engaged in School of Chemical Sciences activities has the right to approach the Head of School, the School Safety Advisor, Assistant School Safety Advisor, or Chief Technical Officer on any matter relating to health and safety.

9.

Safety matters within the School of Chemical Sciences are discussed, and recommendations made, during the course of monthly meetings for all staff, which are held by the Head of School.
The S.S.A./A.S.S.A. shall also represent the School of Chemical Sciences at general **Faculty Safety Committee** (see point **13**.) meetings and also liaise with the University Safety Officer as required.

10.

It is expected that all members of the School of Chemical Sciences, students engaged in School of Chemical Sciences activities and visitors, contractors and lessees of areas on the School of Chemical Sciences premises abide by all relevant safety guidelines as contained in this handbook.

11.

To check compliance with the legal requirements and with safety regulations concerning health and safety at work, inspections/audits of School of Chemical Sciences premises may be carried out by the School Safety Adviser, the Assistant School Safety advisor, and any member of the University Safety office where applicable. Members of the School in charge of workshops, laboratories, stores etc. are informed of any breaches in safety found during such inspections together with suggestions for improvements to the working environment. Such breaches must be addressed immediately. **Failure to do so may result in closure of that work area until such breaches are rectified.**

12.

Communication between the Head of School and members of the School of Chemical Sciences on matters of health and safety is achieved via school meetings, internal e-mail, and via safety inspections/audits. The School of Chemical Sciences Safety Handbook and documents are posted on the School of Chemical Sciences Web Page under "Safety Information"- **(http://www.dcu.ie/safety/chemistry.php)**

13.

The School of Chemical Sciences is also represented on the **Faculty Safety Committee**, which also encompasses the Schools of Biotechnology, Physics, Sports Science, Nursing, and faculty research companies such as N.C.S.R., B.D.I., N.I.C.B., and the I.C.N.T. The aim of the Faculty Safety Committee is to establish common safety practices and procedures and also serve as a forum to address safety matters that pertain to the faculty. This handbook will form, in part, these common safety practices and procedures. Further information on this committee can be obtained from the Faculty Director of Facilities and Associated Services, Mr. Michael Burke ext. 5110 Email: michael.burke@dcu.ie

14.

The School of Chemical Sciences will also offer every co-operation and compliance necessary with inspectors from the **Health and Safety Authority of Ireland (H.S.A.),** in the event that these inspectors visit the school. , Such visits may occur at any time, without prior notice from the H.S.A. The **H.S.A.** is the state sponsored body of Ireland which has overall responsibility for securing safety, health and welfare at work and it operates under the Safety, Health and Welfare at Work Act 2005

SCHOOL OF CHEMICAL SCIENCES

Health and Safety Responsibilities

President of Dublin City University

Has ultimate responsibility for all aspects of health and safety on the entire campus of Dublin City University.

Head of School

The Head of School has responsibility for all aspects of health and safety within the School of Chemical Sciences. However, for practical reasons, the Head of School delegates much of this responsibility to the School Safety Adviser, Assistant School Safety Adviser, to Technical and Administrative Supervisors and also to Academic Staff in their roles as Research Group Supervisors (to postgraduate students carrying out Research Projects); and as Undergraduate Teaching Laboratory Organizers/Academic Demonstrators.

University Safety Officer

The School looks to the University Safety Officer for advice on all safety matters pertaining to the School.

Employees

Under the Safety, Health and Welfare at Work Act -2005, an employee has the following responsibilities:

- To take reasonable care while at work for his or her own health and safety and for that of persons who may be affected by his or her acts or omissions;

- To co-operate with the employer on safety matters in order to enable the employer to fulfil his/her legal duties;

- Not to misuse or damage safety equipment provided by the employer.

As employees of Dublin City University, members of the School of Chemical Sciences whether Academic, Technical, Secretarial, research, or other personnel have these duties, as enshrined in the Safety, Health, and Welfare at Work Act 2005. Each employee is responsible for complying with the applicable provisions of Health and Safety Regulations. Each employee must also adhere to all University or School safety policies/procedures, and to comply with safety instructions issued by their individual Supervisors. All employees are accountable to the Head of School in matters of health and safety.

Research group supervisors and teaching laboratory supervisors/demonstrators

Research group supervisors and teaching laboratory supervisors/demonstrators are responsible for:

Maintaining a safe working environment and in particular providing such supervision as is necessary to ensure the health and safety of students and research workers within their area of responsibility;

Ensuring that undergraduate students understand basic safety rules/regulations in the undergraduate teaching laboratories, and that students adhere to same when working in these laboratories.

Research students understand the School of chemical sciences safety handbook, obey the associated rules relating to their work, and that they complete a school **SAFETY DECLARATION FORM** (See page.43-44- this handbook) before starting work in the School.

All new research students in the school are expected to attend the faculty **SAFELAB MODULE** programmes http://www.dcu.ie/science_and_health/safety_info.shtml, and attend outside hours induction training.

Consulting with the students and research workers for whom they have responsibility on all matters of health and safety and for bringing to the attention of the School Safety Adviser or Head of School any matter that they are concerned with.

Visiting research workers, visiting lecturers, school students, and visitors

All visitors are obliged to follow those safety regulations and procedures detailed in this handbook where applicable.
In the event of visitors being shown around the School, safety glasses will be provided on request. These are obtainable from the chemistry stores at X1-64 or X1-61. Return glasses to stores when finished with them.

In the event of primary or secondary school students visiting/working in the Schools laboratories, adequate supervision must be provided by those members of the School of Chemical Sciences, who are organizing these events. Basic laboratory safety regulations will also apply at all times during these events. (See Appendix 7 of this document).

In the event of visiting lecturers, visiting demonstrators etc., it is incumbent upon same to follow the safety rules and regulations as laid down in this handbook. Visiting lecturers and demonstrators must liaise with those members of staff responsible for bringing them to the School, in conjunction with the School Safety Adviser and/or the university safety officer where appropriate.

School Safety Adviser (SSA)

On behalf of the Head of School, the School Safety Adviser is responsible for giving advice and help on all matters concerning health and safety in the School and also for ensuring compliance with relevant safety guidelines as laid down in this handbook.

Assistant School Safety Adviser (ASSA)

The Assistant School Safety Adviser is responsible for assisting in overseeing day-to-day compliance with the school safety regulations, and helping with the maintenance of a safe working environment within the School of Chemical Sciences.

Appointing a School Safety Adviser, or assistant school safety adviser

The appointment of a school safety adviser and assistant school safety adviser is done on a voluntary basis, and such appointments are made by the Head of School.
The school safety adviser is a member of academic staff, and the assistant school safety adviser is a member of technical staff.

CONTACTS for EMERGENCY

First Aid personnel:

Damien McGuirk
***Phone:* 5111/5373**
Vincent Hooper
Phone: 5476/8195
Mary Ross
Phone: 5745/5111/5906

Ambulance/Fire Brigade
Phone: 7999

Nearest Hospital :
Beaumont Hospital
Phone: **8377755**
(If ringing from within school, dial O followed by the above number)

Poison Information Service:
Beaumont Hospital
Phone: **8092566**
(If ringing from within school, dial O followed by the above number)

Taxis:
Phone reception **Dial 9, or security at 5999**

School Safety Adviser:
Dr. Michael Oelgemoller
Phone: **5312**

Assistant School Safety Adviser:
Damien McGuirk
Phone: **5111/5373**

Campus Nurse:	Ms. Sinead Mahon/ Ms. Edel Fogarty ***Phone***: **5143** (8.30am-6.30pm) ***Emergency Mobile***: **087-6794552** Outside these hours, ***Phone***: **Security 5999**
Doctors:	***Phone: 5143***
Security:	***Phone***: **5999**
Chemistry Technicians:	**Phone: 5111**
Chief Technical Officer-Veronica Dobbyn	**Phone: 5840/5111**
Reception:	**Dial 9**
Buildings Office:	**Phone: 5142/5362**
University Safety Officer – Eileen Tully	**Phone: 8896**

COPING WITH AN EMERGENCY

Normal University Working Hours:

These are from 9 a.m. to 5.15 p.m. Monday to Friday.

Precautions

Know at least two routes from your laboratory to a Fire Exit.
Know the location of:
Telephones
First Aid Boxes
Fire Extinguishers
Fire Alarm Points
Emergency contact numbers
How to switch off gas, water. Electricity etc. in your laboratory if it is possible to do so.

Evacuation Procedure:

- All test ringing of the Fire Bells and Fire Drills will be notified in advance; however such notification will be given to fire wardens only. **AT ANY TIME, IF A FIRE ALARM SOUNDS- EVACUATE THE BUILDING THROUGH THE NEAREST EXIT, AND FOLLOW THE FIRE WARDEN'S INSTRUCTIONS.**

- **COMPLY WITH DIRECTIONS FROM FIRE WARDEN OR SECURITY STAFF.**

- **NEVER USE A LIFT**. Assemble away from danger and clear of the building at your nearest ASSEMBLY POINT.

- **DO NOT RE-ENTER THE BUILDING UNTIL YOU ARE TOLD IT IS SAFE TO DO SO BY SECURITY STAFF OR BY A FIRE WARDEN.**

- The nearest assembly points for the school of chemical sciences are, **ASSEMBLY POINT 4** (outside main atrium door adjacent to library), **ASSEMBLY POINT 20** (Collins avenue side of the building adjacent to NICB), and **ASSEMBLY POINT 17** (located between the Physics and Reception block)

On Discovering a Fire:

- The main priority is **to RAISE THE ALARM BY USING THE 'BREAK GLASS FIRE ALARM' AND EVACUATE THE BUILDING .**

- **DO NOT ENDANGER YOURSELF. OPERATE THE NEAREST FIRE ALARM POINT, AND INFORM TECHNICAL STAFF (5111) OR SECURITY (5999) IMMEDIATELY**.

Escape of Toxic Material

- **LEAVE THE AREA IMMEDIATELY.**
- **LOCK ACCESS DOOR TO AREA WHERE POSSIBLE AND DISPLAY A SIGN 'CHEMICAL SPILL (NAME OF REAGENT/DATE) IN THIS ROOM- DO NOT ENTER!!' ON THE LABORATORY DOOR. IF THERE IS IMMEDIATE DANGER TO OTHER STAFF IN THE BUILDING AS A RESULT OF THE ESCAPE OF TOXIC MATERIAL, SOUND THE FIRE ALARM IMMEDIATELY.**
- Close all doors on exit**.** Phone the technical staff (ext. 5111) during normal working hours. In the event the spill is serious outside normal university hours, inform security at 5999 , detailing basic safety information about the reagent i.e. Name, Risk phrase, quantity spilled etc.. (This information will be of benefit to the emergency services if they are to be called.)
- In the case of liquid reagents if the spill of chemical is small and localized and there is no immediate danger to yourself or others, throw absorbent materials on to the spillage area obtained from the laboratory SAFETY STATION, evacuate the laboratory and inform the technical staff (ext. 5111) inside normal working hours. Outside working hours, follow the same procedure and contact security as detailed above..
- In the case of suspect odors originating in the school, evacuate area and contact any member of technical staff, S.S.A., A.S.S.A. immediately, or failing that ,contact estates office ext. 5362, or security at ext. 5999

Safety stations:

In most of the research and teaching areas a **SAFETY STATION**, marked by a green sign and white lettering is present. The station has a green/red plastic box, which can contain the following items as appropriate for each laboratory:

- Dust Masks
- Absorbent mats for small spillages and containment socks
- Sand (particularly useful for fires involving metals such as sodium, potassium etc.)
- Gloves for handling cryogenic fluids, such as liquid nitrogen.

For replacements on any of the above items contact the School ASSA.

Safety equipment requests:

Requests for additional safety equipment, which needs to be purchased for a particular work area, should be submitted to the S.S.A/ A.S.S.A. in the first instance.

Safety information:

There are a number of safety reference books are available from the technical staff, Room X1-61. A current list of these books can be found in APPENDIX 6 of this document.

Aiding an Injured Person during normal university hours:

If a staff member/student/member of the public has suffered an injury in the school, contact any registered **first aider** for the area as soon as possible. A general access first aid station, with all the relevant contact information is located on the first floor of the atrium of the science building- directly adjacent to the main entrance to the office areas of the School of Chemical Sciences. There is also first aid contact information on the emergency contact cards located in each laboratory within the school. A key to the first aid box is available in the Chief Technicians office, Room X1-61.

Aiding an Injured Person outside normal university hours:

If a staff member/student/member of the public has suffered an injury in the school outside normal university hours contact security on ext. 5999 immediately for assistance or contact the emergency services on 7999.

Where Emergency treatment is required-normal university hours:

(Note: Even if a fire alarm sounds, do not attempt to move the injured person out of the building unless there is imminent danger to that person and the first aider. Stay with the injured person until help arrives.)

- Dial 7999 from any internal phone or 0 (for outside line) then 999 – you will be connected to the emergency services directly
- Ask for an Ambulance to attend Dublin City University Campus, Collins Ave, Dublin 9. Specify which building the casualty is in (Henry Grattan, Sports Complex etc).
- Request that the ambulance enter the Campus from Collins Avenue and report to DCU Main Reception where security will be awaiting its arrival.
- Dial 5999 (DCU Security Emergency Line) and notify Security that an ambulance is on its way. Inform Security which building (and which room in the building) the ambulance should attend.
- Security will meet the ambulance at Reception and accompany it (or direct it, if after hours) to the designated building.
- If possible have someone wait at the entrance to the building to take the ambulance personnel directly to the casualty

Where Non Emergency treatment is required- normal university hours:

(Note: Even if a fire alarm sounds, do not attempt to move the injured person out of the building unless there is imminent danger to that person and the first aider. Stay with the injured person until help arrives.)

DCU has approximately 60 staff members on campus who are trained Occupational First Aiders. It is expected that the majority of occupational injuries sustained by campus users, will be dealt with by trained First Aid teams working in conjunction with the DCU Health Centre. In order to ensure that significant injuries (requiring medical attention) sustained by campus users during the course of their employment/studies/visit are dealt with swiftly, DCU has arranged that the First Aid Team can refer certain conditions to VHI/Swiftcare Minor Injuries Clinic (ph 7994192) on campus.

Clinic Opening Hours: 8am – 10pm – 7 days. Occupational injuries requiring medical attention outside clinic opening hours must be referred to Hospital A&E.

The following is the list of 'occupational injuries' that can be referred to the on-campus VHI Swiftcare Clinic;

- Sprains or possible breaks
- Minor burns
- Cuts requiring stitches
- Eye and ear minor injuries requiring medical attention

NOTE: Sports injuries and medical conditions/illnesses are not 'occupational injuries' and are not covered by this scheme. Attendance at the Clinic in such instances will be at the patient's cost.

The procedure to be followed in referring an occupational injury is as follows:

1. **The injured party must be examined by a member of the DCU Occupational First Aid team.**
2. The First Aider must be satisfied that the injury resulted from an occupational accident and that medical assistance is necessary.
3. The injured party must be accompanied to the **VHI/Swiftcare Clinic** by a DCU First Aider or by DCU Security Staff
4. The accompanying person must provide their name and contact details to the Clinic
5. Where the above procedure has been complied with the **VHI/Swiftcare Clinic** team will attend to the injured party and will retrospectively bill the DCU Health and Safety Office for the expenses incurred.
6. The First Aider must also complete the relevant sections of the **DCU Injury/Incident Report Form** for each person they treat, or refer for medical attention.

Injured parties attending the clinic unaccompanied by a DCU First Aider will be responsible to VHI/Swiftcare for any charges incurred.

On Discovering a Flood:

- If it is obvious, stop the leak; phone the Buildings Office (ext. 5362) or technical staff (ext. 5111). Outside normal university hours contact Security (ext: 5999).
- Warn people in the labs below to safeguard equipment etc.
- DO NOT ATTEMPT TO MOVE WET ELECTRICAL EQUIPMENT UNTIL IT IS DISCONNECTED FROM THE MAINS.

Failure of Mains Services:

If there is a failure of fumehood, gas, water, electricity or lift services during working hours, phone the Buildings Office (ext: 5362/5142) or contact by electronic means via e-mail at Helpdesk.Estates@dcu.ie
For failure of mains services OUT OF HOURS, phone Security (ext: 5999)

PREVENTING FIRES AND FLOODS:

Fire

Apart from the obvious dangers of horrendous injury/death, fires are enormously destructive.

The Fire Detection System

All parts of the School are fitted with detectors in or near the ceiling. The detectors are on alert at all times. A red light appears when a detector is activated, the alarms bells will ring and you must leave the building until the alarm is over.

PLEASE TAKE GREAT CARE TO AVOID CAUSING FALSE ALARMS!
WILFUL TAMPERING WITH FIRE ALARMS IS A VERY SERIOUS OFFENCE!!

Solvents in Laboratories

A working minimum of flammable solvents should be stored in a given laboratory in an appropriate cabinet. In event of fire, excess amounts of solvent could endanger lives and the fabric of the building. As far as possible, and certainly overnight, solvents should be stored in the ventilated cupboards under the fume hoods or in solvent cabinets. Full 2.5 liter glass winchesters of solvent should not be routinely stored on a laboratory work bench. Place lids back on solvent bottles when finished using them.

Solvent Stills

A large number of fires and injuries have been caused in various chemistry schools through the improper use of stills for drying and purification of solvents. Such apparatus must be treated with the greatest of care. Detailed instructions and precautions are outlined in Standard Risk Assessment No. 15, covering the use of solvent stills (Appendix 5 of this handbook). The most important question you must ask is "**Do I really need to use a solvent still?"** All stills must be labeled clearly to identify the following;

1. Solvent
2. Metal or material which solvent is been distilled over.
3. Date of inception.

It is worth noting that the purchase of 'anhydrous' grade solvents (eg. Analytical/Hplc Grade solvents) can be a more practical, safer, and economical alternative to stills.

Leaving a Laboratory or Workshop:

Serious damage often occurs in unoccupied areas because something has been left on inadvertently or incorrectly. When you leave your workplace in the evening (or during the day if you are to be away for long) you have the responsibility to check that:

- There are no obvious problems with any reactions or equipment left running. These should have an appropriate overnight form, an example of which is given in Appendix 14.

- Flammable solvents are properly stowed in closed storage cupboards.

- Unnecessary electrical equipment (e.g. ovens) is turned off and NO NAKED FLAME OR FLAMMABLE GAS IS LEFT ON.

- If water has to be left running, the tubing is in good condition and is secured in the event of water pressure fluctuations. Otherwise, switch off running water sources.

- All fume cupboards have their covers lowered.

- Lights are turned off.

- Fire doors and other doors are closed.

Floods

Apart from the damage they can cause to equipment and paperwork, and the considerable inconvenience to personnel, floods can be dangerous, for example by bringing down ceiling tiles and soaking live electrical equipment. The greatest care must be taken to avoid floods. In the event of a flood, notify the technical staff at 5111, or outside normal working hours contact security at 5999. There is a water hoover present in the School to help deal with such floods, which is available from the technical staff Room X1-61, during normal working hours.

Water cooling connections

It is recommended that plastic or rubber tubing bringing cooling water to rotary evaporators, solvent stills, diffusion pumps and other semi-permanent systems, should be fastened on to the apparatus and the water taps with wire, plastic cable ties, or screw clips. Cable ties are available from the chemical stores- Room X1-64. The exit tube must pass the water properly down a drain that is able to cope with the flow and be anchored to prevent splashing or ejection if the water pressure rises. This is **ESSENTIAL** with overnight reactions.

PERSONAL SAFETY:

General principles:-

- **THINK BEFORE YOU START AN EXPERIMENT**
- **RISK ASSESS, IF THE PROCEDURE WARRANTS IT (See Risk assessment procedures-this handbook).**
- **IF A PROBLEM OCCURS DURING AN EXPERIMENT, PUT YOUR PERSONAL SAFETY FIRST.**
- **WEAR P.P.E. (Personal protective equipment)**
- **NEVER PERFORM EXPERIMENTAL WORK ALONE IN A LABORATORY**
- **KEEP YOUR LABORATORY WORK BENCH/FUMEHOOD TIDY**

Safety/Risk assessment forms:

The School of Chemical Sciences currently uses three forms which are completed as follows:

- **Safety Declaration Form for Research Workers (See p.43-44 this handbook)** must be filled out for the project by the research student undertaking the project, in close consultation with their academic supervisor. This form must be filled out by hand and countersigned by the academic supervisor and school safety advisor.

- **Risk Assessment-Experimental Method Form (See P.45-46 this handbook)** is to be completed for any special activities not covered by the **List of Standard Risk Assessments** given in Appendix 9 of this handbook. This form must be filled out by the researcher proposing to do the task, and countersigned by the academic supervisor and school safety advisor.

- **Control of Substances Hazardous to Health (COSHH) form (see P.47-48 this handbook)** is to be completed by the researcher wishing to use that chemical agent in the School and must be countersigned by the academic supervisor. These forms can be filled out electronically. For more detail consult Appendix 1 of this handbook. No chemical reagent will be issued from stores to any researcher, without a completed COSHH form.

Eating, Drinking or Smoking

These are strictly forbidden in laboratories and workshops. Smoking is forbidden in all parts of the School. There is a postgraduate common room/meeting room area located in the School office area, where eating and drinking is permitted.

Mobile phone usage

It is advised not to have mobile phones switched on while working in laboratories. They can be a source of immediate distraction when they ring in a laboratory, and such distraction may prove fatal to you or your work colleagues. Mobile phones should only be used in the adjoining corridors of laboratories.

Mp3 players/Personal stereo equipment

During normal course of lab work, use of such equipment is forbidden for reasons as outlined in' Mobile Phone Usage' and also for not being able to hear a colleague in distress, fire alarm sounding etc etc.

Personal protective equipment- P.P.E.

Safety Glasses: Have a pair of Safety Glasses, which you can wear in comfort and use them in all designated areas and whenever you are handling chemicals, glass, vacuum or pressure apparatus and equipment with moving parts. Safety glasses may be obtained from chemistry stores room X1-61. The School of Chemical Sciences advocates that safety glasses must be worn at all times in those areas where they are required. In the case of research workers that require prescription glasses or contact lenses to see clearly, the School will provide individual prescription safety glasses. (In this case, contact the S.S.A./A.S.S.A., who will arrange fitting.). The School currently uses the services of **Isight Icare Ltd.- Contact Mr. Graham Smithers** Tel. 087-2534724.

For undergraduates wearing prescription glasses, the campus shop provides safety glasses, which can be worn over their prescription glasses when in the laboratory.

REMEMBER: PRESCRIPTION GLASSES ARE NOT SAFETY GLASSES.

With respect to contact lenses, there is no definitive rule regarding their use, save that it is incumbent upon the research worker to inform his/her supervisor that he/she is wearing same during laboratory work. The important thing to remember is that proper eye protection be worn at all times when working in the laboratory or in other

areas where safety glasses are required. If there are any further concerns regarding contact lenses and individuals who need to wear them, contact the School Safety Advisor.

Laboratory coats: Wearing a laboratory coat can give considerable protection against splashed chemicals and flash burns. YOU ARE REQUIRED TO WEAR ONE (fastened) and to keep it reasonable order.

Protective gloves: The school provides a range of gloving materials, the most commonly used one being the 'SUPAGLOVE'disposable blue nitrile gloves, which offer protection against a broad range of solid chemical agents and are available from the school stores, room X1-64. In the case of undergraduate teaching laboratories they are provided to the student as required. Use with care in case you trap a chemical within a glove you are wearing. Even if you have been wearing gloves, wash your hands frequently when working. Never wear rubber or plastic gloves when working with flame. GLOVES WORN IN LABORATORIES MUST NOT BE WORN IN "CLEAN AREAS" (CORRIDORS, OFFICES, COMPUTER LABORATORIES ETC). Gloves provide limited protection against laboratory solvents and there is no gloving material which will give you protection for all solvents. For workers suffering from contact dermatitis, or other skin conditions, which may be aggravated by wearing protective clothes, there are cotton under-gloves available from the service hatch Room X1-64. Gloves must also be removed when working with PC's and when a worker is moving from one lab to another, to minimize the spread of potential contamination which could inadvertently harm other colleagues. The proper use of gloves/glove selection should form part of any COSHH or Risk assessment for a chemical reagent. For further information on gloves and gloving materials see the following links as an example:

http://www.labsafety.com/refinfo/ezfacts/ezf191.htm

http://pubs.acs.org/hotartcl/chas/97/novdec/eval.html

Fume-hood Safety

Fume-hoods in the School are of the built-in ducted type, which vent to the outside through outlets on the roof. The draught in all ducted fume-hoods is tested for velocity the hoods are labeled with the correct fumehood velocity.

Using fumehoods as storage space greatly impairs the efficient operation of same.

Fume-hood Sashes: The ducted fume-hoods in the School of Chemical Sciences have very heavy glass fronts held by sashes. **Chemical Systems Ltd**., in conjunction with the Buildings/Estates office, services all fumehoods on a twice-yearly basis.

All defects in fumehood function should be reported to the Buildings office at ext. 5142/5362 or via helpdesk.buildings@dcu.ie

Chemical Safety

In accordance with guidelines and codes of practice for the handling of chemical agents, as laid down by the Safety, Health and Welfare at Work Act- 2005, (and enforced by the **Health and Safety Authority of Ireland**- see http://publications.hsa.ie/index.asp?locID=7&docID=-1 for more details), a risk assessment must be carried out on all chemical agents before they are to be used. In the case of undergraduate teaching laboratories, this will be carried out by members of academic staff and technical staff, in conjunction with undergraduate students where necessary. In the case of postgraduate/post doctorate research staff, such risk assessments will be carried out using a **C.O.S.H.H.** (**C**ontrol **O**f **S**ubstances **H**azardous to **H**ealth) form.

The detailed basis for COSHH, and the procedure filling out a COSHH form is given in Appendix 1 of this handbook.

The following general points are worth emphasizing:

***Solvents/Powders*:** Many common solvents, e.g dichloromethane, are toxic and in handling (or spilling them) in the open laboratory you will easily exceed danger limits for the vapour concentration (see Appendix 1). Use an effective fume cupboard whenever possible. Dusty substances can be as dangerous as highly volatile substances both in toxicity and in explosion risks. Wear protective dust masks where applicable. These may be obtained from the School stores, and are also located at the Safety stations. Also consult standard **Risk Assessment #14-Transport, Storage, and use of solvents-Appendix 5.**

Mercury: Mercury is very toxic. All glass apparatus containing mercury MUST have secondary containment to catch mercury in the event of a breakage. Spilt mercury should be collected up immediately. Details on how to clean up a mercury spill are given in the standard **Risk assessment #21" Use, Handling and Clean-up Procedures for Mercury"-Appendix 5**

Cyanides: Think very carefully before working with cyanides. **THE USE OF CYANIDES OUTSIDE OF NORMAL WORKING HOURS IS STRICTLY FORBIDDEN**. Before beginning any work with cyanides a detailed written **Risk assessment-Experimental method Form (p.45-46)** must be completed and countersigned

by the School Safety Advisor/Supervisor. Part of this assessment is the requirement to inform an appropriately technical staff of your intentions. See the standard **Risk Assessment #23 –on the Use of Cyanide Salts-Appendix 5**. Return all unused stocks of Group 1 Cyanide salts eg. Sodium/Potassium cyanide to Stores immediately you have finished. If someone is affected by cyanides phone x7999 for an ambulance, then contact a First Aider if possible and inform Security ext. 5999.

THE USE OF CYANIDES SHOULD BE AVOIDED AS MUCH AS IS PRACTICALLY POSSIBLE. FIND ALTERNATIVE REAGENTS WHERE APPLICABLE!!

Hydrofluoric acid (abbv. HF): Think very carefully before working with HF. **THE USE OF HF OUTSIDE OF NORMAL WORKING HOURS IS STRICTLY FORBIDDEN**. At concentrations above 1M (2%) in water, HF can cause very painful burns, which may not be apparent for some hours. Before beginning any work with HF, a detailed **Risk assessment-Experimental method Form** must be completed and countersigned by the School Safety Advisor/Supervisor.

All research workers intending to work with HF must undergo specialized training which is run in the school by the assistant school safety advisor, Damien McGuirk ext. 5111
For further information see Risk assessment #22-"Use of Hydrofluoric Acid"-Appendix 5.
The use of hydrofluoric acid should be avoided as much as is practically possible. find alternative reagents where applicable!!

Pyrophoric and related reagents: Think very carefully about using these reagents. Some spontaneously ignite in air at room temperature (pyrophoric materials), and others may react vigorously with moisture to give off flammable gases, which may in turn ignite in air. Pyrophoric and other related materials must not be stored in any research laboratory. Pryophoric materials must be stored in a flame retardant vented cabinet **P1**, which is located in room X2-54. This cabinet will be locked at all times. All pyrophorics must be obtained via the service hatch X1-64. When working with pyrophorics, inform your work colleagues of your intentions to do so, where you will be working with them, and what controls you have in place should the agent be accidentally released ie. proper extinguishing agent close to hand, evacuation in case of fire etc. In most cases, dry sand is a suitable 'first aid' agent for pyrophoric materials. Containers of dry sand should be present at your lab SAFETY STATION. If sand is not present, please inform the SSA/ASSA. **UNDER ABSOLUTELY NO CIRCUMSTANCES ARE PYROPHORIC AND RELATED AGENTS TO BE USED IN THE DEPARTMENT OUTSIDE NORMAL UNIVERSITY WORKING HOURS**. See the standard **Risk Assessment #24- Appendix 5'Use of pyrophoric reagents'.**

THE USE OF PYROPHORIC REAGENTS SHOULD BE RESTRICTED AS MUCH AS IS PRACTICALLY POSSIBLE. FIND ALTERNATIVE REAGENTS WHERE APPLICABLE!!

Potentially explosive reagents eg. Picric acid/Metal Picrates: Think very very carefully about using these reagents. Some of theses agents can explode under the influence of impact, friction, abrasion particularly when dry. Disposal of these reagents may have to be done via the Defence forces under controlled conditions. Purchase as small a quantity of explosive reagents as possible and ensure all wastes are catalogued and stored as safely as possible. Before beginning any work- a detailed **Risk assessment-Experimental method Form** (p.45-46) must be submitted to the School Safety advisor.

Scaling down reactions: The School advocates that all synthetic research chemists perform reactions scaled down to the minimum. It is incumbent upon each researcher to be responsible for the amount of chemicals purchased, the amount of chemical waste generated and the safety of execution of their chosen reactions while working in the School. Consult with members of academic and technical staff where appropriate**. As a guideline, reactions should be carried out in vessels no greater than 250cm3 in volume.**

Electrical Safety

Notice the danger signs. On all electrical equipment you use, watch for signs of wear on the cable and insulation problems where it connects to the plug or equipment. If it looks less than perfect, contact any member of technical staff (ext. 5111). Do not bring old equipment into use without first having it checked for safety.
Consult technical staff, if there is any doubt.

Water and electricity: Wet electrical equipment is very dangerous. Disconnect from the mains before touching it. BEWARE OF WET HEATING MANTLES. Inform any member of technical staff.

Never use equipment, which carries a "Failed" , “Do Not Use” or any other visible indication that it is not fit for use.

Consult the standard **Risk Assessment #3- on the "Use of Standard Electrical Equipment"-Appendix 5**

Mechanical Safety

Carrying solvents: Winchester bottles of solvents may be carried in the corridors or lifts only in carriers (maximum load per person, two carriers) or on sturdy trolleys fitted secondary containment. See the standard **Risk Assessment #14 "Transport, Storage, and use of solvents and other flammable liquids" - Appendix 5.**

Rotary equipment: Make sure equipment with rotating parts, e.g. stirrers, rotary evaporators, rotary pumps cannot catch hair, clothing, or any trailing wires/ tubing.

Gas cylinders: Most of the various gas supplies to laboratories used in the School of Chemical Sciences are plumbed in from various gas storage 'pods'. These pods are located on the first floor of the school, adjacent to rooms X1-55 and X1-59, and from a pod located in the basement area. The in-house gas nitrogen supply comes from a nitrogen generator which is located adjacent to the NICB building. Every effort should be made to minimize the need for gas cylinders in laboratories. However, due to the continually changing needs of the School, it may be necessary to install other gas cylinders in the laboratories from time to time.
Cylinders must be installed by liaison with any member of technical staff.
In some cases, a **Risk assessment-Experimental method Form** (see p..45-46) must be filled out, particularly if toxic or highly flammable gases are to be used. All risk assessments must be submitted to the academic supervisor and school safety adviser for approval. All cylinders must be secured in the work area, and tested for leakages where applicable. See Risk **Assessment #4 "The transport and use of compressed gas cylinders" – Appendix 5**

Postgraduate workers who intend using gas cylinders as part of their research should inform the S.S.A. of their intentions, and must be instructed in the safe use of same. Undergraduates/Postgraduates must never attempt to move or fit compressed gas cylinders. In general, all transport of gas cylinders and fitting of regulator heads is performed by Mr. Ambrose May Ext. 8198- Room X1-64/X1-61, or contact any member of technical staff at ext. 5111. Since the new science block was incepted in the year 1999, nearly all gas supplies are piped into laboratories from a series of gas pods, two of which are located on the first floor of the school adjacent to rooms X1-55 and X1-59, and one in the basement area of the building.

Glassware Safety

Evacuated glassware: When glassware under vacuum breaks, the implosion may spray glass pieces around. GLASSWARE UNDER PRESSURE IS EVEN MORE DANGEROUS AND SHOULD ONLY BE USED WITH TOTAL CONTAINMENT. See the standard **Risk Assessment #2 "Use of Glassware"- Appendix 5**

Broken glass and empty bottles: Broken glass or used disposable pipettes and other items, must be put only in the appropriate waste bins (yellow in colour) labeled FOR BROKEN GLASS –These broken glass bins are in turn placed into special bins and are then removed by a glassware disposal company-ECOSAFE Ltd. All broken glassware will be removed from labs by technical staff, **Under no circumstances should broken glass or indeed any sharp objects be placed in normal waste bins, where such objects may seriously injure cleaning staff. Also, it is important that glassware contaminated with chemical residues shall not exceed ~ 1% by weight.- as a 'rule of thumb'. If in doubt, contact any member of technical staff.**

Before they leave your laboratory it is vital that all glassware bottles/containers for disposal are treated appropriately. Please see **Appendix 5 --Risk Assessment #26- Cleaning of Glassware**

Cryogenic Safety

Refrigerators and freezers: **Refrigerators/freezers must not to be used as 'dumps' for various chemical reagents!** Make sure everything you put in is tightly sealed in a way that will not leak when cold. Most commercial refrigerators and freezers are not flameproofed and a leak of flammable vapours can cause an explosion. All such refrigerators must therefore have their thermostat wired externally before they are used in the laboratory-or purchase spark proof models. Check the contents frequently and discard unwanted samples/chemicals. NEVER PUT FOOD IN A REFRIGERATOR WITH CHEMICALS. NEVER Put UNLABELLED CHEMCIAL COMPOUND CONTAINERS IN FRIDGE.

Liquid N_2/ Solid CO_2: These substances can cause freeze-burns. Equipment cooled outside by liquid N_2 but open to air will allow liquid O_2 to form INSIDE which can create a dangerous pressure rise or give an explosion with flammable material. ONLY USE LIQUID NITROGEN TO COOL SEALED OR EVACUATED SYSTEMS.
Wear the correct protective gloves (safety station) when handling these cryogenic substances. If you do not have access to a pair of cryogenic gloves, contact the school stores X1-64.

See standard **Risk Assessment #18 "Handling, Transportation and Storage of Liquid Nitrogen and other Cryogenic materials" – Appendix 5**

Radiation and Laser Safety

Do not start any work involving radioactivity or high energy radiation (>10 keV) without first consulting the Faculty Radiation Protection Supervisor (currently Dr. Rosaleen Devery ext.5406) or work with lasers without first consulting the Faculty Laser Protection safet officer Dr. Paul Van Kampen. See standard **Risk Assessments #6 Laser work in the laboratory and #20 Use of laser dyes- Appendix 5.**

Noise

Changes in sounds are often a first indication that something is amiss with equipment or machinery. Make every effort to keep background noises from pumps, shakers, compressed air jets, etc. at as low a level as possible for the comfort of everyone and so that you can hear when something is going wrong eg. Fire alarm, equipment malfunction, etc. Excessively loud radios/stereo units are not allowed as they may interfere in the ability of one worker hearing another's verbal call for assistance. The use of personal stereo equipment, which use earphones in both ears, mp3 players etc. are forbidden in the research and teaching laboratories of the School of Chemical Sciences, for the same reasons.

Labeling of Glassware/Sample Bottles

All glassware and sample bottles used for storing compounds which are intended for further use, should be labeled with the following minimum information :

NAME:
DATE:
COMPOUND:
SOLVENT (where applicable):

If there are known hazards associated with the compound, the appropriate warning symbol should also be displayed. As a minimum guideline, all labels should be done in pencil. In addition, a labeling machine ***('p-Touch')*** is available from the school stores X1-64 for making custom labels for safety purposes.

N.M.R. Safety

The NMR system uses a static magnetic field to make nuclear spins orientate in the magnetic field. There are different strengths of magnets from 1,500 to 200,000 gauss (0.15 to 20 tesla). A radio frequency (RF) pulse pulls the effective magnetic dipole away from equilibrium in the static magnetic field. Research NMRs are more powerful than medical devices but their fields are of smaller volume, are focused and fall off quickly, therefore it is easier to provide personnel protection. To a lesser extent the same provisions and precautions apply to electron spin resonance devices.

When installing a new NMR some factors must be considered. The weight of an instrument in the order of several tons and requires that it be placed in an area with substantial structural support. If the structural support includes steel beams or steel reinforced concrete, these ferromagnetic materials may have an effect on the magnetic field. The device should not be located near sources of RF such as heavy motors or relays. Personnel must be instructed on the hazards associated with an NMR unit.

Warnings:

The magnet of a spectrometer is always at field. Strong fields are produced outside the magnet; therefore, no movable metal objects should be allowed within 3 meters of the instrument. Small, sharp metal objects flying towards the magnet are highly dangerous. Larger objects (watch that floor polisher!) are troublesome to scrape off the magnet, and can seriously damage the magnet. Metal belt buckles, steel tipped shoes, and any other metal on the person may be strongly attracted when close to the magnet.

Magnetic fields may affect heart pacemakers. Demand-type pacemakers may be switched to basic rate pacing. Persons fitted with pacemakers should not come closer than 3 m of the center of the magnet. A recent publication suggests that long term cumulative large exposures to oscillating magnetic fields (60 Hz) may be associated with increased incidence of brain cancer in power industry workers. The cumulative doses for an effect were large, and represent no hazard outside the 5 gauss safety line normally used. Reasonable caution in avoiding lengthy exposure to higher fields seems prudent, nonetheless. Our current conclusion then is that NMR workers should then spend no longer than reasonably necessary within the 5 gauss line for sample changing and adjustments. No other equipment unrelated to the NMR system should be placed within the 5 gauss line. (David A. Savitz and Dana P. Loomis (1995). "Magnetic field exposure in relation to leukemia and brain cancer mortality among electric utility workers." Am. J. Epidemiology 141(1): 123-134.) On Oct 31, 1996, the National Research Council issued a report, which generally confirms this optimism that effects are minimal, but definitive studies are difficult to design, and have yet to be done.

In the unlikely event of the magnet quenching or of a cryogenic failure, up to 100 m^3 of helium gas may evolve over a period of several minutes. Although inert, lighter than air and non-toxic, there could be a risk of asphyxiation in a confined space. Personnel should evacuate the area in such a situation. A quench warranting

evacuation would be obvious by the noise of the escaping gas and clouds of vapor. When transferring liquid nitrogen or helium, the following steps should be observed to avoid accidents:

- Gloves, eye protection, and closed shoes must be worn.

- Doors should be propped open to increase ventilation.

- Tanks on wheels must be chocked or held by another person.

- The transfer must be continuously attended and helium transfers MUST be done in buddy pairs.

Since the possibility of a helium quench is higher when filling the magnet, and since the transfer involves manual operations, there is a remote possibility that an operator could be rendered unconscious at the time of a quench. Fills must only be done by two operators, (use buddy system), particularly if a Helium fill is being carried out.

Cautions:

Magnetic fields may permanently damage watches, calculators and certain types of credit cards. Keep those items more than 2.5 m away from center of magnet.
Failure to refill or de-energize the magnet when low levels occur (indicated by cryogen level sensors) may result in a magnet quench with possible magnet damage. If low-level warning lights on sensors are continuously lit, immediately inform the NMR operator. The nmr operators for the School are Mr. John McLoughlin Ext. 5745 and Mr. Damien McGuirk Ext. 5111/5373.
Use only carbon dioxide fire extinguishers to avoid equipment damage.
In case of serious flooding or other situations where there is risk of electrocution, turn off the equipment circuit breakers.

Working outside normal university hours/lone working

There are special risks from working in a laboratory in the School outside normal working hours (9 a.m. – 5.15 p.m. Monday to Friday) as help may not be to hand in the event of an accident. To address this issue, the university has implemented an '**outside hours'** policy and procedures as specified in **APPENDIX 8** of this handbook. The procedures may also be found at the following web-site address: http://www.dcu.ie/safety/out_of_hours.shtml In addition to this policy, the following rules specifically apply to the school of chemical sciences.

1.

Undergraduates are forbidden to be in laboratories outside normal working hours, this includes undergraduate exchange students.

2.

Never work alone, particularly if hazardous activities are being carried out. Research workers working outside university working hours must comply with those policies and procedures as laid down in **Appendix 8** of this handbook. **These policies and procedures come into effect from Dec.6th. 2002 onwards.**

3.

Leave experiments, which involve any significant measure of risk to normal working hours. **NO WORK INVOLVING CYANIDES,HYDROFLUORIC ACID, EXPLOSIVE, PYROPHORIC OR RELATED COMPOUNDS MAY BE CARRIED OUT OUTSIDE NORMAL WORKING HOURS.**

4.

If you are very tired or very hungry, stop working as this could lead to potentially fatal laboratory accidents.

Experiments left on overnight or at weekends:

1.

Leave equipment, ovens or experiments running overnight only when absolutely necessary.

2.

All experiments left on must have a notice on an **overnight form**, an example of which is given in **Appendix 9,** indicating potential hazards in plain English, and the name and telephone number of the person who is responsible for it.

3.

Experiments involving overnight refluxing of solvents must be put in a functioning fume-hood and care taken to ensure that the water tubing is anchored down the drain.

4.

Potentially hazardous experiments that must be left on for periods of more than three consecutive nights must be risk assessed using a **Risk Assessment-Experimental Procedure Form.p.45-46**-, and permission to perform same must be obtained from the project supervisor and the SSA.

Pregnancy

Certain chemicals and radiation pose a greater than normal danger to an expectant woman and to her unborn child. Under the Safety, Health, and Welfare at Work Act-2005, if you become pregnant and you are working with chemical, biological, or radioactive agents, you **must** inform the Health and Safety office Ext. 8678 **immediately,** and complete a preliminary 'pregnancy at work' risk assessment form which can be found at . **http://www.dcu.ie/safety/pregnancy_lab.shtml.** For information/advice on pregnancy and the workplace contact the University safety officer Eileen Tully-ext. 8896. Also consult the H.S.A. http://www.hsa.ie/eng/Legislation/Acts/Safety_Health_and_Welfare_at_Work/General_Application_Regulations_2007/Pregnant_PostNatal_Breastfeeding_Guidance.pdf

Tidiness and finishing work in the School

The prospect that you and your co-workers stay safe will be increased if you all keep your working environment reasonably tidy, free of obstacles underfoot or trailing wires or tubes. Double check with yourself before you do anything in a laboratory. If you are not sure, stop and think, or ask for advice.

All research workers are required to make safe their workspaces, on finishing work within the School. This includes tidying work area, cleaning glassware, disposal of chemical waste etc.

For finishing postgraduate workers in the School, the form **CS RES 1** must be completed. Failure to do so will result in that **postgraduate not being allowed to graduate.** See **Appendix 10** of this handbook.

REPORTING ACCIDENTS AND INCIDENTS

If there is a dangerous incident/accident in the School, it has to be reported IMMEDIATELY to the technical staff/SSA/ASSA. A report on the injury/incident **must** (in accordance with current Safety, Health and Welfare Act 2005) be completed by those person(s) directly involved, or by that person involved in the post incident investigation. using the **DCU INJURY/INCIDENT REPORT FORM***. The completed form is then forwarded to Eileen Tully- University Safety Officer Ext. 8896, so that ways can be suggested of avoiding a re-occurrence of the event. In very serious cases, the Government Health and Safety Authority (H.S.A.) will be informed by the University safety officer. **Incidents** are defined as unplanned events in which no one was hurt but which either had the potential to cause injury or did cause damage to apparatus, equipment or the building. **Accidents** are defined as events in which someone gets injured/fatally injured.

A copy of the DCU Injury/Incident report form is available in each laboratory, from the S.S.A./A.S.S.A., or can be obtained directly from the university safety officer.

*Instructions for the correct completion of this form are given on the back of the form. If you are still not sure about filling out the form, contact the S.S.A. or A.S.S.A.

CHEMICAL WASTE DISPOSAL

For safety and environmental protection reasons, government regulations are making disposal of chemical waste increasingly difficult and costly. Generate as little waste as possible during the course of your work within the School. Wherever practical, try to recover, re-use and recycle substances. **At the end of research project dispose of all unknowns/unwanted products in a safe manner. In the event of product retains fro further research, ensure all products are fully labeled. Seek advice from your project supervisor/technical staff as appropriate.**

For further advice on waste management/disposal consult any member of technical staff Room X1-61 or ext. 5111.

Waste Chemicals

GUIDANCE FOR THE DISPOSAL AND STORAGE OF SPECIAL WASTE AND OTHER HAZARDOUS WASTE.

1.

INTRODUCTION

IT IS INCUMBENT UPON EACH RESEARCH WORKER TO MINIMIZE THEIR WASTE GENERATION THROUGHOUT THE ENTIRE PERIOD OF HIS/HER WORK.

NEVER BUY CHEMCIAL REAGENTS IN BULK- BULK REAGENTS TODAY BECOME BULK WASTE TOMORROW.

ADOPT THE 'LOW-WASTE' APPROACH AT EVERY AVAILABLE OPPORTUNITY.

NEVER ASSUME THAT ALL WASTES CAN BE DISPOSED OF EASILY. NEVER ASSUME THAT WASTE DISPOSAL COMPANIES WILL TAKE ANY TYPE OF CHEMCIAL WASTE.

WASTE DISPOSAL COSTS ARE INCREASING ALL THE TIME

The technical staff arrange for on site collection of School Special wastes, and the final disposal of Special Waste in accordance with the Waste Management Act 1996 and the Waste management permit regulations 1998. (See http://www.epa.ie/downloads/legislation/waste/licensing/).
Their main purpose is to provide an effective system of control, which ensures that Special Wastes are soundly managed from the moment they are produced until they reach their final destination.

The method of disposal should be determined as part of the appropriate COSHH assessment for the given reagent.

PROCEDURE FOR THE DISPOSAL OF WASTES IN THE SCHOOL OF CHEMICAL SCIENCES

The bulk disposal of Waste from the School of Chemical Sciences is co-ordinated via the Technical Staff (Mr.Ambrose May , Room X1-61/X1-64.)

i.
All waste must be stored in suitable containers i.e. the container must be compatible with its contents and not cause corrosion.

ii.
All containers should be adequately labeled enabling identification and should bear the appropriate hazard warning symbol where necessary. All other markings should be removed or deleted. The following details should be included:-

description of the waste including all components of any mixtures
approximate amount, weight (solids) or volume (liquids)
type of containers e.g. winchester, drum, bottle, etc.
origin of waste by room ,and person,

Customized in-house waste labels are available from the service hatch X1-64, for this purpose.

iii.
All waste placed in the waste stores is listed and catalogued by Mr. Ambrose May Ext. 8198 c/o the service hatch X1-64.

NB: Those substances listed in Appendix 6 must not be discharged to the drain.

The remainder of the waste generated in laboratories etc. will typically comprise of either broken glassware, neutralised absorbents from liquid spills or insoluble chemicals. For the purpose of this guidance such waste will be referred to as Difficult Waste.

The following are the arrangements for the disposal of waste

i.
Solid waste with low levels of contamination, glass and other sharps except clinical waste should be disposed of into specially designated containers available from stores X1-64. When full, said containers will be collected by members of the technical staff and disposed of off-site by **ECOSAFE** ltd.

2.

Non-hazardous solid waste should be placed in labelled containers available from the service hatch, room X1-64.

3.

Solvent wastes are designated halogenated/chlorinated or unhalogenated/non-chlorinated and both of these waste are routinely stored in flame proof solvent cans in the laboratories in the school. These cans are emptied routinely by technical staff, and the resulting wastes stored in labeled 200 litre drums in the basement area

4.

Aqueous waste streams are routinely stored in labeled 2.5.litre glass Winchester bottles.

If in doubt about waste streams- consult any member of technical staff.

All wastes generated and stored in basement stores are monitored by Mr. Ambrose May c/o room X1-64.

SAFE STORAGE OF WASTE

i.

Different types of waste should be stored separately where possible. Hazardous waste should be stored away from the general non-hazardous waste. The school waste storage area is located in the basement yard area of the science building and all waste generated by the school is monitored by the technical staff.

ii.

Waste should be stored under cover, away from direct sunlight wind and rain. Hazardous waste should be stored in sealed containers and should be kept under cover to protect the integrity of the container.

iii.

Containers for the storage of waste should be adequately labeled. Hazardous wastes must not be placed in containers provided for general commercial waste. Such errors may be lead to hazardous material being handled as non-hazardous thus putting the carrier (as well as others) at risk, or may lead to the waste being improperly disposed of. Adequate labeling should also ensure that when the waste is collected the correct material is removed. In the case of hazardous waste adequate labeling is required by law and is necessary both to inform potential handlers of the risks and to ensure that non-compatible materials are not stored or transported together. Appropriate labels for waste containers are available from the stores room X1-64.

Iv.

As far as practical the storage of wastes should be kept to a minimum. This is to encourage good housekeeping and, in the case if hazardous wastes, reduces the risks associated with the storage of large quantities of hazardous materials.

v.

Care should be taken to ensure the compatibility of containers with their contents e.g. metal drums are not suitable for acid wastes. Sufficient free space should be left in containers of liquids to allow for expansion of the contents. Bungs and lids must be securely fastened. Poor quality containers should not be used for wastes as a means of disposing of the container.

vi.

Non-compatible wastes should not be stored together (see material safety data sheets or below chemical incompatibilities survey) and all containers should be adequately labeled.

FINAL DESTINATION OF WASTE:

All wastes are removed off site by a licensed disposal company bi-annually, in accordance with the WASTE MANAGEMENT (MOVEMNENT OF HAZARDOUS WASTE) REGULATIONS, 1998. All waste must be accounted for on **FORM C.1**., as issued by Dublin City Corporation. The School currently uses ENVA Ltd. (www.enva.ie) And ECOSAFE Ltd. (http://www.ecosafesystems.ie/), as external disposal contractors for its wastes.

Chemical Incompatibilities- A general summary

Acid + Alkali	= Heat
Acid + Hypochlorite	= Toxic Gas
Acid + Metal	= Toxic Gas/Flammable Gas
Acid + Cyanide/Sulphide	= Toxic gas
Oxidising agent + Organic Solvent	= Fire
Reducing agent + Organic Solvent	= Fire

Water Reactive + most things = Fire

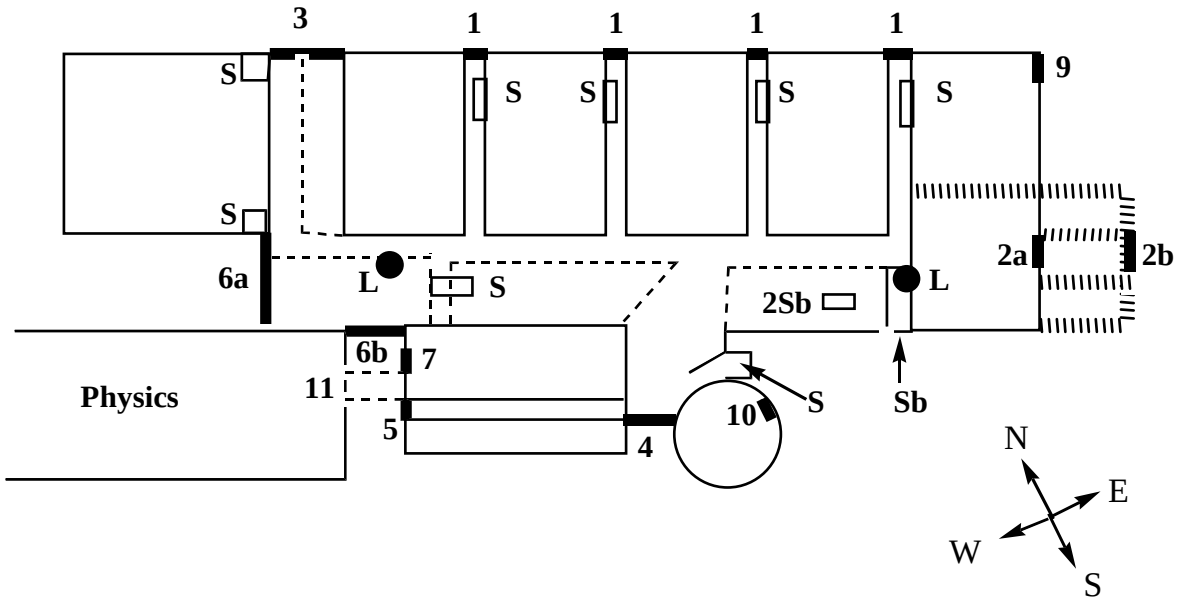
The list of chemical incompatibilities is not fully comprehensive. Further information is given in Brethericks Handbook of Reactive Chemical Hazards 3, which is available from the technical staff (room X1-61) for reference or from numerous sources via the world wide web.

School of Chemical Sciences

Emergency Evacuation Routes

Emergency Evacuation:

Normal and Signed Exit Routes



basement **1st and 2nd floor bridges and balconies**

S = stairs leading to all floors. 2Sb = stairs leading to basement only.
Sb = stairs leading from all floors including basement. L = lift

There are no external external escape routes from the 1st and 2nd floors. Either corridor stairs or stairs leading from the balconies and bridges must be used.

There are four fire doors **1** at the end of the ground floor main corridors. These cab be used by any one exiting via the corridor stairs, or by exiting rear ground floor laboratories. Under normal conditions these access doors are

'magna-locked' , and will only open in the event of a fire alarm activation. Front facing ground floor laboratories should empty onto the atrium.

It is possible to exit the main atrium by several routes. **2Sb** lead to the basement only and it is possible to exit to the external yard through **2a**. However, continued exit through **2b** is mandatory, as the external yard would constitute an extreme hazard in the event of a very serious fire. Exits **6**, **4** and **3** are the main routes out of the atrium and minor atrium. Atrium lecture theatres can exit into the atrium and via **6**, **4** and **3** or onto the corridor and out of **5**. The East atrium lecture theatre can also empty via **7**. The ground floor tower lecture theatre may empty via **10** or **4**. In extreme case evacuation via **9**, through the biology laboratory is possible.

Exit from the 1st and 2nd floor offices, computer rooms and lecture theatres are down onto the atrium and out. The bridges to physics **11** may also be utilised.

Green "running man" symbols have been posted around the School of Chemical Sciences to clarify the emergency escape routes or "Fire Exits" as they are known.

UNDER NO CIRCUMSTANCES MUST ELEVATORS BE USED IN THE EVENT OF A FIRE.
COMPLY WITH INSTRUCTIONS FROM THE SCHOOL FIRE WARDENS.

Assembly Points; For those personnel exiting via **3** and **1** assembly is located at the temperorary car park area located adjacent to main reception and beside multi-story car park i.e. **ASSEMBLY AREA 20**. For those exiting via **6a** the assembly point is to the rear of Physics at **ASSEMBLY AREA 17** . For those exiting via **6b**, **7**, **5**, **4**, **10**, **11** and **2b** are to assemble at **ASSEMBLY AREA 4, which** is located in front of exit **6b**. Under no circumstances should people assemble around exit **2b**, this is a hazardous area.

School Safety Forms

The following pages contain all the forms associated with Health and Safety, COSHH, etc, for use within the School of Chemical Sciences. Any queries should be referred to the School Safety Advisor.

1.

Safety Declaration form for Research workers p. 43-44.

This form **MUST** be completed by all postgraduate and postdoctorate researchers in the school, before any work is to be undertaken in a research laboratory within the School. The completed form is countersigned by the project supervisor and submitted to the SSA for review and subsequent filing.

2.

Risk Assessment-Experimental Method form- p. 45-46

This form must be used for any special procedures not covered by the school's standard **Risk Assessments - Appendix 5** of this book. They are only to be used if special procedures other than those as set down in **Appendix 5** are to be used during the course of a postgraduate/postdoctorate's research work. Eg. "Use of concentrated acid etching solutions" etc. etc. Completed forms are countersigned by the project supervisor and submitted to the S.S.A. for review and subsequent filing.

3.

COSHH Assessment form p. 47-48

This is form is an absolute requirement when ordering new chemicals or when using a chemical imported into a laboratory by someone other than you (even if the other person has filled out a COSHH Form). As from March 12th 2001, ALL COSHH FORMS MUST BE FILLED OUT ELECTRONICALLY. As guidance please consult **Appendix 1 of this book "Control of Laboratory and Workshop Hazards including Chemical Hazards-Risk Assessments".**

D.C.U.- SCHOOL OF CHEMICAL SCIENCES

SAFETY DECLARATION FORM FOR RESEARCH WORKERS

THIS FORM MUST BE COMPLETED BY ALL RESEARCH WORKERS (POSTGRADUATES, POSTDOCTORAL, AND VISITING WORKERS) BEFORE WORK TERM COMMENCES.

- This form (consisting of p.43 and p.44 of this document) should be completed jointly by postgraduate, postdoctoral or visiting research worker, and the appropriate research supervisor. This form must then be reviewed and countersigned by the School Safety Adviser- S.S.A. The Assistant School Safety Adviser will then file the completed form in room X1-61.
- Research workers must refer to the school's **standard risk assessments as detailed in Appendix 5** of this book before starting work.
- Special procedures/systems that a research worker will be carrying out during the course of his/her research work that are not detailed in the standard risk assessments, then that worker **must** fill out a detailed **RISK ASSESSMENT EXPERIMENTAL METHOD** (see P.45 and P.46 this handbook) for that procedure in consultation with his/her project supervisor. Guidance for making a Risk Assessment is given on P.62/ Appendix 1 of this handbook.
- Chemical reagents can only be obtained by filling out an appropriate **COSHH form**, as detailed on P.47-48 of this handbook.

Name of research Project Supervisor Name of research worker* Lab. Room No.

*Status: postgraduate, postdoctoral or visitor (delete as appropriate)

Project title/Research area .....

Give a brief description of the type of research work to be undertaken.

For the research worker:

- I have read the School of Chemical Sciences Safety Handbook and I fully understand the safety recommendations contained therein..
- I have read and fully understand the School's standard risk assessments as detailed in Appendix 7 of the Safety Handbook.
- I will carry out **COSHH Assessments** and **EXPERIMENTAL RISK ASSESSMENTS** as required during the course of my work within the School of Chemical Sciences, Dublin City University as detailed on p. 45-48 of this handbook. I will seek advice from my project supervisor, S.S.A. , A.S.S.A., where appropriate, if I am in doubt about any safety matter relating to my work.

Signature of the research worker.....
Date.....

For the project supervisor:

I have discussed in detail the nature of the research work with the research worker. I am fully aware that the research worker will consult with me on matters pertaining to his/her safety at all times. I will also consult with the S.S.A., A.S.S.A., or technical staff where appropriate on matters pertaining to my research worker's personal safety.

Signature of project supervisor……

Date

For the School Safety Adviser (S.S.A.)

I reviewed the above Safety Declaration Form for the research worker and, on behalf of the Head of School, allow him/her to start research work in the School of Chemical Sciences- D.C.U.

Signature of the School Safety Advisor.....……
Date.....

D.C.U.- SCHOOL OF CHEMICAL SCIENCES

RISK ASSESSMENT--EXPERIMENTAL METHOD FORM

This form (p.45 and p.46 of this document) should only accompany the "**SAFETY DECLARATION FORM FOR RESEARCH WORKERS"** when the following circumstances apply:

- The research worker intends to carry out specialised operations/procedures not covered by the School's standard risk assessments as detailed in Appendix 5 of this handbook. These specialised operations/procedures will pertain specifically to the researcher's individual research work eg. operating a piece of specialised equipment or carrying out a special procedure, where there are inherent safety risks to that research worker. This risk assessment form should be filled out in close consultation with the research worker's project supervisor and the completed risk assessment(s) submitted to the S.S.A. for review. Consult Appendix 1 of this handbook for further guidance.
- Additional Risk Assessment –Experimental Method can be made during the course of the research worker's project as they are required, again in close consultation with the project supervisor.
- Submit all completed risk assessments to the S.S.A. for review. Completed risk assessment forms will be filed by the A.S.S.A. in X1-61, alongside the research worker's **Safety Declaration Form**.
- Fill out the risk assessment data as follows:

Specialized operation/procedure being assessed (give specific details):

Risk Category Rating (See P.63 this handbook):

Known or expected hazards associated with the activity:

Precautions to be taken to reduce the level of risk:

Training prerequisite:

Risk remaining:

Emergency procedures:

Detail references if any:

For the research worker and project supervisor:

We have carried out a risk assessment for the above operation/procedure in accordance with those guidelines as detailed on P.59 and in Appendix 1 as detailed in the school safety handbook.

Signature of research worker: Date:

Signature of project supervisor: Date:

For the School Safety Adviser:

I have reviewed the above risk assessment and found same to adequately comply with the safety guidelines as set down in the School of Chemical Sciences safety handbook- D.C.U.

Signature of School Safety Adviser: Date:

D.C.U- FACULTY OF SCIENCE

Control Of Substances Hazardous to Health (C.O.S.H.H.) form.

This form should be completed by the research worker and then reviewed by the researcher's Supervisor (or a competent Assessor).

Please enter all data requested. Most of the information required will be found on the Material Safety Data Sheet (MSDS) for that reagent. No chemical will be released from stores without a HSAF completed.

Standard Laboratory P.P.E.: Safety glasses, White Coat and appropriate gloves

1	Name of Staff member/ Research worker	
2	School/Research Centre	
3	• Name of Research worker's supervisor • Name of staff member's Head of School/ Centre	
4	Location of research worker (room number):	
5	Location of storage area of substance (room number):	
6	Hazardous Substance Name and proposed quantity for use	
7	Brief description of proposed use for this substance, including frequency of use	
8	List Risks involved in the use of this substance (list "R" numbers and phrase descriptor)	
9	List Safety precautions involved in the use of this substance (list "S" numbers and phrases descriptor)	
10	Can substance be replaced with less hazardous material? Yes or No: (If yes then complete an assessement for the safer material!)	
11	List basic first aid measures if exposed to the substance	
12	How will you dispose of the waste generated by using this substance?	
13	**If the substance is a known carcinogen, teratogen, or mutagen, then sections 14 – 22, must be completed.**	
14	What additional measures are in place to minimise exposure?	

15	Are additional warning signs required to minimise risks to other users (e.g. pregnant researchers etc)	
16	If the substance is a carcinogen/teratogen/mutagen, are storage and labelling provisions adequate?:	
17	If the substance is a carcinogen/teratogen/mutagen, does the working area require further demarcation?:	
18	Is further PPE required?	
19	Is the risk in using this substance acceptable? Yes or No (If 'No' do not complete this assessment without further consultation)	
20	Any other details	

By completing this assessment, the research worker acknowledges the risks associated with using this substance and will take all necessary steps to ensure that this assessment is followed at all times when using this substance.

Date: **Signature of Research worker:**

Date: **Signature of Supervisor:**

Standard emergency procedures to be followed when using this substance:

- **Work in fumehood where appropriate. Ensure fumehood is lowered when reagents are in use.**
- **Spill release:**
  In the event of spillage, EVACUATE THE AREA!-POST WARNING SIGNS ON ENTRANCE DOORS TO THE AREA TO INFORM CO-WORKERS OF THE REAGENT SPILLED AND IT'S R PHRASES. Inform technical staff inside normal university working hours, or inform security staff/fire services outside normal university working hours.
- **Event of fire.**
  Activate fire alarm. Evacuate work area. Inform the fire wardens, security or technical staff as appropriate.
- **Waste disposal:**
  See Appendix 2 this handbook.

Standard ‘In-House’ Risk Assessments for Common Activities and Substances

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You are required to read the **standard Risk assessments found in Appendix 7** of this document, and confirm that you have understood all the relevant information by filling in the **Safety Declaration form for Research Workers.** If you will be doing any activities or using any substances that are not covered by any of the standard forms, you will need to write your own Special Risk Assessment using the **Special Risk Assessment form** in this Safety handbook and notes for making a risk assessment).

_____

Equipment

- Risk Assessment #1 Use of Fume Hoods
- Risk Assessment #2 Use of Glassware
- Risk Assessment #3 Use of Standard Electrical Equipment
- Risk Assessment #4 Transport and Use of Compressed Gas Cylinders
- Risk Assessment #5 Use of high power Microwave and Radio frequency power supplies
- Risk Assessment #6 Laser Work in a Laboratory
- Risk Assessment #7 Use of Reduced Pressure or Vacuum
- Risk Assessment #8 Visual Display Equipment
- Risk Assessment #9 Use of Ultra-Violet Light Sources
- Risk Assessment #10 Use of Laboratory Heating Equipment
- Risk Assessment #11 Use of Laboratory Centrifuges
- Risk Assessment #12 Use of a Potentiostat

Procedures

- Risk Assessment #13 General Office Work
- Risk Assessment #14 Transport, Storage and Use of Solvents and other Flammable Liquids
- Risk Assessment #15 Distillation of Solvents
- Risk Assessment #16 Disposal of Waste solvents
- Risk Assessment #17 Use of the Sodium Press to make Sodium Wire for solvent drying
- Risk Assessment #18 Handling, Transportation and Storage of Liquid Nitrogen and other Cryogenic Material
- Risk Assessment #19 Use of flammable, explosive and toxic gases
- Risk Assessment #20 Use of Laser dyes and dye solutions

Chemicals and Materials

- Risk Assessment #21 Use, Handling and Clean-Up Procedures for Mercury
- Risk Assessment #22 Use of Hydrofluoric Acid
- Risk Assessment #23 Use of Cyanide Salts
- Risk Assessment #24 Use of Pyrophoric reagents
- Risk Assessment #25 Cleaning of glassware contaminated with chemical residues
    - Risk Assessment #26 Procedure for preparative thin layer (TLC) and flash chromatography.

Useful Information

Risk Phrases - code letters
Safety Phrases - code letters
Hazardous Property Phrases
Notes for Making a Risk Assessment

RISK PHRASES

RISK PHRASES used in the classification, packaging, labeling and provision of information on dangerous substances. This list is by no means definitive as new risk phrases are continually devised over time. For an up to date listing please consult the current Aldrich (or equivalent) chemical reagent catalogue.

R1 : Explosive when dry

R2 : Risk of explosion by shock, friction, fire or other source of ignition

R3 : Extreme risk of explosion by shock, friction, fire or other source of ignition

R4 : Forms very sensitive explosive metallic compounds

R5 : Heating may cause an explosion

R6 : Explosive with or without contact with air

R7 : May cause fire

R8 : Contact with combustible material may cause fire

R9 : Explosive when mixed with combustible material

R10: Flammable

R11: Highly flammable

R12: Extremely flammable

R13: Extremely flammable liquefied gas

R14: Reacts violently with water

R15: Contact with water liberates highly flammable gases

R16: Explosive when mixed with oxidising substances

R17: Spontaneously flammable in air

R18: In use, may form flammable/explosive vapour-air mixture

R19: May form explosive peroxides

R20: Harmful by inhalation

R21: Harmful in contact with skin

R22: Harmful if swallowed

R23: Toxic by inhalation

R24: Toxic in contact with skin

R25: Toxic if swallowed

R26: Very toxic by inhalation

R27: Very toxic in contact with skin

R28: Very toxic if swallowed

R29: Contact with water liberates toxic gas

R30: Can become highly flammable in use

R31: Contact with acids liberates toxic gas

R32: Contact with acids liberates very toxic gas

R33: Danger of cumulative effects

R34: Causes burns

R35: Causes severe burns

R36: Irritating to eyes

R37: Irritating to respiratory system

R38: Irritating to skin

R39: Danger of very serious irreversible effects

R40: Possible risk of irreversible effects

R41: Risk of serious damage to eyes

R42: May cause sensitisation by inhalation

R43: May cause sensitisation by skin contact

R44: Risk of explosion if heated under confinement

R45: May cause cancer

R46: may cause heritable genetic damage

R47: May cause birth defects

R48: Danger of serious damage to health by prolonged exposure

R49: May cause cancer by inhalation

R50: Very toxic to aquatic organisms

R51: Toxic to aquatic organisms

R52: Harmful to aquatic organisms

R53: May cause long-term adverse effects in the aquatic environment

R54: Toxic to flora

R55: Toxic to fauna

R56: Toxic to soil organisms

R57: Toxic to bees

R58: May cause long-term adverse effects in the environment

R59: Dangerous to the ozone layer

R60: May impair fertility

R61: May cause harm to the unborn child

R62: Possible risk of impaired fertility

R63: Possible risk of harm to the unborn child

R64: May cause harm to breastfed babies

R65: Harmful: May cause Lung damage if swallowed.

R66: Repeated exposure may cause skin dryness or cracking.

R67: Vapours may cause drowsiness or dizziness

R68: Possible risk of irreversible effects

Combination of risks:

R14/15:	Reacts violently with water liberating highly flammable gases
R15/29:	Contact with water liberates toxic, highly flammable gas
R20/21:	Harmful by inhalation and in contact with the skin
R20/21/22:	Harmful by inhalation, in contact with the skin and if swallowed
R20/22:	Harmful by inhalation and if swallowed
R21/22	Harmful in contact with the skin and if swallowed
R23/24:	Toxic by inhalation and in contact with the skin
R23/24/25:	Toxic by inhalation, in contact with the skin and if swallowed
R23/25:	Toxic by inhalation and if swallowed
R24/25:	Toxic in contact with the skin and if swallowed
R26/27:	Very toxic by inhalation and in contact with the skin
R26/27/28:	Very toxic by inhalation, in contact with the skin and if swallowed
R26/28:	Very toxic by inhalation and if swallowed
R27/28:	Very toxic in contact with the skin and if swallowed
R36/37:	Irritating to eyes and respiratory system
R36/37/38:	Irritating to eyes, respiratory system and skin
R36/38:	Irritating to eyes and skin
R37/38:	Irritating to respiratory system and skin
R39/24:	Toxic: Danger of very serious irreversible effects if in contact with skin
R39/23:	Toxic: danger of very serious irreversible effects through inhalation
R39/23/24:	Toxic: danger of very serious irreversible effects through inhalation in contact with skin
R39/23/24/25:	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
R39/23/25:	Toxic: danger of very serious irreversible effects through inhalation and if swallowed

R39/24: Toxic: danger of very serious irreversible effects in contact with skin

R39/24/25:	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed
R39/25:	Toxic: danger of very serious irreversible effects if swallowed
R39/26:	Very Toxic: danger of very serious irreversible effects through inhalation
R39/26/27:	Very Toxic: danger of very serious irreversible effects through inhalation and in contact with skin
R39/26/27/28:	Very Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
R39/26/28:	Very Toxic: danger of very serious irreversible effects through inhalation and if swallowed
R39/27:	Very Toxic: danger of very serious irreversible effects in contact with skin
R39/27/28:	Very Toxic: danger of very serious irreversible effects in contact with skin and if swallowed
R39/28:	Very Toxic: danger of very serious irreversible effects if swallowed
R42/43:	May cause sensitisation by inhalation and skin contact
R48/20:	Harmful: danger of serious damage to health by prolonged exposure through inhalation
R48/20/21:	Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with the skin
R48/20/21/22:	Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with the skin and if swallowed
R48/20/22:	Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
R48/21:	Harmful: danger of serious damage to health by prolonged exposure in contact with skin
R48/21/22:	Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
R48/22:	Harmful: danger of serious damage to health by prolonged exposure if swallowed
R48/23:	Toxic: danger of serious damage to health by prolonged exposure through inhalation
R48/23/24:	Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with the skin

R48/23/24/25:	danger of serious damage to health by prolonged exposure through inhalation, in contact with the skin and if swallowed
R48/23/25:	Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
R48/24:	Toxic: danger of serious damage to health by prolonged exposure in contact with skin
R48/24/25:	Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
R48/25:	Toxic: danger of serious damage to health by prolonged exposure if swallowed
R50/53:	Very toxic to aquatic organisms, may cause long term adverse effects in the aquatic environment
R51/53:	Toxic to aquatic organisms, may cause long term adverse effects in the aquatic environment
R52/53:	Harmful to aquatic organisms, may cause long term adverse effects in the aquatic Environment
R68/20:	Harmful: possible risk of irreversible effects through inhalation
R68/20/21:	Harmful: possible risk of irreversible effects through inhalation and in contact with skin
R68/20/21/22:	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed
R68/20/22:	Harmful: possible risk of irreversible effects through inhalation and if swallowed
R68/22:	Harmful: possible risk of irreversible effects if swallowed
R68/21:	Harmful: possible risk of irreversible effects in contact with skin
R68/21/22:	Harmful: possible risk of irreversible effects in contact with skin and if swallowed
R68/22:	Harmful: possible risk of irreversible effects if swallowed

SAFETY PRECAUTION PHRASES

SAFETY PRECAUTION PHRASES used in the classification, packaging, labeling and provision of information on dangerous substances. This list is by no means definitive as new risk phrases are devised over time. For an up to date listing please consult the current Aldrich (or equivalent) chemical reagent catalogue.

:

S1 : Keep locked up
S2 : Keep out of reach of children
S3 : Keep in a cool place
S4 : Keep away from living quarters
S5 : Keep contents under.....(appropriate liquid to be specified by the manufacturer)
S6 : Keep under.....(inert gas to be specified by the manufacturer)
S7 : Keep container tightly closed
S8 : Keep container dry
S9 : Keep container in a well ventilated place
S12: Do not keep the container sealed
S13: Keep away from food, drink and animal feedstuffs
S14: Keep away from..... (incompatible material to be indicated by the manufacturer)
S15: Keep away from heat
S16 Keep away from sources of ignition - No Smoking!
S17 Keep away from combustible material
S18: Handle and open container with care
S20: When using do not eat or drink
S21: When using do not smoke
S22: Do not breathe dust
S23: Do not breathe gas/fumes/vapour/spray (appropriate wording to be specified by the manufacturer)
S24: Avoid contact with the skin
S25: Avoid contact with eyes
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
S27: Take off immediately all contaminated clothing
S28: After contact with skin, wash immediately with plenty of.....(to be specified by the manufacturer)
S29: Do not empty into drains
S30: Never add water to this product
S33: Take precautionary measures against static discharges

S34: Avoid shock and friction

S35: This material and its container must be disposed of in a safe way

S36: Wear suitable protective clothing

S37: Wear suitable gloves

S38: In case of insufficient ventilation, wear suitable respiratory equipment

S39: Wear eye/face protection

S40: To clean the floor and all objects contaminated by this material use (to be specified by the manufacturer)

S41: In case of fire and/or explosion do not breath fumes

S42: During fumigation /spraying wear suitable respiratory equipment (appropriate wording to be specified by the manufacturer)

S43: In case of fire, use....(indicate in this space the precise type of fire fighting equipment. If water increases the risk, add "never use water")

S44: If you feel unwell, seek medical advice (show the label where possible)

S45: In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)

S46: If swallowed, seek medical advice immediately and show the container or label

S47: Keep at temperature not exceeding....°C (to be specified by the manufacturer)

S48: Keep wetted with....(appropriate material to be specified by the manufacturer)

S49: Keep only in the original container

S50: Do not mix with... (to be specified by the manufacturer)

S51: Use only in well ventilated areas

S52: Not recommended for interior use on large surface areas

treatment plants

S55: Treat using the best available techniques before discharge into drains or the aquatic environment

S56: Do not discharge into drains or the environment, dispose to an authorised waste collection point

S57: Use appropriate containment to avoid environmental contamination

S58: To be disposed of as hazardous waste

S59: Refer to manufacturer/supplier for information on recovery/recycling

S60: This material and/or its container must be disposed of as hazardous waste

S61: Avoid release to the environment. Refer to special instructions/ material safety data sheet

S62: If swallowed, do not induce vomiting: seek medical advice immediately and show the container or label

S63: In case of an accident by inhalation: remove casualty to fresh air

and keep at rest.

S64: If swallowed, rinse mouth with water (only if person is conscious)

Combined safety phrases

S1/2 Keep locked up and out of reach of children

S3/9 Keep in a cool, well ventilated place

S3/7/9 Keep container tightly closed in a cool, well ventilated place

S3/14 Keep in a cool place away from..... (incompatible materials to be indicated by the manufacturer)

S3/9/1 Keep in a cool, well-ventilated place away from. ..... (incompatible materials to be indicated by the manufacturer)

S3/9/49:Keep only in the original container in a cool, well ventilated place

S3/9/14/49:Keep only in the original container in a cool, well ventilated place away from. ..... (incompatible materials to be indicated by the manufacturer)

S3/14: Keep in a cool place away from.....(incompatible materials to be indicated by the manufacturer)

S7/8 Keep container tightly closed and dry

S7/9: Keep container tightly closed and in a well ventilated place

S7/47 Keep container tightly closed and at a temperature not exceeding.....deg.C (to be specified by the manufacturer)

S20/21 When using do not eat, drink or smoke

S24/25 Avoid contact with skin and eyes

S29/56: Do not empty into drains: dispose of this material and its container to hazardous or special waste collection point

S36/37: Wear suitable protective clothing and gloves

S36/37/39:Wear suitable protective clothing, gloves and eye/face protection

S36/39:Wear suitable protective clothing and eye/face protection

S37/39: Wear suitable gloves and eye/face protection

S47/49: Keep only in the original container at a temperature not exceeding.....°C (to be specified by the manufacturer)

HAZARDOUS PROPERTY PHRASES

(These phrases will be displayed on reagent container/transport box.

"Explosive": substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

"Oxidizing": substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

"Highly flammable":
liquid substances and preparations having a flash point below 21 °C (including extremely flammable liquids), or substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or gaseous substances and preparations which are flammable in air at normal pressure, or substances and preparations, which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.

"Flammable": liquid substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C.

"Irritant": non-corrosive substances and preparations, which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

"Harmful": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.

"Toxic": substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

"Carcinogenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

"Corrosive": substances and preparations which may destroy living tissue on contact.

"**Infectious":** substances containing viable microorganisms or their toxins, which are known or reliably believed to cause disease in man or other living organisms.

"Teratogenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

"Mutagenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

Substances and preparations, which release toxic or very toxic gases in contact with water, air or an acid.

Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.

"Ecotoxic": substances and preparations, which present or may present immediate or delayed risks for one or more sectors of the environment.

NOTES FOR COMPLETING A "RISK ASSESSMENT--EXPERIMENTAL METHOD FORM"

Hazards and Risks

"Hazard" and "risk" are words which are synonymous in common use but in the technical jargon of Safety Management have different meanings:- the hazard presented by a substance or activity is its potential to do harm (rock-climbing is a hazardous activity) and risk from a substance or activity is the likelihood that it will cause harm in the circumstances of actual use (rock-climbing may be of low risk if the proper equipment is used and the rules are followed).

The aim of making a "risk assessment" is to identify the hazards associated with an activity, to assess the seriousness of these hazards and to formulate systems of work, training or other methods to reduce the associated risks to a minimum or at least to an acceptable level. This procedure has to be carried out by someone who is experienced and fully familiar with the activity.

Example- Risk assessment for 'Crossing The Road'

The steps involved in making a risk assessment can be illustrated by a simple example i.e. the activity of crossing the road.

Activity or operation:
Crossing the road

Hazards
Possibility of injury or death from collision with motor vehicle. (The level of risk may be high or low depending on whether the road is a busy dual carriageway or a quiet country lane or on the age/physical ability of the person crossing the road.)

Measures to reduce the level of risk
Look both ways and cross only when clear.
Use a Zebra or Pelican crossing.
Introduce traffic calming measures etc.

Training
Consult the "Safe Cross Code".
Read the Rules of the Road.

Emergency Action
Call Emergency Services, give First Aid, etc.

Level of risk remaining
Provided the above measures are followed the risk of injury is low however any accident that does occur may be serious. Even with training, competence should not be assumed especially with young children who should always be overseen by an older person.

References
"The Rules of the Road" published by the Irish Road Safety Council etc etc.

Risk Categories for special risk assessment of experimental method:

Advisors/supervisors should identify areas of work in the following risk categories:

A : Those in which work may not be undertaken without close senior supervision.
Bp : Those in which work may not be started without Advisor's advice. (Postgraduate)

Bu : Those in which work may not be started without Supervisor's advice.(Undergraduate)
C : Those with some risks (other than A and B) where care must be observed but it is considered that workers are adequately trained and competent in the procedures involved.
D : General laboratory practice.
E : Those, which, even without training, have very low levels of risk.

Tasks in category A should never be assigned to Undergraduates. Post-Docs and Visitors may be considered to be senior if they themselves are carrying out the work.

Those in category B are subdivided depending on the experience of the researcher.

Tasks C require a small amount of training but form a large part of the "background" of daily business and fall outside of Category D. Note that the use of Visual Display Equipment falls within Category C.

Tasks D or General Laboratory Practice will cover all of the procedures covered in undergraduate Teaching Laboratories.

Tasks E are associated with projects that are purely theoretical or computational and which require no written risk assessment except if the use of VDU equipment plays a large part in that project in which case Category C applies.

(*Note: A separate risk assessment/category procedure is used for those procedures which are to be used 'outside university hours' working. See Appendix 8 of this handbook.)

Risk Assessments

A number of standard **'in-house' Risk Assessments** have already been completed covering some of the more common tasks and pieces of equipment in the School of Chemical Sciences- **Appendix 5** this handbook (and suggestions for other topics or indeed written risk assessments are always welcome). Note that it remains the responsibility of individual Supervisors/Advisers to check the correctness and appropriateness of these risk assessments especially with regard to the level of skill and competence of the researcher.

The task required of all Advisors/Supervisors is, using the above as a guide, to look carefully at the research work for which they are responsible and to use their best judgement to identify procedures that fall within Categories A,

B or C. If risk assessments do not exist for these procedures then they must be written using the **RISK ASSESSMENT- EXPERIMENTAL METHOD** form.

COSHH Assessments

Please see the separate notes (**Appendix 1**-this handbook) for making a COSHH assessment.

Postgraduate induction

Postgraduate induction is normally run at the beginning of each academic year semester, which cover the various general/safety aspects within the Faculty of Science and Health of which the School of Chemcial Sciences is a part. To address safety aspects of the multi-discipline approaches used in the Faculty of science and health, the **SAFELAB** postgraduate programme has been created to induct all new researchers into the Faculty of Science. See http://www.dcu.ie/science_and_health/safety_info.shtml. Dates for these sessions will be announced by e-mail and via posted notice. **It is a requirement for new researchers to attend these SAFELAB seminars, as well as those existing research workers within the School.** Dates for this induction will also be communicated via e-mail and posted notice.

Appendix 1

CONTROL OF LABORATORY/ WORKSHOP HAZARDS AND COSHH ASSESSMENTS.

1. LABORATORY /WORKSHOP HAZARD ASSESSMENTS.

As stated earlier, it is a legal requirement that an assessment is made of risks in your laboratory or workplace. This assessment has to be made by your Advisor/Supervisor/Workshop Head or other "competent person" in collaboration with you. Part of this risk assessment will be concerned with chemical hazards covered by the School's COSHH (Control of Substances Hazardous to Health) regulations but a wide range of other hazards, e.g. mechanical, electrical etc., may also be relevant to your particular work situation and must also be assessed under the Management of Health and Safety at Work regulations. The aim of making a "risk assessment" is to identify the hazards associated with an activity, to assess the seriousness of these hazards and to formulate systems of work, training or other methods to reduce the associated risks to a minimum.

For Undergraduates, Postgraduates, Postdoctorals, Visitors and Technical Staff working in a laboratory the following procedure should be adopted in making a risk assessment.

Categories of Risk. In areas other than those of chemical risk, Advisors/Supervisors should rate areas of work in the School of Chemcial Sciences by the following ratings system

A
Those in which work may not be undertaken without close senior supervision.
Bp
Those in which work may not be started without Advisor's advice. (Postgraduate)
Bu
Those in which work may not be started without Supervisor's advice. (Undergraduate)
C
Those with some risks (other than A and B) where care must be observed but it is considered
that workers are adequately trained and competent in the procedures involved.
D
General laboratory practice.
E
Those which, even without training, have very low levels of risk.

(*Note: A separate risk assessment procedure is used for outside university hours working. See Appendix 8 of this handbook.)

Tasks in category A should never be assigned to Undergraduates, those in category B are subdivided depending on the likely experience of the researcher, those in category C require a small amount of training but form a large part of the background of daily business and fall outside of category D. Category D tasks or General Laboratory Practice covers procedures taught in the Undergraduate Laboratories and requires no special risk assessment. Tasks in category E include those which are purely theoretical or computational and again which require no special risk assessment, except if the use of VDU equipment plays a large part in the project in which case Category C applies.

The requirement of Advisers/Supervisors is that, using the classes of hazard covered earlier in this handbook, and any others that may be appropriate as a guide, they look carefully at the research work for which they are responsible and use their best judgement to identify procedures which fall within Categories A, B or C. If risk assessments do not exist for these procedures then they must be written.
If at any time, new procedures or operations are to be carried out not covered by an existing risk assessment, then a new assessment must be made before any work begins.

For further help in writing risk assessments see "Notes for Making a Risk Assessment" P.59 of this document. A number of Risk Assessments of general applicability have been written “Completed Safety Forms for Common Activities and Substances”.

For technical staff not mainly working in the laboratory, Risk Assessments must also be completed but the procedure of identifying Risk Categories may differ depending upon the nature of their work.

2. COSHH ASSESSMENTS

C.O.S.H.H. (Control Of Substances Hazardous to Health), is basically an assessment that a user carries out on a chemical agent before use in his/her area of work, based on information contained in a Material Safety Data Sheet (MSDS). This information guides the user in how he/she controls the use of the reagent in his/her laboratory. COSHH has to be made to establish the actual risk of working with chemicals and substances involved in the laboratory. The aims of COSHH are to make the user and his/her Supervisor aware of the risks to health from a reagent and to the health of those working in the vicinity of the reagent, of proper handling of dangerous substances/chemical agents. The COSHH assessment for the work of any student (undergraduate or postgraduate),

for any member of the technical staff and for postdoctorals, visitors and academic staff who work with chemicals, must be made by same in so far as is reasonably practical to do so, and reviewed by a competent person eg. academic staff member, postdoctorate staff member, technical staff, safety advisor,,. Nevertheless, collaboration and consultation are key elements of COSHH - it is risks to the health of the user that are being assessed. Indeed, Advisers/Supervisors to research students and postdoctoral assistants will expect active participation in the assessment as part of the educational process.

The Basis of a COSHH Assessment

As COSHH Assessment for any chemical reagent you wish to use in the school, with the exception of those chemicals covered by the in-house COSHH assessments. These assessments are extremely relevant when ordering reagents or obtaining reagents from the chemical stores located at room X1-61. Examples where COSHH is extremely relevant is as follows:

a.a carcinogen; that is a substances which is in the Health and Safety Executive category R45 "may cause cancer" or which is described in other reliable sources as a cancer suspect agent or which you or your Supervisor/Adviser know to be in a class of compounds some of which have already been described as cancer suspect agents.

b.highly toxic, very toxic or poison; substances which are described in Safety Literature as highly toxic or very toxic or as poisons, must be considered carefully and will require a Special Assessment if they are volatile or dusty so they could be inhaled or if they can be readily absorbed from solution through the skin.

c.explosive; this term would cover any endothermic compounds which can detonate, e.g. many solid or gaseous diazo compounds, some compounds containing nitro, nitroso or other groups which make oxygen available to carbon or hydrogen in the compound, or solutions which contain fuel/oxidant mixtures, e.g silver perchlorate in ethanol (perchlorates have caused many accidents and all work with solid perchlorates, perchlorates in organic media, or with perchloric acid except in <4M aqueous solution, requires elaborate safety precautions).

d.normally pyrophoric; this would definitely include silane or phosphine or potassium metal. Substances like lithium aluminium hydride which can be pyrophoric but which are frequently handled without catching fire.

NOTE: Perform reactions using these compounds on small scales as much as possible!!!!!

All COSHH assessments generated by each research worker are done so electronically using the format form as described on P. 47-48 and will be stored on computer database in the chemical stores. No chemical reagent will be issued to any research worker without properly completed COSHH.

COSHH Assessments must be made for all chemicals ordered after 1st December 1998
Resources for making COSHH assessments, in addition to this Handbook (see page for example of COSHH) are as follows:

1. The Sigma-Aldrich chemical catalogue of MSDS is available through the internet at http://www.sigmaaldrich.com/Area_of_Interest/Europe_Home/Ireland.html. Follow the LOGIN link and enter USER NAME: **dcuchemistry** and PASSWORD : **chemistry**. Follow the ALDRICH link and from that web page select the MSDS link. Follow the onscreen instructions and enter the name or the CAS number (obtainable from an Aldrich or indeed any chemical reagent catalogue) to display the desired MSDS. The MSDS may be downloaded or printed as desired. Note: an MSDS is **not** a COSSH assesment.

2..Material Safety Data Sheets (MSDS) supplied by chemical suppliers for all newly arrived compounds. Manufactures are required by law to supply these MSDS and must be willing to provide them for any compounds in their catalogues.

3.The University Library has a number of reference and general books on chemical reagents

Completion and Submission of COSHH.

Upon completion of the form, save a copy of the completed COSHH form to a personal PC as a *.doc file.. The standard file name should be named in the following format:

Firstname Surname : Chemical name*.doc

Once the file has been saved it must then be attached to an e-mail to the academic supervisor for review and approval. This is done so that both parties can review the cosh together.

After supervisor has reviewed COSHH he/she in turn emails the approved COSHH*.doc to COSHH@dcu.ie.

COSHH@dcu.ie is the email address that is used by technical staff to download approved COSHH forms and keep records for stores and information purposes. It also lets technical staff know that the researcher has done the

COSHH for a given chemical aganet, and that the chemical agent can be issued for chemistry stores to the researcher.

Reliable sources of Risk and Safety Numbers.

- See http://www.sigmaaldrich.com/Area_of_Interest/Europe_Home/Ireland.html. This is the best source for accessing material safety data sheets. The generic login user name is **dcuchemistry** and the password is **chemistry**

- Also see: http://en.wikipedia.org/wiki/Risk_and_Safety_Statements

- The SIGMA, ADLRICH and FLUKA chemical catalogues (R and S numbers and phrases only available)

- The Chemical Container itself. However note that in certain cases the chemical container will may give you the R number only. It may not tell you the descriptor for the R number. The warning symbols associated with the chemical will also be displayed.

Appendix 2

Safe chemical reagent waste disposal procedures as adopted in the School of Chemical Sciences:

For the purposes of disposal of waste from the School of Chemical Sciences, all waste will be treated as hazardous chemical waste, which may be harmful to human health or the environment. This waste also includes all glassware or other laboratory disposables that are contaminated by chemical reagents.

The following procedures are adopted:

-non-halogenated organic solvent waste shall be stored in appropriate safety cans in a given laboratory and are emptied when full by technical support staff. It is the duty of technical staff to transfer this waste to a purpose built chemical waste stores area which is located basement area of the Science building-(X Block).

-halogenated organic solvent waste shall be stored in appropriate safety cans in a given laboratory and are emptied when full by technical support staff. It is the duty of technical staff to transfer this waste to a purpose built chemical waste stores area which is located in the basement area of the Science building-(X Block).

- other liquid wastes may be stored in appropriately labeled glass or plastic containers. It is the duty of technical staff to transfer this waste to a purpose built chemical waste stores area which is located in the basement area of the Science building-(X Block).

- solid wastes eg. silica waste/magnesium sulfate waste is stored in appropriately labeled glass or plastic containers. It is the duty of technical staff to transfer this waste to a purpose built chemical waste stores area which is located in the basement area of the Science building-(X Block).

- miscellaneous liquid and solid waste containers can be obtained from the chemical stores room X1-64.

- glassware contaminated with residual chemical reagents eg. Pasteur pipettes, small empty reagent bottles, may be placed in yellow 'ECO SAFE' bins obtained from chemical stores room X1-64 provided that they are contaminated with trace chemical residues. Consult Risk assessment **Risk Assessment #25: Cleaning of glassware contaminated with hazardous residues- see appendix 26 this handbook**. It is the duty of technical

staff to transfer this waste to a purpose built chemical waste stores area which is located in the basement area of the Science building-(X Block).

-all chemical wastes removed from a laboratory must be labeled clearly before they are removed. All chemical wastes must be accurately catalogued before they are placed in the chemical waste storage area, which is located in the basement area of the Science building-(X Block).

-all chemical wastes must be labeled correctly before they are transferred to the chemical waste storage area.

-all chemical wastes must be catalogued accurately before they are transferred to the chemical waste storage area.

-for further advice on waste disposal contact any member of technical staff.

Appendix 3

D.C.U.- LICENSE TO DISCHARGE TRADE EFFLUENT OR OTHER MATTER TO A SEWER

Sanitary Authority: Dublin Corporation

Register Reference: **LDS 12-95; 13-95**

M.D.D. Reference: **SSS 05-92; 06-92**

Conditions for the discharge of trade effluent **Chemical**

1. The temperature of the trade effluent shall not exceed 42 degrees centigrade.
2. The pH shall lie in the range **six to ten.**
3. Over any 24hr period the mean conc. of **BOD** in the trade effluent shall not exceed 300mg/l. The max. conc. shall not exceed 400 mg/l. The total quantity of **BOD** discharged per day shall not exceed 0.9kg
4. Over any 24hr period, the mean conc. of **COD** in the trade effluent shall not exceed 500mg/l. The max. conc. shall not exceed 1,000mg/l. The total quantity of **COD**. discharged per day shall not exceed 1.5kg.
5. Over any 24hr period, the mean conc. of **Suspended Solids** in the trade effluent shall not exceed 400mg/l. The max. conc. shall not exceed 500mg/l. The total quantity of **S.S**. discharged per day shall not exceed 1.2kg.
6. The conc. of extractable oils, greases and fats **(OGF)** in the effluent shall not exceed 100mg/l. The total quantity of **OGF** discharged per day shall not exceed 0.3kg.
7. The conc. of detergents a s Methylene Blue Active substances **(MBAS)** shall not exceed 100mg/l. The total quantity of detergents discharged per day shall not exceed 0.3kg.
8. The max. conc. of any individual **heavy metal** shall not exceed 5.0mg/l. The total conc. of all heavy metals shall not exceed 10mg/l. The total quantity of each individual heavy metal discharged per day shall not exceed 0.015kg, and the total quantity of all metals discharged per day shall not exceed 0.03kg.
9. Radioactive wastes shall comply with the conditions applying in the license issued by the nuclear energy board.
10. The effluent discharge shall not contain petroleum spirits or organic solvents which would give rise to flammable or explosive vapors in the sewer.
11. The effluent shall be screened prior to discharge to the sewer to remove gross solids, which may give rise to blockage in the sewer.

SUBSTANCES WHICH MUST NOT BE DISCHARGED TO THE DRAIN

1.Certain substances are not allowed to be discharged at all. The following must be eliminated before discharge can take place:

calcium carbide (produces highly flammable acetylene on contact with water)
carbon disulphide (highly toxic and flammable)
organo halogen compounds including pesticide residues and degreasing agents.

2.The following substances known as List 1 (the Black List) are classed by the EEC as dangerous according to their persistence, toxicity and bio accumulation in the aquatic environment.

Apart from mercury, cadmium and their compounds, these substances are all either chlorinated solvents or pesticides:

mercury and its compounds
cadmium and its compounds
gamma hexachlorocyclohexane
DDT
pentachlorophenol
hexachlorobenzene
hexachlorobutadiene
aldrin
dieldrin
endrin
chloroform
carbon tetrachloride
1,2-dichloroethane
trichloroethylene
tetrachloroethylene
trichlorobenzene

3.The following substances known as Red List Substances were originally agreed as dangerous to the marine environment by Ministers representing North Sea States. The UK has since extended the list to apply to all coastal waters around the UK

substances in List 1 (see 2 above)

polychlorinated biphenyls (PCBs)
dichlorvos
1,2-dichloroethane
trichlorobenzene
atrazine
simazine
tributyltin compounds
triphenyltin compounds
trifluralin
fenitrothion
azinphos-methyl
malathion
endosulfan

Appendix 4

CHEMICAL INCOMPATABILITY GUIDELINES.

This guide is particularly useful for moving bulk chemicals from one storage location to another. Storage Groups are groups of chemicals that will not react violently if mixed together. Individual chemical reagent incomaptabilities can also be determined as per COSHH assessments for that reagent.

Storage Group identifiers (A-X) are assigned to each chemical.

Storage Group identifiers are used for:

storing solids, liquids and gases;
grouping hazardous chemicals in the same secondary containment tray, including Hazardous Waste; and
determining the appropriate re-use of empty chemical containers.

Important note: Never store chemicals from different Storage Groups in the same secondary container.

A Compatible Organic Bases, Flammables, and Poisons.

B Pyrophoric and Water Reactive Materials.

C Compatible Inorganic Bases, Oxidizers, and Poisons.

D Compatible Organic Acids, Flammables, and Poisons.

E Compatible Oxidizers, Organic Peroxides, and Acids.

F Inorganic Acids not including Oxidizing or Organic Acids.

G Non-Reactive Materials and Non-Hazardous Materials.

H Flammable or Pyrophoric Compressed Gases.

I Compatible Corrosive and Oxidizing Gases and Inert Gases.

J Poison Compressed Gases.

K Explosive or other unstable material.

L Solvents, Flammables, and Combustible Materials.

X Needs secondary containment separate from ALL groups and from each other individually.

E. INCOMPATIBLE CHEMICALS

Violent reactions may occur when the following chemicals from different Storage Groups are mixed:

Corrosives + Flammables = Explosion/Fire
Corrosives + Poisons = Poison Gas
Flammables + Oxidizers = Explosion/Fire
Acids + Bases = Corrosive Fumes/Heat

F. SECONDARY CONTAINMENT

Use secondary containment to separate incompatible chemicals where possible.

Secondary containers:
must be capable of holding any spilled material until the spill can be cleaned up;
must not be degraded by the spilled material (i.e.: the secondary container must be compatible with the hazardous material).
….should hold an absorbant non reactive spill absorbant such as Vermiculite.
….must be clearly labeled with all relevant information.

APPENDIX 5

STANDARD 'IN-HOUSE' RISK ASSESSMENTS

The following list is by no means complete and is updated as the need for additional assessments arises. The following list of risk assessments are those which are commonly used by researchers/technical staff in the School, on a daily basis.

RISK ASSESSMENT #1: USE OF FUME HOODS

Risk Category. C

The fumehood is probably the most important piece of protective equipment in the laboratory. Those in the School of Chemistry are built-in ducted fumehoods that vent to the outside through outlets on the roof. The draught in all fumehoods is routinely tested with the front sash open 500 mm and the cupboards are labeled with a fumehood velocity, depending on the flow that is found.

- Category A and B fumehoods have sufficient draught to be used safely with most gases or vapours.
- Category C cupboards are safe to use with care but it would unwise to expect them to cope fully with a massive release of a dangerous gas or vapour.
- Category D fumehoods should be used only for the release of tiny quantities of toxic substances or for the storage of toxic substances in fairly leak-tight containers.
- **Any COSHH assessment must consider the use of fumehoods as a standard safety procedure.**

Hazards

While fumehoods are designed to protect the user against hazards from other sources *e.g.* from toxic or obnoxious material or from flammable materials such as solvents, their misuse can lead to them affording less protection than expected or being hazards in their own right.

- The effectiveness of a fumehood is much reduced if they are open too wide or cluttered with apparatus which interferes with the smooth flow of air or are clogged with dirt around the vents at the back of the cupboard.
- Fumehood fans are susceptible to failure. This means that the draft also fails leaving the hood effectively useless.
- The front sash of most of the School of Chemistry fumehoods is made up of a very heavy sheet of glass . Accidents have occurred when the sash cords have broken allowing the front to crash down.

Precautions

- Keep the interiors of fumehoods tidy and ensure that the rear vents are not blocked and are free from a build-up of grime.
- Keep the front sash down as far down as is comfortable while working and closed when not actively working.
- Do not put your head into the fumehood whilst working.
- To detect and be warned of any fan failure, pin up a strip of tissue or some other visible indicator of air flow (more modern fumehoods have built in air flow warning devices).
- Examine the sash cords visually from time to time. If you see any wear on the cords or if the sash pulley seems to stuck and the cord is just sliding over it inform the SSA/ASSA. Take great care with the sash until the cord is repaired. If a cord breaks, STOP WORK IMMEDIATELY and inform the SSA/ASSA. NEVER WORK IN A HOOD WITH A BROKEN SASHCORD. A falling sash could easily shatter an arm or cause even more serious damage.

Emergency Procedures

Fan failure

- Most fumehoods are part of a bank of hoods vented by a single fan. If the flow fails in one hood it will have failed in others. Most fumehoods also now have notices pinned to them indicating the fan number and the location of other hoods on the same fan. Follow the instructions outlined on the notice and inform other users, Buildings (ext. 5362) as appropriate.
- If your fumehood has its warning notice turned over, do not attempt to use it until you are told that it is safe.

Sash Cord Failure

- Stop work, turn over your warning notice, and inform the SSA.
- NEVER WORK IN A FUMEHOOD WITH A BROKEN SASHCORD.
- DO NOT ATTEMPT TO LOWER A SASH WITH A BROKEN CORD BY YOUR SELF.
- GET COMPETENT HELP.

Training Requirements

Although the use of fumehoods is part of the training of most Undergraduate Chemists, newcomers to the School of Chemical Sciences should be instructed in the specific local rules.

Level of Risk Remaining

Slight if the outlined procedures are followed.

RISK ASSESSMENT #2: USE OF GLASSWARE

Risk Category D

Hazards

- Cuts from damaged or broken glass
- Cuts from flying glass due to explosion, implosion following pressurisation, evacuation, mechanical shock or stress
- Cuts from forcing plastic tubing, teats or rubber bungs onto glass tubing, pipettes or condensers that break.
- Cuts from broken glass and sharp items e.g.. Pasteur pipettes disposed in ordinary waste bins.
- Burns from heated glass
- Poisoning following cuts by contaminated glassware.

Precautions

- Before use, check that all glassware is free from cracks, flaws or scratches that may cause it to fail in use.
- Have damaged glassware repaired or dispose of it in the "Broken Glass" bin. Do not use the ordinary waste bins. Use a brush and dustpan to clear up broken glass. Be especially careful when clearing broken glass from a sink where water can make sharp edges invisible. Use tongs to pick out pieces.
- Dispose of glass "sharps" in the proper containers and not in the ordinary waste bins.
- When fitting tubing to glassware, lubricate the glass with water or glycerol and soften the plastic tubing by brief immersion in hot water. Do not use excessive force. Do not exert force in a direction that will make the glass snap. Think about where the sharp edge of the glass might go if it does break and arrange your grip accordingly. Wrap the glass in a towel or thick layers of paper tissue. When removing tubing, use a sharp knife to cut off tubing that does not yield to gentle pressure.
- Take care with hot glass (which looks the same as cool glass). Place hot glass where no one can accidentally come into contact with it before it has cooled.
- **Joints and stoppers.** Lubricate ground glass connections before assembling and disassemble them immediately after use. Do not stopper hot flasks or container. If a stopper seizes, do not reheat the container to remove it.
- **Vacuum or pressure use.** Glassware subjected to either pressure or vacuum should be carefully inspected for flaws before use.
    - **Pressure:** Use only special glassware rated well above the pressure to be used. See the separate Risk Assessment appropriate to the task for other details of shielding and procedure.
    - **Vacuum:** For glassware under vacuum, volumes of 1 liter or larger should be enclosed in tape or plastic mesh to restrain fragments in the event of implosion. This applies to equipment such as vacuum storage bulbs, rotary evaporators, vacuum desiccators etc. See the Risk Assessments "Use of Reduced Pressure or Vacuum".
- **Washing.** Detergents are the normal means of cleaning glassware. However, in the case of glassware badly contaminated with reagent residues, a pre-wash with solvent/dilute acids or bases may be more appropriate. In the case of glassware being contaminated with lachrymator/noxious smelling reagents, pre-wash in a fumehood with a suitable solvent and allow that glassware to air dry in the fumehood. The washings can then be transferred to a suitable waste receptacle. Beware of fire risk if using solvents to clean or dry glassware. **Under no circumstances should glassware contaminated with these reagents be washed outside a fumehood.**
  Under no circumstances should you endanger glassware cleaning staff by submitting glassware for cleaning that is badly contaminated with reagent residues. For more precise instruction on cleaning glassware see Risk Assessment 25 –Appendix 5 of this handbook.

Seek advice from the SSA/ASSA/technical staff if in doubt about glassware cleaning. More drastic methods such as the use of chromic acid and if so, should be used only when cleaning with detergents or solvents is inadequate and should be covered by a thorough Risk Assessment.

Avoid using concentrated acid baths to clean glassware as much as possible. If using acid/alkali baths is the only solution to washing glassware, use in small quantities and ensure proper secondary containment for these baths.

Training

The safe use of glassware is part of Undergraduate training.

Remaining Risk

Cuts from broken glass or the misuse of glass remain amongst the commonest form of injury in the School of Chemical Sciences. Great care is always required.

Emergency Procedures

Always treat cut and burns immediately. Apart from very minor injuries, call for First Aid treatment. In the event of serious injury, follow the procedure "Aiding an Injured Person" described in the School of Chemical Sciences Safety Handbook.

RISK ASSESSMENT #3: USE OF STANDARD ELECTRICAL EQUIPMENT

Risk Category. C

Laboratory supply of mains electricity is *via* individual socket outlets which may be 3-pbase 415 V, 50 Hz, or single-phase 240 V, 50 Hz. Office supplies are normally 240 V, 50 Hz. Most electrical equipment operates on 240 V, 50 Hz.
A very wide range of electrically powered equipment is found in the laboratory including fluid and vacuum pumps, lasers, power supplies, electrophoresis and electrochemical apparatus. X-ray equipment, stirrers, hot plates, ovens both conventional and microwave and computers, printers and VDU equipment. In the office, there are, amongst other things, computer equipment, FAX machines and photocopiers. In the lecture theatres there are overhead and slide projectors. In fact, everyone in the School of Chemistry is exposed at some time to electrical equipment.

Hazards

- Electric shock is the effect produced on the body and particularly on the nervous system by an electrical current passing through it. The effect depends on the current strength which itself depends on the voltage and body resistance *i.e.* path length and surface resistance of skin (which is much reduced when wet). Death can be the result of the normal voltage of 240 V causing currents of greater than 30 mA to flow through the body for more than 40 ms. Minor shocks may also cause injury following involuntary muscle contraction.
- Burns caused by the passage of heavy currents through the body or by direct contact with an electrically heated surface.
- Explosion and fire caused by electrical sparks, short circuits or overload heating, old wiring in the presence of flammable material.
- Injury from microwave and radio-frequency sources and from induction heating equipment.

Precautions

These precautions are not meant to be exhaustive or to cover aspects of repair or construction of electrical equipment, but to cover everyday use in the laboratory and office.

Plugs and fuses

- **Do not use plugs that are cracked or broken. Ensure that the plugs are wired properly, that conductors are securely fixed and that the cable is firmly held by the strain relief grip. If in doubt- consult any member of technical staff.**
- Ensure that the rating of the fuse is appropriate to the appliance. Most electronic equipment (computers, measuring instruments *etc.)* requires only a 3 A fuse, which will load to 720 W. Reserve 13 A fuses (loading to 3000 W) for heavier equipment. Consult with technical staff.

Cabling

- Ensure that the cable is in good condition and free from breaks in the insulation. Cable must be sufficiently robust to withstand the wear and tear of laboratory or office use and fully waterproof where water may come within the vicinity of the apparatus.
- Cables must not be run across the floor in such a way as to cause a tripping hazard or to be susceptible to damage from passing traffic. If it is necessary to run cables across walkways, cover them with cable protectors.

Extensions

Do not daisy-chain extension leads. Kettles, microwaves and heaters that have higher power demands must not be used on such an extension but must be fed from an installed socket point. Consult technical staff.

Mains Switch

Make sure you know where the mains switch is so that you can turn off power in an emergency.

Use

- No apparatus with exposed mains terminals should ever be used.
- Do not use ordinary electrical equipment in the vicinity of flammable or explosive gases. Ordinary electrical equipment could be a source of ignition.
- Likewise do not use ordinary electrical equipment where it may get wet. Water may cause a dangerous short circuit.
- Never switch on equipment that has had liquid spilt on it until the equipment has been tested. Tell anyone to whom you take the equipment for testing what has happened.

Repairs

- Do not attempt to repair electrical equipment. Consult technical staff.
- Ensure that the equipment is disconnected from the main power.
- If in doubt, send equipment to manufacturer for repair, or serviced by qualified person eg. Registered electrician.

Testing

Before embarking on more sophisticated electrical work such as building your own equipment you should read reference advice on "Electrical Safety" paying particular attention to the regulations regarding the proper insulation of conductors and the earthing of apparatus. Custom built apparatus will be subject to a detailed Risk Assessment Experimental Method where necessary. Also consult with the School of Electronics or Buildings Office where necessary.

Training

The use of electrical equipment is part of the day to day routine for every person. However, in the case of electrical work this must be carried out by qualified electricans- techcncial staff who have been trained in this area.

Risk Remaining

Mains electricity will always remain a potentially lethal hazard if mishandled. Following the precautions outlined above, the risk remaining should be minimal.

Emergency Procedure

Electric Shock.

- Switch off the power before touching the injured person. Follow the procedure given in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency”.

Fire.

- Follow the procedures given in the School of Chemical Sciences Safety Handbook. Never use water on an electrical fire.

RISK ASSESSMENT #4: THE TRANSPORT AND USE OF COMPRESSED GAS CYLINDERS

Risk Category. C

Hazards

- Pressurised gas cylinders are very heavy and unstable objects and as such can present considerable danger to those handling them.
- They contain gas which may be toxic, asphyxiating or flammable and at high pressure.
- Apart from the chemical risk from these gases, serious physical damage can be caused by exposure to the full force of escaping gas.
- Gas cylinder valves are very robust but a broken valve can turn a cylinder into a lethal projectile.
- Gas pressure regulators are much less robust and if damaged may allow the escape of gas.

Risk

For an untrained person, the most probable source of injury is from incorrect fitting of the pressure regulator allowing the escape of gas (likely) or from a falling cylinder (unlikely). Resulting injuries may be moderate to severe.

Who is likely to be injured?

A falling cylinder or exposure to high pressure gas is likely to injure only the user of the cylinder however if equipment is blown apart by excessive pressure or toxic or asphyxiating gases escape the damage may be widespread within a laboratory or beyond.

Control Measures

Physical: Cylinder trolleys to be supplied for transport Secure racks for storing.
Training: Newcomers must attend Training/Induction at the beginning of the Session.
P.P.E.: Safety glasses or face shield should be worn when locating or removing the pressure regulator and when opening the spindle valve.

Operating Precautions

- Ensure that the cylinder contains the expected gas (check the label).
- Transport the cylinder on an approved .
- Make sure the cylinder is firmly secured in an approved location. CYLINDERS MUST NEVER BE LEFT FREESTANDING.
- Check the Pressure Regulator. Is it designed for the gas you are using? Check the pressure rating. Is it capable of coping with the pressure in the cylinder? Is the regulator marked with a red line to indicate the maximum pressure to be applied to the experimental apparatus?
- Never use oil or grease especially on an Oxygen cylinder: - the oil or grease may ignite - and do not use PTFE tape to attempt to seal leaks.
- Turn the regulator to zero before opening the valve at the spindle and when finished, close the valve at the spindle.
- **NEVER** transport a cylinder with its regulator in place.

Remaining Risks

These should be slight if the precautions outlined above are followed.

Emergency Procedures.

- Escape of gas: If the gas escape is large follow the procedure describes in the School of Chemical Sciences Safety Handbook for the escape of toxic material: remember even an inert gas can kill by asphyxiation. For small non-toxic leaks, inform a member of staff, ventilate, evacuate, seal and secure the room.
- Falling cylinder: If a cylinder falls over, NEVER attempt to catch it. It is much too heavy and will cause you serious injury. It is also very robust and is unlikely to be damaged although it may make a loud noise. Do not attempt to upright it by yourself. Get competent help.

References

http://www.bocgases.ie/product_catalog/Safety_Documentation,305,0.html
Refer also to the Risk Assessment: Use of Flammable, Explosive or Toxic Gases

RISK ASSESSMENT #5: USE OF HIGH POWER MICROWAVE AND RADIO-FREQUENCY POWER SUPPLIES

Risk Category. C or Bu

Activity being assessed:

Use of high power Microwave (MW) and Radio Frequency (RF) power supplies, for plasma generation, heating, *etc.*

Hazards

i. Biological heating and cooking (!) effects of MW and RF radiation, especially to eyes *(e.g.* cataract formation), and other soft tissues.
ii. Electric shock and burns (these may be different from, and far more serious, than the types of burns caused by conventional electrical supplies).
iii. High temperatures associated with high power equipment.

Precautions

Ensure equipment is properly:

i. Screened and shielded. Use an emission monitor to check that emitted MW power is <5mW cm^2 @ 5 cm. For RF emission, a good rule of thumb is if any LED or LCD displays in the lab start flickering they are being affected by excessive RF output, and the power supply or leads need more shielding. Note that at this level of interference, other sensitive electronic equipment may be adversely affected - with corresponding safety implications. For example, mass flow controllers that are monitoring (toxic, explosive...) gases are particularly susceptible to RFI, and can give incorrect readings or be fully open/off without the user being aware of this.
ii. Cooled. If water-cooling is used, ensure water connections are fitted correctly with no chance of leakage onto the power supply.
iii. Earthed. The casing of all power supplies MUST be earthed, and all electrical leads must be shielded with coaxial cable.

Training Requirements

Training by an experienced person is essential.

Risk Remaining

The handling of MW and RF power supplies will always have some degree of risk and constant vigilance is required in their use.

Emergency Procedures

Shut off power supply; seek medical aid if necessary.

RISK ASSESSMENT #6: LASER WORK IN A LABORATORY

Risk Category: Bu or Bp

Known or Expected Hazards

- **Eyes: The entry of even a very weak laser beam into the eye can cause partial or complete loss of sight in that eye. The risk is present even for stray reflections off optical surfaces and it is such stray reflections that have caused serious incidents in the past**
- **Skin: Ultra-Violet lasers can burn and induce cancer (as for sunburn). The more powerful lasers of any wavelength can burn the skin.**
- **Most primary lasers use high currents and voltages internally so following the manufacturer's instructions for any maintenance procedures is important**

Measures to reduce the level of risk

- Use the lowest laser *output* possible.
- Totally enclose the laser system or use shields to constrain the laser beams.
- Wear laser-blocking goggles.
- Clearly designate and restrict access to the laser area (particularly anywhere in the line of sight) to laser trained personnel.
- Ensure laser beams (including stray reflections) constrained to one level (well below eye level).
- Remove all reflective surfaces from laser area (including wristwatch faces and similar objects); securely mount all optics.
- Follow proper procedures when aligning laser beams.
- The School Laser Officer must be notified of all class H and above lasers.

Training Prerequisite

Laser work, except with class I lasers, is in risk category B, so NO LASER WORK WITH CLASS II AND ABOVE LASERS MAY BE UNDERTAKEN UNTIL THE WORKER IS SUITABLY TRAINED. All users of class III lasers and above must be registered with the School Laser Officer before starting work and the CVCP booklet (see references) should be read. The faculty Laser Safety Adviser can advise on the training required appropriate to the proposed laser use. He can also advise on the class of any laser if the worker is unsure.

Level of Risk Remaining

It is not possible to remove the risk entirely for some laser work, but the risk is low if the taught procedures are followed.

Emergency Action

Switch off laser; seek medical advice if eye damage is known or suspected.

References

See SAFELAB MODULE 2- Laser safety at:
http://www.dcu.ie/science_and_health/safety_info_pres.shtml

RISK ASSESSMENT #7: USE OF REDUCED PRESSURE OR VACUUM

Risk Category: C

Glassware

Hazards

Implosion and flying glass leading to cuts and lacerations. Any piece of glassware under vacuum *e.g.* rotary evaporators, vacuum desiccators, Schlenk lines and storage bulbs on vacuum lines have the potential to do harm following implosion.

The energy imparted to flying fragments is directly proportional to the volume of the glass vessel evacuated. It follows that the potential to do harm is also directly proportional to the volume of the glass vessel and a rotary evaporator with its associated flasks is a greater hazard than a small Schlenk tube.

It is a common misconception that so called "high vacuum" (typically 10^{-3} mbars or better) systems present a significantly greater hazard than everyday vacuums produced by *e.g.* a water pump (around 30 mbars). These may differ by four orders of magnitude but the forces to which the glassware is subjected is essentially the same *i.e.*

- High Vacuum, 99.999% of atmospheric pressure.
- Water Pump, 97% of atmospheric pressure.

Precautions

- Lab coats and glasses should be worn. In certain circumstances *e.g.* when introducing liquid nitrogen or other cryogenic material or when warming storage tubes from low temperature, a facemask and gloves should be worn.
- Use only glassware that is suitable: conical flasks, except the heavy walled Buchner type flasks should **never** be subjected to a vacuum.
- Check that glassware is free from chips, cracks or flaws that would make it unsafe to use. Particular care should be taken to spot any star cracks.
- Volumes of 1 liter or larger should be enclosed in tape or plastic mesh to restrain fragments in case of implosion.Schlenk lines and tubes are generally of small volume and are quite robust in nature and do not require extra protection in the shape of tape or plastic mesh.
- Glass dewars should be fully wound in tape or preferably enclosed in a metal container.
- See the Risk Assessments ‘Use of Glassware and Handling’ and ‘Transportation and Storage of Liquid Nitrogen and other Cryogenics’.

Metal Vacuum Systems

Hazards

There are fewer hazards in handling metal vacuum systems due to the very unlikely risk of implosion.

House Vacuum

Water, solvents or corrosive gases should not be allowed to pass into the building vacuum system, as much as possible! When a potential for such a problem exists, a trap must be inserted between apparatus and the vacuum inlet.

Pumps

Hazards

Vacuum pumps are of various kinds. The most common are oil rotary pumps and oil (or more rarely mercury) diffusion pumps of glass or metal. Turbomolecular pumps are also used but apart from being electrical equipment, these present little danger being totally enclosed.

- Vacuum pumps are electrically powered apparatus.
- Belt driven rotary pumps present danger of entrapment in the moving belt and pulley wheels.
- The exhaust of rotary pumps may be contaminated chemically but will also contain an oil mist from the pump itself.
- There is a danger of explosion if the exhausts of rotary pumps that are pumping large volumes of air or other gas are blocked or obstructed.
- Diffusion pumps are heated to boil the pumping liquid and so present a risk of burns.
- Glass diffusion pumps are vulnerable to breakage and if these contain mercury the danger of mercury contamination is great.

Precautions

- The usual precautions must be taken when using electrical equipment.
- Rotary pumps must have belt guards to prevent entrapment.
- A trap (either a cold trap or molecular sieve) should be used between system and pump to prevent contaminants reaching the pump oil or being exhausted into the laboratory.
- The exhausts of rotary pumps must be free from obstruction.
- Exhaust lines must be vented to a fume hood by tubing of large enough cross section not to cause obstruction.
- Where possible mercury diffusion pumps should be replaced by oil versions. Mercury pumps must have secondary containment.
- The boilers of diffusion pumps must be shielded to prevent burns by contact.
- Diffusion pump fluids may be subject to a COSHH Assessment.

Pump Maintenance, Changing Oil

Pump maintenance including oil changes may be carried out by users themselves or by a member of the technical staff assigned that duty.

Hazards

Pump oil possibly contaminated with solvents, mercury, corrosive or obnoxious substances.

Precautions

- As far as possible, pump oil should be drained with the pump in a fume hood.
- Wear gloves and a lab coat.
- If there is any suspicion of contamination, treat the oil as hazardous waste.
- Waste oil should normally be taken to the technician in charge of pump maintenance for disposal.

- Pumps left for service by technical staff should bear a warning about possible oil contaminants.

Pressure Gauges

Hazards

Vacuum pressure gauges are mainly of two kinds *i.e.* the manometer or McLeod Gauge type, which are made of glass and contain mercury or some other liquid, and electrical devices, which measure pressure dependent properties such as thermal conductivity or ionisation current.

- Danger from glass apparatus and possibly mercury.
- Electrical equipment.

Precautions

- Glassware gauges should be treated as indicated above under "Glassware".
- Secondary containment must be used around systems that contain mercury.
- Where possible, mercury should be replaced by some other less hazardous fluid.
- Manometer fluids may be subject to a COSHH Assessment.
- The usual precautions must be taken when using electrical equipment.

Leak Testing

Hazards

Leak testing or searching for leaks in vacuum systems has often been done by spraying likely areas with solvent (acetone) and watching for pressure changes. The dangers here are obvious especially from flammable liquid in the vicinity of hot diffusion pump boilers. This method is to be strongly discouraged. Instead, use a stream of helium gas directed by Pasteur pipette onto likely areas.

Use of a Spark Tester (Tesla Coil)

These are devices used to test for pinhole leaks in glass vacuum systems but also for testing insulating coatings, removing deposits from insulators and exciting discharge lamps. They consist of an electrode that carries a (usually variable) high voltage (10-50 kV) with a frequency of around 200 kHz.

Hazards

Electric shock from high voltage, ignition of solvent, shattering of glass vacuum system.

Precautions

Do not touch the discharge electrode end when the coil is operating and never point the electrode at another person.
Use the coil on the lowest setting possible.
Never use the spark coil in the vicinity of flammable liquids or gases. Take care if acetone has been used for cleaning taps.
Always wear safety glasses when leak testing.

Training

The use of glassware under vacuum or reduced pressure is part of undergraduate chemistry training. For more advanced vacuum systems, a person competent and experienced in their use should instruct users.

Remaining Risk

This is slight if the precautions outlined above are followed. However, glass systems remain more dangerous than metal systems because of the possibility of implosion.

Emergency Procedures

In the event of injury or fire follow the procedures outlined in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency".

References

See the associated Risk Assessments:

- Use of Glassware
- Handling, Transportation and Storage of Liquid Nitrogen and Other Cryogenics.
- Use, Handling and Clean-up Procedures for Mercury.

RISK ASSESSMENT #8 AND CHECKLIST: VISUAL DISPLAY EQUIPMENT

Risk Category. C

Introduction

The **Display** Screen **Rules** apply to all **display screen equipment** fitted at **workstations** operated by **users.**
Display Screen Equipment (dse): any alphanumeric or graphic display system including non-electronic systems such as microfiche readers.

Workstation: Computers, disk drives, modems, office furniture, *etc.* in the immediate work environment of the display screen equipment.

User: an employee who habitually uses dse for a significant part of his/her job. Thus a person may be classified as a user if some or all of the following circumstances apply:

a. The individual depends on the use of dse to do his/her job, there being no alternative means.
b. The individual has no discretion as to the use or non-use of the dse.
c. The individual needs particular skills in the use of dse.
d. The individual normally uses dse for continuous spells of an hour or more at a time.
e. The individual uses dse daily.
f. Fast transfer of information between the user and the screen is important
g. High levels of attention and concentration are demanded of the user.

It can be seen, especially with regards to items c), d), e) and g) that within the School of Chemical Sciences, there are Office Workers and Research Workers who fall within the definition of "user" and to whom the rule applies. Research Workers who can be defined as "users" are most likely, but not exclusively, to be found in the Physical/Analytical Section.

The Display Screen Rules require employers to carry out an assessment of workstations and to remedy any shortcomings that are identified. New workstations installed after 1st Dec. 1998 must meet the standards described below and it is advised that all existing workstations must be updated by 1st Dec. 1999.

Lighting, Glare and Reflection and Noise

These are general office specifications but apply also to workstations. The requirements are for adequate but not excessive lighting, avoidance of glare or reflection from windows and reasonable levels of noise. (For these and other requirements outlined below, more detailed specifications are contained in the University Code of Practice on Office Safety and VDU Use.)

Display Screen Equipment

The display screen itself must be able to be positioned and angled for comfortable viewing.

Chairs and Desks

Chairs should have a base with at least five castors (star wheeled) for stability and easy movement, should be able to swivel easily and be adjustable in height and in back support. Desks should have adequate surface area to accommodate equipment and documents, manuals *etc.*, be of appropriate height and have sufficient leg/knee space.

Keyboards

The position of the keyboard on the desk should be such as to allow 100mm in front of the keyboard. Keys should be clearly marked.

Footrests

These may be appropriate depending on the physical stature of the user.

Floor

The floor covering should be such as to allow the wheels of the chair to move freely.

Hazards:

- Repetitive Strain Injury (RSI) a musculo-skeletal disorder, the symptoms of which include pain, swollen soft tissue, restricted joint movement, loss of function and possible permanent disability. Users of keyboards who are not trained typists are more susceptible to such problems.
- Eye Strain: Evidence indicates that using dse is not associated with damage to the eyes or eyesight although uncorrected defects can increase the stress of working with such equipment.
- Fatigue and stress.

Precautions

- Avoidance of RSI. Good economically designed seating arrangements and posture when using the keyboard or mouse. Frequent breaks either resting the fingers and wrists or carrying out alternative work provided it does not involve the use of the joints in a manner similar to keyboard use. Further details are given in the Note of Guidance "Computer Related Repetitive Strain Injury" and in the University Code of Practice referenced below.
- Eye strain. If defective vision is suspected, users are entitled to vision screening and full eyesight test if necessary. If prescribed for VDU work, basic spectacles can be supplied but remain the property of the University.
- Fatigue and stress can be reduced by providing a sympathetic working environment. Computer programs should be as far as possible "user friendly" and allow for the recovery of errors. (It is recognised that this will not always be possible in research work but it should be a major consideration in office computing.)

Training.

See http://www.dcu.ie/safety/office.shtml

RISK ASSESSMENT #9: USE OF ULTRAVIOLET LIGHT SOURCES

Risk Category. C

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Hazards

Two categories of hazard are involved in the use of UV lamps used in experiments: those inherent in the radiation itself and those associated with operation of the lamps. All radiation of wavelength shorter than 250 nm should be considered dangerous.

- Damage to eyes and skin caused by exposure to UV radiation.
- Burns caused by contact with a hot UV lamp.
- Fire ignited by hot UV lamp.
- Interaction of other nearby chemicals with UV radiation.
- Damage caused to apparatus placed close to UV lamp.

Precautions

Lab-coats, gloves and safety glasses or other appropriate eye/skin protection such as UV protective glasses or a UV protective face shield must be worn.
Sources of UV should as far as possible be contained in a closed radiation box.

Reactions using UV lamps

- **An untrained person must never attempt these operations.**
- **A single person must never attempt these operations.**
- **These operations must never be attempted out of normal working hours.**
- **Use of UV lamps must be carried out in the vented cabinets provided in the photochemistry laboratory.**
- **The vented cabinet doors must remain closed while the UV lamp is switched on.**
- **The vented cabinet must contain only the UV lamp and associated apparatus and chemicals. No other chemicals are to be stored in the vented cabinet and no other reactions are to be performed in the vented cabinet.**
- **Care must be taken with flammable solvents to avoid excessive heating.**
- **Flammable equipment *(e.g.* rubber tubing) must be positioned at least 10 cm away from the lamp.**
- **After the UV lamp is switched off, unless the reaction mixture requires immediate attention, the vented cabinet should remain closed for 30 minutes to allow the UV lamp to cool.**

Visualisation using UV lamps

When using UV lamps for visualisation of TLC plates, treat with similar caution, although many of the above requirements obviously do not apply.

Training

New users must be trained by another member of the laboratory who, in the opinion of the member of staff in charge of the laboratory, is sufficiently competent to give instruction on the correct procedure. A competent person should oversee newly trained users for some time.

Level of Risk Remaining

Low if the above Precautions are followed. The risk remaining is of burns from hot equipment.

Emergency Procedures

Fire or injury: Follow the procedures outlined in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency".

RISK ASSESSMENT #10: USE OF LABORATORY HEATING EQUIPMENT

Risk Category: C

The equipment considered in this Risk Assessment includes laboratory ovens, Bunsen burners, heating plates and mantles, steam oil and sand baths and hot air guns *i.e.* temperatures up to 800°C. A separate Risk Assessment must cover the use of very high temperatures, furnaces, experimental rigs etc..

Hazards

Personal injury and burns from hot surfaces, liquids, vapours or flames.
Sources of ignition both from hot surfaces, liquids, flames, and from electrical components.

Precautions

Many heating appliances contain electrical elements (see the separate Risk Assessment Use of Standard Electrical Equipment). If any heating device becomes so worn or damaged that the heating element is exposed, then the device should be immediately taken out of service.
All heating devices (apart from steam baths) must be kept well away from flammable material.

Ovens

- With the exception of vacuum drying ovens, laboratory ovens rarely have any means of preventing the discharge of material volatilised within them. Thus it should be assumed that these substances will escape into the laboratory atmosphere but may also be present in sufficient concentration to form explosive mixtures within the oven itself. Venting the oven to an exhaust system may reduce this hazard.
- Ovens should not be used to dry any chemical sample that has even moderate volatility and might pose a hazard because of acute or chronic toxicity unless the oven is constantly vented to a safe exhaust.
- Glassware rinsed in solvent poses a danger of explosion if dried in a non-vented oven.

Bunsen Burners

- Bunsen burners are used less and less in laboratories. The naked flame is liable to set off the fire alarm system if set in the line of sight of a flame detector. If used, be careful to shield the flame from the detector.
- The naked flame is a particularly hazardous ignition source and must never be used near open containers of flammable liquid or in environments where appreciable concentrations of flammable vapour may be present.
- A Bunsen flame may be difficult to see in bright sunlight. Pull blinds to shade the flame.

Hot Plates, Heating Mantles

- Check the state of the heating element. If the covering is broken or worn do not use it. If water or other liquid has been spilled onto the element, have the equipment electrically checked before use.

Steam, Oil and Sand Baths

- Take extreme care to mount the baths in such a way that they cannot be overturned or that water cannot fall into an oil or sand bath causing hazardous splattering. **For oil baths, use secondary containment to restrain any possible spills.**
- Remember oil expands in volume when heated: - do not overfill.

- Material heated in such a bath should be mounted in such a way that it can be quickly and easily removed from the bath in an emergency.
- Oil must not be overheated so that it smokes or decomposes or is in danger of ignition.
- Ensure proper labeling which identifies the oil and its safe working temperature.
- Pay attention to the following: -
  the size and location of the bath,
  operating temperature and temperature control devices,
  the type of oil used,
  available ventilation,
  the method of cooling hot oil,
  storage of oil for reuse,
  proximity of water or chemicals.
- Steam baths present a danger of scalding from hot steam and care must be taken especially when mounting or removing reaction vessels.
- In all cases, when using such apparatus, proper protective equipment must be worn *i.e.* laboratory coat, safety glasses, and gloves.

Hot Air Guns

- Laboratory hot air guns contain an electrically heated element that typically glows red-hot. Also, the on-off switches and motors are rarely spark free. For these reasons, hot air guns present as serious an ignition hazard as a naked flame and must never be used near open containers of flammable liquid or in environments where appreciable concentrations of flammable vapour may be present *e.g.* over glassware rinsed in solvent.
- The air emerging from a heat gun is very hot indeed and is invisible and so the front end should be treated with all the respect due to a blowtorch.

Training requirement

The use of some of these heating devices *i.e.* steam baths, Bunsen burners, hot plates and heating mantles is part of Undergraduate training. In the remaining cases, training should be given by a competent person.

Level of Risk Remaining

With the proper training, the level of risk is low although constant vigilance is necessary to avoid injury and possibly serious burns.

Emergency Procedure

Personal injury, burns. Follow the procedure outlined in the School of Chemical Sciences Handbook under the heading "Aiding an Injured Person".

Fire or Explosion. Follow the procedure outlined in the School of Chemical Sciences Handbook under "Coping in an Emergency".

References

See the Risk Assessment. "Use of Standard Electrical Equipment".

RISK ASSESSMENT #11: USE OF LABORATORY CENTRIFUGES, ESPECIALLY HIGH SPEED, SUPERSPEED AND ULTRACENTRIFUGES IN CHEMISTRY LABORATORIES

Risk Category. B

Definitions

- Laboratory centrifuge: An apparatus used in the laboratory for separating substances of different density or particle size, when suspended in a fluid, by spinning them about an axis in a suitable container.
- Rotor: Primary component of a centrifuge which holds the material to be subjected to centrifugal force (in some form of tube/container) and which is rotated by the drive system.

Hazards

- Mechanical failure of rotating parts (often violent).
- Contact with rotating parts.
- Sample leaks causing aerosols, stress corrosion, contamination.
- Sample imbalance causing machine movement / walking (or stress failure of component parts).
- Fire or explosion.
- Health (contact with contaminated components / vapours).

Operation

- **Only suitably trained persons may operate a centrifuge.**
- **Where necessary, the machine logbook must be filled in (a logbook must be kept for ultra centrifuge rotors as the hours run determine the life of the rotor).**
- **Before use the rotor, its lid and seals must be examined for cleanliness and damage (a build-up of chemicals from spillages may cause a tube to jam in the rotor or cause corrosion that could lead to a rotor failure). Damaged rotors must not be used and should be reported to the Supervisor, dirty rotors must be cleaned by the approved method, (see rotor care).**
- **Never fill centrifuge tubes above the maximum recommended by the manufacturer, (see manufacturers catalogue).**
- **Never exceed the maximum stated speed for any rotor.**
- **Derate the rotor speed whenever-**
    - **a. the rotor speed/temp combination exceeds the solubility of the gradient material and causes it to precipitate,**
    - **b. the compartment load exceeds the maximum specified.**

  Failure to reduce rotor speed under these conditions can cause rotor failure.
- **Balance the rotor to within the limits specified (take care that materials of similar densities are in opposite positions of the rotor).**
- **Do not operate the centrifuge without the appropriate rotor cover securely fitted and its seals in place.**
- **Check compatibility of tube material to solvent medium (some solvents may cause the tubes to swell or crack in the rotor).**
- **Use only correctly fitting tubes.**
- **Clean up spillages immediately (use appropriate PPE if necessary).**

- **Do not use chemicals that are explosive, highly flammable or have vigorous chemical interaction without observing the appropriate safety Precautions to minimise risk of vapour build-up.**
- **Never attempt to open the lid of a centrifuge or slow the rotor by hand or open the lid while rotor is in motion as serious injuries may be incurred.**
- **Only authorised and suitably trained persons may service or repair a centrifuge, report all faults promptly, do not attempt repairs yourself. Do not use the centrifuge until the fault has been inspected or repaired.**

Rotor Care

- Stress corrosion is thought to be initiated by certain combinations of stress and chemical reaction. If the rotor is not kept clean and chemicals remain on the rotor, corrosion will result. Also, any moisture left for an extended time can initiate corrosion. It is important that the rotor is left clean and dry. Wash with mild detergent and warm water, careful use of a nylon bottlebrush when necessary. Dry the rotor thoroughly and store upside down with the cover and tubes removed.
- Do not autoclave at temperatures above 100°C.
- Do not expose aluminium rotor components to strong acids or bases, alkaline lab detergents or salts (chlorides) of heavy metals *(e.g.* cesium, lead, silver or mercury). Use of these can initiate corrosion.

Pre-run safety checks

- Make sure each tube compartment is clean and corrosion free.
- Make sure the rotor itself is clean, corrosion and crack free and that there are no scratches or burns around its rim.
- Check that the centrifuge chamber, drive spindle and tapered mounting surface of the rotor are clean and free of scratches or burns.
- Wipe drive surfaces prior to installing the rotor.
- If the temperature of the chamber is below room temperature, pre-cool the rotor to the lower temperature before securing the rotor (this will minimise the chance of it seizing to the tapered spindle).
- Make sure that any rotor lid securing device and any rotor to spindle securing device is fully secured before starting the machine.

Training

All new users of centrifuges must be trained by a competant person (who may be an appropriately qualified or experienced member of staff) before attempting to use a centrifuge.

Level of Risk Remaining

Centrifuges are potentially lethal pieces of equipment and care and vigilance need to be exercised at all times. Following the procedures outlined here will reduce risk to a low level.

References

- BS 4402 1982 Safety requirements for laboratory centrifuges.
- BS 7687 1993 section 2.20 specification for lab. centrifuges.
- Institution of Chemical Engineers. *User guide for the safe operation of centrifuges.*
- Beckman. *Principles and Practices of centrifugation* (video).

RISK ASSESSMENT #12: USE OF A POTENTIOSTAT

Risk Category: C or Bu

The use of potentiostats in the laboratory involves the application of potentials and the consequent passage of currents through solutions of electrolytes and as such the risks associated with the combination of an electrical appliance and a conducting fluid medium are always present. In many cases the potentiostat is computer driven and controlled, hence the positioning of this second electrical appliance must be evaluated. The use of conducting solutions of ions, many of which are transition heavy metal ions and whose solutions often need degassing, require the operator to be familiar with the relevant COSHH data and the use of and/or conveyance of compressed gas cylinders.

HAZARDS

The main hazards are those encountered in the use of any electrical appliance but with the added complication of the presence of electrochemically active solutions namely:

- The cell design incorporates non-insulated contact points, as well as exposed electrode surfaces hence electric shock is a major risk. Electric shock is the effect produced on the body and particularly on the nervous system by an electrical current passing through it. The effect depends on the current strength which itself depends on the voltage and body resistance *i.e.* path length and surface resistance of skin (which is much reduced when wet). Death can be the result of the normal voltage of 240 V causing currents of greater than 30 mA to flow through die body for more than 40 ms. Minor shocks may also cause injury following involuntary muscle contraction.
- Burns caused by the passage of heavy currents through the body.
- Explosion and fire caused by electrical sparks, short circuits or overload heating, old wiring in the presence of flammable material.
- The by-products of many electrochemical reactions are gaseous and occur in the confined volume of the cell. As a consequence injury from flying glass and other debris as well as the possible injury and contamination from the reaction media during an explosion exists.
- Electrochemical cells are designed to be opaque and glass is predominantly the preferred fabrication material hence cuts from damaged or broken glass and poisoning following cuts by contaminated glassware is possible.
- The degassing of solutions prior to electrochemical investigation with an inert gas is a frequently employed operation.
  As such:
  Pressurised gas cylinders are very heavy and unstable objects and as such can present considerable danger to those handling them.
  They contain gas which may be toxic, asphyxiating or flammable and at high pressure.
  Apart from the chemical risk from these gases, serious physical damage can be caused by exposure to the full force of escaping gas.
  Gas cylinder valves are very robust but a broken valve can turn a cylinder into a lethal projectile.
  Gas pressure regulators are much less robust and if damaged may allow the escape of gas.
- The hazards associated with the use of computers include:
  Repetitive Strain Injury (RSI) a musculo-skeletal disorder, the symptoms of which include pain, swollen soft tissue, restricted joint movement, loss of function and possible permanent disability. Users of keyboards who are not trained typists are more susceptible to such problems.
  Eye Strain: Evidence indicates that using dse is not associated with damage to the eyes or eyesight although uncorrected defects can increase the stress of working with such equipment.
  Fatigue and stress.

Precautions

The operator should ensure the following:

- That the potentiostat, cell design and computer hardware all meet the relevant standards (for further details see the Risk Assessment Use of Standard Electrical Equipment). If in doubt check with the Technicians.
- That the wiring of the potentiostat to the cell assembly has been undertaken with due care and attention.
- That all wiring has been attached to the appropriate electrodes, that the connections have been checked for their ability to remain fast to the area of application and that no undue strain is placed upon them.
- That contact with any exposed electrically active areas is avoided once the experiment has been set in motion.
- That all excess solvents and solutions have been removed from the area in and around the working potentiostat to avoid spillage and resulting contamination and/or electrical shock as well as the danger of explosion and fire from sparks associated with the use of flammable solvents.
- That the cell is supervised to avoid the build up of pressure due to the evolution of gaseous products. If harmful by-products result the cell should be placed in a fume cupboard and the appropriate precautions observed.
- That s/he has familiarised themselves with all aspects of the degassing procedure including the use of the Compressed Gas Cylinders and the risks associated with VDU Operation.

Training

No specific training is required in the use of potentiostats, however the operator should familiarise themselves with the relevant references and user manuals.

Risk Remaining

There will always remain a risk from electrical injury and injury from sudden and unexpected gas release but with the correct operational procedures in place the dangers will be minimised.

Emergency Procedures

Electric Shock

- Switch off the power before touching the injured person. Follow the procedure given in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency".

Fire

- Follow the procedures given in the School of Chemical Sciences Safety Handbook. Never use water on an electrical fire.

Escape of gas

- If the gas escape is large follow the procedure described in the School of Chemical Sciences Safety Handbook for the escape of toxic materials: remember even an inert gas can kill by asphyxiation. For small non-toxic leaks, inform a member of staff, ventilate, evacuate, seal and secure the room.

Falling Cylinder

- If a cylinder falls over, NEVER attempt to catch it, it is much too heavy and will cause you serious injury. It is also very robust and is unlikely to be damaged although it may make a loud noise. Do not attempt to upright it by yourself but get competent help.

Cuts from Glassware

- Always treat cut and burns immediately. Apart from very minor injuries, call for First Aid treatment. In the event of serious injury, follow the procedure "Aiding an Injured Person" described in the School of Chemical Sciences Safety Handbook.

References

The completed Safety Forms for the following Common Activities:
Use of Fumehoods Use of Glassware
Use of Standard Electrical Equipment
Transport and Use of Compressed Gas Cylinders
Visual Display Equipment

RISK ASSESSMENT #13: GENERAL OFFICE WORK

Risk Category: D

Hazards

Housekeeping.	Rubbish and temporary storage of material presenting a fire or tripping hazard.
Electrical.	Hazards due to electrical faults or from tripping on electrical cables.
Storage.	High or awkward shelves, unstable items.
Machinery.	Guillotines, staplers, scissors and other items with sharp edges.
Lifting.	Heavy or unstable objects.
VDE use.	Musculo-skeletal disorders from poor posture, poor arrangement of equipment and eye strain from poor lighting, incorrect spectacles, fatigue and stress.

Precautions

- Practice good housekeeping in the office especially with regard to walkways and fire exits.
- Electrical equipment, see the Risk Assessment Use of Standard Electrical Equipment. All portable electrical equipment (typewriters, computers, adding machines, desk lights *etc.)* must be tested from time to time and carry a sticker recording the test. Care must be taken that cables do not trail across walkways.
- Only one drawer of a filing cabinet should be open at one time so that it cannot topple over. Objects should not be stored on high or unstable shelving.
- Potentially dangerous machinery like guillotines or shredders must be properly guarded to prevent damage to fingers and hands. Extra care should be taken with sharp edges or points. Even the edge of paper can cut which is all the more painful from being unexpected.
- Take great care when lifting heavy or awkward items. See the University Code of Practice on Mechanical Safety for more advice.
- VDE use. See the Risk Assessment and Check List for Visual Display Equipment.

Training

Apart from general experience, office workers may require frequent update training in the use of office computer software.

Level of Risk Remaining

Slight but significant in the area of musculo-skeletal disorders due to improper posture or typing techniques in the use computing equipment.

Emergency Action

Refer to the section "Coping with an Emergency" in the School of Chemical Sciences Safety Handbook

References

http://www.dcu.ie/safety/office.shtml

RISK ASSESSMENT #14: TRANSPORT, STORAGE AND USE OF SOLVENTS AND OTHER FLAMMABLE LIQUIDS

Risk Category. C

Known or expected Hazards: The primary hazard arises from the solvent's property of being highly or extremely flammable but several are also described as harmful and/or toxic and this should be reflected in the relevant COSHH assessment.

Flammable Hazards. The most common fire hazard in the laboratory is a flammable liquid or the vapour produced from such a liquid. For a fire to occur requires: i) an oxidising atmosphere (usually air), ii) flammable gas or vapour at a concentration within the flammability limits of the substance and iii) a source of ignition. Under normal circumstances oxygen or air will always be present and the optimal way to prevent fire is to segregate the vapour or gas from sources of ignition. Some specific properties of flammable materials are:

Flash Point. The flash point is the lowest temperature at which a liquid has a sufficient vapour pressure to form an ignitable mixture with air near the surface of the liquid. Many common organic liquids have a flash point below room temperature *e.g.* acetone (-18°C), diethyl ether (-45°C) and amongst the most hazardous liquids are those that have flash points near or below 38°C. corresponding to the common laboratory environment. It is important to note that some flammable liquids will maintain their flammability even at concentrations as low as 10% by weight in water. Methanol and iso-propanol have flash points below 38°C at concentrations as low as 30% by weight in water; HPLC acetonitrile/water mixtures of 15% to 30% acetonitrile are flammable.

Ignition Temperature. The ignition (auto-ignition) temperature of a substance is the minimum temperature required to initiate or cause self-sustained combustion independent of the heat source. A spark is not necessary for ignition when a flammable vapour reaches its auto-ignition temperature. Carbon disulphide is particularly dangerous in this respect with an auto-ignition temperature of 90°C. For Diethyl ether this is 160°C- and the material can be ignited by a hot plate.

Lower and Upper Explosive Limits. These limits define the range of concentrations in mixtures with air (or oxygen depending on definition) that will propagate a flame and cause an explosion. The lower values of these limits are normally well above the levels legally allowed as ambient in laboratories and workplaces but can be easily exceeded following a spillage. The upper limits of the flammability range offer little margin of safety because, when a solvent is spilled in the presence of a source of ignition, the lower level will be reached quickly and fire or explosion will occur before the upper limit is attained.

Sources of ignition. The most common sources of ignition in the laboratory are gas flames and heating elements but there are a number of less obvious electrical sources such as refrigerators, stirrer motors, heatguns, microwave ovens *etc.* It also must be remembered that vapours from flammable liquids are denser than air and can spread over bench and floor surfaces to sources of ignition, which are apparently remote.

Transport of Solvents

The aim is to move solvents to and from laboratories avoiding the dangers of fire and toxicity that might arise from spillage. Winchester bottles of solvent must be transported in the corridors or lifts only in suitable carriers with a maximum load of two carriers per person or on a sturdy trolley with wheels at least 3 inches in diameter and raised sides to restrain bottles. Plastic waste solvent containers must also be carried on such trolleys. A lab coat should be worn as a first barrier against spillage. In the School of Chemical Sciences, no solvents must be transported over the 1st and 2nd floor bridges to the office block. Extreme care should be used in the transportation of solvents along the 1st and 2nd floor balconies.

Storage of Solvents

Keep only the practical minimum amount of solvent in the laboratory: do not hoard or stock up on material. Solvents must be stored in non-flammable containers. Winchesters of solvent should be stored in fire resisting cupboards when not in use, put away at night and not stored in or on the workbench. Solvents must not be stored with incompatible materials such as cone, nitric acid (oxidising agent). Waste solvent is as flammable as pure solvent and containers should not be left in the open laboratory.
Solvents and other flammable liquids should be used with constant regard to the danger they pose to life and property. Under normal circumstances they should always be used in a fumehood away from possible sources of ignition. Flammable solvents must never be poured down sinks.

Training

This Assessment should be read by everyone who uses solvents, and the method of collection and storage should be demonstrated to newcomers. The use of solvents is a normal part of general chemical training.

Level of Risk Remaining

Solvents are used in large amounts in much of Chemistry and this is unlikely to change so the flammability risk will remain. Constant vigilance is required by the users.

Emergency Procedure

1. **Personal injury or fire: follow the procedures outlined in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency".**
2. **Spillage, no fire**
   a. **Serious - toxic or large quantities. Evacuate and ventilate the affected area, closing doors and eliminating sources of ignition if it is safe to do so. Telephone the Buildings (5336) and the SSA (5689) or SECURITY out of hours (5999) and OPERATE THE NEAREST FIRE ALARM POINT. Advise the emergency team of the nature of the incident. DO NOT ATTEMPT TO CLEAN UP A MAJOR SPILLAGE BY YOURSELF.**
   b. **Minor. Ventilate the affected area and eliminate any sources of ignition. Inform a member of Staff and your co-workers. Decide on and use suitable protective equipment such as gloves, lab. coats, respirators. The liquid may be absorbed onto absorption granules available at the Fire Points (have them replenished after use) and, as appropriate, transferred to a fumehood to evaporate or to a suitable sealed container for waste disposal. In a well-ventilated area such as a laboratory, the best procedure may be simply to turn off sources of ignition, ventilate, evacuate and seal and secure the room.**

References

For further information on Boiling Points, Flash Points, Ignition Temperatures *etc.* see "Hazardous Chemicals Handbook" by PA. Carson and CJ. Mumford.

RISK ASSESSMENT #15: DISTILLATION OF SOLVENTS

Risk Category: C (Postgraduate), Bu (Undergraduate).

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This Risk Assessment should be read in conjunction with that for Transport, Storage and Use of Solvents and other Flammable Liquids.

Additional Hazard

With distillation, a specific chemical drying agent is used for each solvent, which may react violently with other solvents. Particularly dangerous in this respect are sodium and lithium aluminium hydrides.

Remaining Risks

Risks should normally be low if the rules below derived from experience are followed carefully, the stills are constructed to the standard design and sources of ignition are controlled. However, distillation does involve risks and an important first question must be do you really need a solvent still? Can you use commercial dried solvent or share a still?

Training

mic staff-School of Chemical Sciences. New students must take the training course in the use of stills given at the beginning of the Session.

Recommendations for Solvent Still Operation and Construction

A. Location of Stills

i. Solvent stills are potentially dangerous and should be located in a fume cupboard dedicated to this purpose wherever possible. Stills for diethyl ether or for toxic solvents like benzene must be located in a fume cupboard.
ii. If stills have to be located in a fume cupboard that is also used for other activities, a barrier should be erected to prevent dangerous interaction between these activities.
iii. If stills have to be located in the open laboratory they should be away from areas where people sit, from any source of ignition and should be protected from damage if a flood brings down ceiling tiles.

B. Water Supply

i. All water connections, from the tap to the still and from the still to the drain, are to be secured using nylon ties.
ii. Water tubing to be made of a material such as translucent polyvinyl chloride, which is resistant to perishing.
iii. The outlet water from a still or from the last still in a group must pass through a flow switch (see electrical requirement).
iv. Stopcock to be inserted into water supply to limit maximum flow rate where possible.
v. Water flow switches must be cleaned regularly as algae may stop correct operation.

C. Nitrogen Supply and Vent

i. On no account must it be possible to seal off a still from its vent and so create a pressurised system.
ii. Each still must have its own individual nitrogen supply valve and bubbler.

iii. Flexible connections are to be made using translucent polyvinyl chloride tubing, and to be secured using a nylon tie to the supply valve, the still 'Tee' pieces and the bubbler.
iv. Flexible connections in the case of a tetrahydrofuran still should be made from polytetrafluorethylene tubing, which is resistant to this solvent. For advice on connecting this tubing to the still head and bubbler, see the SSA.
v. All exit tubing to be attached so as to minimise the danger of kinking and vented to a fumehood or the exterior of the building.
vi. Flexible tubing to be used to attach vent from the bubbler to the copper manifold, which is in turn connected via 10 mm copper pipe to a fume hood or the exterior of the building.

D. Electricity Supply

i. A water flow switch that will turn off the electricity if the water supply drops below a minimum safe flow rate must control the electricity supply. These devices are available from the Electronic Workshop, and are rated at 10 A, 240 V.
ii. The electricity supply from this water flow switch is then connected to a range of individual switched sockets, and finally via fused plugs and thermostats, to the heating mantles.
iii. The solvent catch trays should be earthed.

E. Miscellaneous

i. All still flasks must be labeled in plain English, no chemical shorthand, stating the solvent and the drying agent. Labels available from Stores.
ii. Each still to have its own individual catch tray made of aluminium. These may be ordered from the Mechanical Workshop. A list of recommended sizes is available.
iii. All flammable solvent stills must only be filled or re-filled when they are at room temperature. There should be no electrical device turned on in the fume cupboard when the still is being filled and all heating devices such as mantles or hotplates must have been turned off for at least 5 minutes to avoid chance ignition of vapour.
iv. Stills to be turned off when left unattended.
v. The joint between the still flask and the receiver must be fitted with a heavy-duty p.t.f.e joint sleeve.

F. Recommended Solvent Drying Agents

Solvent	**Drying Agent**
Tetrahydrofuran	Sodium wire/benzophenone
Ethanol	Magnesium
Acetonitrile	Calcium hydride
Acetone	Calcium chloride
Dichloromethane	Calcium hydride
Ethyl acetate	Calcium hydride
(2-Methoxyethyl)ether	Sodium
40/60 Petrol ether	Calcium hydride or Sodium wire/benzophenone/triglyme
Toluene	Sodium
Diethyl ether	Sodium wire/benzophenone
Methanol	Magnesium
Hexane	Calcium hydride or Sodium wire/benzophenone/triglyme
Pentane	Calcium hydride or Sodium wire
Heptane	Calcium hydride or Sodium wire
Benzene	Calcium hydride or Sodium wire
Xylene	Sodium

This list is not exhaustive, but gives combinations of solvents and drying agents in use in the Inorganic Section. **The routine use of potassium or its alloys is not recommended because of the risk of fire; if potassium must be used, a Special Assessment has to be made under COSHH with particular concern for its disposal.**

G. Safe Disposal of Drying Agents in Stills

The reactivity of the above drying agents means that disposal has to be carried out with great care. In the procedures outlined below for *in situ* decommissioning of stills, it is assumed that the stills are at room temperature and electrically isolated and that they remain connected to a flow of cooling water and nitrogen. Put a warning notice on the still during decommissioning so it is not accidentally turned on.

(a) Disposal of sodium (10 g or less)

The flask must be at least 1/3 full of solvent before the addition of reagents is commenced. About 30 cm^3 of ethanol is syringed into the solvent receiver with the tap closed. The ethanol is then added slowly to react with the drying agent. There may be a delay in hydrogen evolution whilst surface contamination of the drying agent is dissolved. It is important to swirl the flask during the addition to ensure adequate mixing. When the evolution of hydrogen has ceased, a small amount *(ca* .15cm^3) of a 1:1 ethanol/water mixture is cautiously added. If no further hydrogen evolution occurs, water is cautiously added to fill the flask and it is left until no more bubbles of gas can be seen. The flask can now be detached, the upper organic layer separated and put into the waste solvent container and the lower, aqueous layer washed down the sink with lots of water (take special care with tetrahydrofuran as this is fairly soluble in water).

(b)Disposal of calcium hydride or magnesium

The procedure is similar to that used for sodium except that a mixture of 90%ethanol and 10% water is used in place of pure ethanol. When hydrogen evolution ceases, water may be added cautiously and the still dismantled when no bubbles can be seen.
If an aqueous and an organic layer have formed, these must be separated, the solvent put into the appropriate waste solvent bottle and the aqueous layer washed down the sink with lots of water. If the water and solvent are miscible, often the whole contents of the flask can be washed down the sink with lots of water to render the mixture non-flammable - if you have doubts about what is allowed, check with the Code of Practice on Disposal of Chemical Waste or with the SSA.

Glass bottles, which contain sodium and solvent, should be handled with extreme care. An incident has occurred in the School of Chemistry when such a bottle, which was being carried, struck and smashed on the edge of a bench. The person involved slipped in the spilled solvent and fell into the pool on the floor absorbing the solvent into their clothing. It was only the speed of a co-worker in dealing with the exposed sodium wire that prevented a horrific burning accident.

Emergency Procedure

1. Personal injury or fire: follow the procedures outlined in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency".
2. Spillage, no fire: Beware of drying agent! Users should be fully conversant with the procedures required to make safe any drying agent that is in danger of being exposed to air or water.

a. Serious - toxic or large quantities. Evacuate and ventilate the affected area, closing doors and eliminating sources of ignition if it is safe to do so. Telephone the Buildings (5336) and the SSA (5312) or SECURITY out of hours (5999) and OPERATE THE NEAREST FIRE ALARM POINT. Advise the emergency team of the nature of the incident DO NOT ATTEMPT TO CLEAN UP A MAJOR SPILLAGE BY YOURSELF.

b. Minor. Ventilate the affected area and eliminate any sources of ignition. Inform a member of Staff and your co-workers. Decide on and use suitable protective equipment such as gloves, lab coats, and respirators. The liquid may be absorbed onto absorption granules available at the Fire Points (have them replenished after use) and, as appropriate, transferred to a fumehood to evaporate or to a suitable sealed container for waste disposal. In a well-ventilated area such as a laboratory, the best procedure may be simply to turn off sources of ignition, ventilate, evacuate and seal and secure the room.

RISK ASSESSMENT #16: DISPOSAL OF WASTE SOLVENTS

Risk Category. C

This Risk Assessment should be read in conjunction with that for Transport, Storage and Use of Solvents and other Flammable Liquids.

Additional Hazard

Waste solvents are most likely contaminated with unknown substances and as such should be treated with extreme care.

The University is able to dispose of some common organic solvents by a mechanism, which is less cumbersome and costly than for other waste chemicals. A list of solvents, which can be accepted, is given below (some other solvents may be acceptable but check with the SSA first). Waste solvent containers are not dumps and may contain only approved waste organic solvents with limited amounts of solute none of which must pose a health risk to School of Chemistry staff who have to pour the solvents into larger containers. Never put reaction mixtures, oxidants or solutions of oxidants into the waste solvent containers. No substances that are listed as carcinogens may be in the waste solvents in any form. Do not allow paper tissue, glass pipettes, vials, hypodermic needles or any other extraneous material into the waste solvent containers.

Organic liquids acceptable as Waste Solvents (from the University Code of Practice “Disposal of Chemical Waste”).

Non-chlorinated

- Hydrocarbons: alkanes C_5-C_{12}, cyclohexane, toluene, xylene
- C_1-C_3 alcohols, ethylene glycol
- Diethyl ether and tetrahydrofuran
- Acetone, ethyl and n-butyl acetate

Chlorinated

- C_1: dichloromethane, chloroform, carbon tetrachloride
- C_2: trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, 1,1,1,-trichloroethane
- C_3: 1-chlorobutane plus small amounts of non-chlorinated materials but no water.
  Other solvents may be acceptable, please check with the DSA.

Risk Control

i. Containers. The accepted container for transfer of waste solvent to the Store is a square section screwcapped 10 liter polythene drum. No other containers are acceptable. The containers must be filled only to the 80% level with approved solvents, sealed with their original caps, not leaking vapour or liquid or excessively contaminated on the outside.

ii. Labeling. The container must be uniquely numbered and accurately labeled Chlorinated or non-Chlorinated.

iii. Storage. Separate containers for Chlorinated and non-Chlorinated solvents should ideally be kept in a fumehood. Large polythene containers of flammable solvents are extremely vulnerable in case of fire and must be kept in a closed cupboard when not being used to receive waste solvent

iv. Collection. Currently, every week there is an opportunity to take waste solvents on a suitable trolley to the Stores for disposal. Stores staff are authorised to refuse to accept containers, which do not meet the criteria described under "Containers".

v. Empty Winchesters. These must be blown dry and empty of solvent and drying agents. Sodium wire and diethyl ether are particularly dangerous. The empty bottles should be taken on a trolley or in a carrier to the store and NOT left by waste bins.

Training

Training in these procedures should be given by a competent person within each laboratory.

Level of Risk Remaining

With careful handling, the level of risk should be low. However, waste solvent remains flammable and of unknown toxicity and should be treated with great caution.

Emergency Procedure

1) Personal injury or fire: Follow the procedures outlined in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency"

2) Spillage, no fire.

a. Serious - toxic or large quantities. Evacuate and ventilate the affected area, closing doors and eliminating sources of ignition if it is safe to do so. Telephone the Buildings (5336) and the SSA (5312) or SECURITY out of hours (5999) and OPERATE THE NEAREST FIRE ALARM POINT. Advise the emergency team of the nature of the incident. DO NOT ATTEMPT TO CLEAN UP A MAJOR SPILLAGE BY YOURSELF.

b. Minor. Ventilate the affected area and eliminate any sources of ignition. Inform a member of Staff and your co-workers. Decide on and use suitable protective equipment such as gloves, lab. coats, respirators. Be aware of the extra degree of toxicity that may be present in waste. The liquid may be absorbed onto absorption granules available at the Fire Points (have them replenished after use) and, as appropriate, transferred to a fumehood to evaporate or to a suitable sealed container for waste disposal. In a well-ventilated area such as a laboratory, the best procedure may be simply to turn off sources of ignition, ventilate, evacuate and seal and secure the room.

RISK ASSESSMENT #17: USE OF THE SODIUM PRESS TO MAKE SODIUM WIRE FOR SOLVENT DRYING

Risk Category. Bp

This Risk Assessment should be read in conjunction with that for Transport, Storage and Use of Solvents and other Flammable Liquids.

Known or expected Hazards

- Severe fire from sodium and ignition of solvent.
- Fire caused by incorrect disposal of unused sodium.
- Violent reaction between sodium and unsuitable solvent.
- Pressure build-up in solvent bottle following addition of sodium.

Precautions

- This operation must never be attempted by an untrained person.
- This operation must never be attempted by a single person.
- This operation must never be attempted out of normal working hours.
- Lab-coats, gloves and safety glasses must be worn.
- No naked flames to be within twenty feet.
- No other flammable chemicals to be within ten feet.
- If the press is found with residue from a previous operation, it must be assumed that sodium is still present and extreme care must be taken in cleaning it.
- Only solvents compatible with sodium to be used (see the recommended solvent drying agents given in the Risk Assessment Distillation of Solvents).
- The solvent bottle to be held firmly in place with the mouth as close as possible to the die.
- Following the operation, the solvent bottle must be left in a fumehood for 18 hours with its cap screwed *loosely in* place.
- Unused sodium to be disposed of carefully (see the procedure outlined in the Risk Assessment Distillation of Solvents).
- In order that the press be safe for future use, it must be left spotlessly clean.
    - **Glass bottles, which contain sodium and solvent, should be handled with extreme care. An incident has occurred in a School of Chemistry when such a bottle, which was being carried, struck and smashed on the edge of a bench. The person involved slipped on the spilled solvent and fell into the pool on the floor absorbing the solvent into their clothing. It was only the speed of a co-worker in dealing with the exposed sodium wire that prevented a horrific burning accident.**

Emergency procedures

Personal injury or fire: follow the procedures outlined in the School of Chemical Sciences Safety Handbook under "Coping with an Emergency".

Risk Remaining.

Provided the above procedures are adhered to, the risk of injury is low. However, any fire that does occur is likely to be serious especially when highly flammable solvents are being used. It is therefore important that persons undertaking this operation are familiar with the correct procedure for dealing with solvent fires.

RISK ASSESSMENT #18: HANDLING, TRANSPORTATION AND STORAGE OF LIQUID NITROGEN AND OTHER CRYOGENIC MATERIALS

Risk Category. C or Bu.

Properties: Liquid Helium

- Liquid Helium has a boiling point of –269 ^{0}C
- Volume of expansion liquid to gas (at 15°C, 1 atm.) = 748.0
- Realtive density (water) = 0.12
- Colourless, odourless liquid which manifests itself as white 'plumes' at room temperature.
- Known or expected hazards similar to that for liquid nitrogen.

Properties: Liquid Nitrogen

- Liquid Nitrogen has a boiling point of -195.8°C
- Volume of expansion liquid to gas (at 15°C, 1 atm.) = 682.1
- Sg = 0.808 (at -195.8°C).
- Density of liquid (normal boiling point, 1 atm.) = 0.807 g/cc
- Colourless, Odourless liquid similar in appearance to water.

Known or Expected Hazards

a) Temperature Related

- The extremely low temperature of the liquid can cause severe burn-like damage to the skin either by contact with the fluid, surfaces cooled by the fluid or evolving gases. The hazard level is comparable to that of handling boiling water.
- The low temperature of the vapour can cause damage to softer tissues *e.g.* eyes and lungs but may not affect the skin during short exposure.
- Skin can freeze and adhere to liquid nitrogen cooled surfaces causing tearing on removal.
- Soft materials *e.g.* rubber and plastics become brittle when cooled by liquid nitrogen and may shatter unexpectedly.
- Liquid oxygen may condense in containers of liquid nitrogen or vessels cooled by liquid nitrogen. This can be extremely hazardous because of the pressure rise on the slightest degree of warming above the boiling point of oxygen (-183^{0}C) and the possibility of explosive reaction with oxidisable material.
- Thermal stress damage can be caused to containers because of large, rapid changes of temperature.

b) Vapour Related

- Large volumes of nitrogen gas are evolved from small volumes of liquid nitrogen (x~700) and this can easily replace normal air in poorly ventilated areas leading to the danger of asphyxiation. It should be noted that oxygen normally constitutes 21% of air. Atmospheres containing less than 10% oxygen can result in brain damage and death (the reflex is triggered by excess carbon dioxide and not by shortage of oxygen), levels of 18% or less are dangerous and entry into regions with levels less than 20% is not recommended.
- Oxygen condensed into leaking containers can explode on heating following reheating or blockage with ice.

Operation

- Always use liquid nitrogen in a well-ventilated area, especially when filling a warm container or transfer tube or inserting a warm object. As potentially large volumes of nitrogen/helium gas can be evolved it is prohibited to travel in a lift with a full dewar of liquid nitrogen or helium, failure of the dewar or a large spillage of cryogenic fluid could result in asphyxia in the confined area of a lift. When using service lifts to transport **full dewars** containing liquid nitrogen or liquid helium obey the warning signs as posted on the service lifts and use portable warning signs on dewars as provided by the technical staff. The term '**full dewar'** is specific to those dewars which are ~10-100litre in capacity, may be pressurized, and need to be moved by wheels. Place full dewars of cryogenic fluid in the service lift and then 'call' the lift to the floor required.

Do not travel in lifts with full dewars containing cryogenic fluids.

- Only use containers or fittings (pipes, longs *etc.)* that have been designed specifically for use with cryogenic liquids as non-specialised equipment may crack or fail. In particular, do not use food type vacuum flasks as they can implode resulting in flying glass fragments.
- All glass Dewars must be protected against the possibility of flying glass fragments, arising from failure by mechanical or temperature stress damage, by sealing all exposed glass either in an insulated metal can or by wrapping with adhesive tape.
- Always fill warm dewars slowly to reduce temperature shock effects and to minimise splashing. Do not overpressure storage dewar when filling a globular dewar. Use the minimum pressure required to maintain a flow of liquid.
- Always make sure that containers of liquid nitrogen are suitably vented and unlikely to block due to ice formation.
- Beware of the formation of liquid oxygen in cold-traps that are open to air or the increase of liquid oxygen content in a flask of liquid nitrogen that has been cold for a long period. (Liquid oxygen has a blue water-like appearance). However, most liquid nitrogen containers are closed except for a small neck area and the nitrogen vapour issuing from the surface forms a barrier which keeps air away from the liquid thus preventing oxygen contamination (an explosion at UMIST was caused apparently by overcooling of Rotaflo taps which leaked and allowed oxygen to condense into a sample tube. Subsequent warming resealed the Rotaflo but blew the tube apart as the oxygen evaporated).
- Avoid skin contact with either liquid nitrogen or items cooled by liquid nitrogen as serious burns may occur.
- Always wear approved Personal Protective Equipment especially safety glasses to protect against splashes, vapour, failure of glass apparatus resulting in implosion, brittle failure of items cooled by liquid nitrogen.

Personal Protective Equipment

- Face shield or safety glasses.
- Appropriate insulated gloving material when handling equipment that has been in contact with the liquid. *NB* there is dispute over the advisability of wearing gloves while handling liquid nitrogen because there is a belief that gloves could fill with liquid and therefore prolong hand contact, which would make burns more severe. If gloves are worn they should be loose fitting and easily removed.
- Lab coat or overalls are advisable to minimise skin contact, also, wear trousers *over* shoe/boot tops to prevent shoes filling in the event of a spillage.

Training

New users of liquid nitrogen should receive instruction in its use from experienced members of the academic or technical staff. Also see References.

Level of Risk Remaining

There remains a significant risk in using liquid nitrogen from the inadvertent condensation of oxygen into a closed system. It is recommended that whenever possible some other coolant is used *e.g.* solid carbon dioxide liquid traps or baths - the preferred liquids for such baths are iso-propanol or glycols. It is strongly recommended that such baths are used in preference to liquid nitrogen when long-term storage is envisaged.

Properties: Solid Carbon Dioxide

Sublimation point	-78.5°C
Melting point	-56.6°C
Volume of expansion solid to gas	~900

Hazards

Apart from being unable to condense oxygen, hazards associated with solid carbon dioxide are similar to those described for liquid nitrogen *i.e.* temperature related and vapour related. In operation, similar precautions should be taken against cold burns and asphyxiation.

Emergency Procedures

Temperature related

- For brief, localised contact with cold material - flush the area with water. (Water is used because of its high heat capacity.) Obtain First Aid assistance.
- More prolonged contact will require medical treatment. Call a First Aider.

Vapour related

- Following a large spillage of liquid nitrogen, evacuate the area and call for help. Follow the procedure outlined in the School of Chemical Sciences Safety Handbook for the escape of toxic material in the section "Coping with an Emergency".

References

- B.O.C. Cryoproducts "Recommended Safety precautions for Handling Cryogenic Liquids".
- B.O.C. "Care with Cryogenics".
- B.O.C. "Prevention of Oxygen Enrichment or Deficiency Accidents."
- B.O.C. "Dry Ice."
- http://www.airliquide.com/safety/msds/en/061B_AL_EN.pdf

RISK ASSESSMENT #19: USE OF FLAMMABLE, EXPLOSIVE AND TOXIC GASES

Risk Category. C or Bu

Hazards

- Leakage or escape of flammable gases can produce a serious explosive hazard in a laboratory. Acetylene, hydrogen, ammonia, hydrogen sulphide, propane and carbon monoxide are especially dangerous. Hydrogen flames from leaks can be almost invisible and thus difficult to detect.
- Apart from explosive hazard, gases can be reactive *e.g.* oxygen and highly toxic *e.g.* carbon monoxide.
- "Inert" gases such as nitrogen, carbon dioxide and argon can cause asphyxiation if released in quantity.

Precautions

- Use only in a fumehood or in a well-ventilated laboratory.
- Rigorously exclude naked flames or other sources of ignition from the vicinity.
- Gas cylinders, control valves and pressure regulators and gauges should all be used carefully and according to the manufacturers' recommendations. Broken or damaged equipment should not be used and must be replaced. Use only equipment that is appropriate i.e. specially designed for use with toxic, explosive or corrosive gases.
- Use the smallest cylinder size that is practicable *e.g.* a lecture bottle, which can be sited in a fume hood.
- There should be a regular check for leaks especially in joints. However, beware of using leak-detecting fluids on oxygen lines unless you are certain they are compatible. NEVER USE A FLAME WHEN TESTING FOR LEAKS. Consider using a gas sensor to detect leakage.
- Consider using automatic gas cylinder shut-offs for use in an emergency.
- Receiving containers should be capable of accepting the gas at the required operating pressure.
- Prior to introducing a flammable gas into a reaction vessel, the equipment should be purged of oxygen by evacuation or by flushing with inert gas at least three times.
- Exhaust lines should be properly vented *e.g.* to a fume hood.
- As far as possible, cylinders of flammable gases *e.g.* hydrogen should not be sited on emergency escape routes.
- Depending on the gas being used a separate Risk Assessment-Experimental Method may have to be made.

Training Requirements

Training by an experienced person is essential.

Risk Remaining

The handling of flammable and toxic gases will always have some degree of risk and constant vigilance is required in their use.

Emergency Procedures

Leakage

- If the leak is small, attempt to close off the cylinder valve but do not **endanger yourself.** Eliminate all sources of ignition, ventilate and evacuate the laboratory. BEWARE of approaching a possible hydrogen leak since the gas burns with an almost invisible flame - carry a rolled up newspaper in front of you to check for a flame.
- If the leak is large, evacuate the laboratory and sound the fire alarm. See "Coping with an Emergency" in the School of Chemical Sciences Safety Handbook.
- Following large-scale leakage of an asphyxiant gas *e.g.* nitrogen, argon never re-enter a laboratory without permission. Lack of oxygen may not be apparent but the effect will still be deadly. Be aware that asphyxiant gases may be heavier than air and accumulate at floor or lower levels.

Fire

- Evacuate and sound the alarms.

References

http://www.bocgases.ie/product_catalog/Safety_Information,272,0.html

RISK ASSESSMENT #20: USE OF LASER DYES AND DYE SOLUTIONS

Risk Category. C or Bu

Hazards:

- Most laser dyes have not been subject to the rigorous testing required to determine the level of toxicity, mutagenicity, teratogenicity or carcinogenity of these chemicals. It is therefore recommended that users treat laser dyes as toxic materials.
- Fire or excessive heat may produce hazardous decomposition products. Water, dry chemical or CO_2 fire extinguishers may be used and self-contained breathing apparatus is advised.
- Laser dyes tend to be strong oxidisers and should be stored well away from oxidising materials.
- The solvents used to make up the dye solutions have their own associated hazards and the user is referred to the information given on the solvent bottle for full details.

Handling Procedure

Always wear butyl rubber gloves, safety glasses and face mask when handling dye.
Work should be carried out within a fume hood or a well-ventilated area.
Clean up any glassware and equipment that come into contact with the laser dye.

Exposure First Aid

- **Eye: Immediately flush eyes with copious water for at least 15 minutes and seek medical attention if symptoms are present (Expected to by an irritant)**
- **Inhalation: Remove to fresh air and treat symptomatically. If symptoms persist, seek medical attention.**
- **Skin: Wash after each contact with soap and copious amounts of water.**
- **Ingestion: Drink 1-2 glasses of water or milk. Seek medical attention. (Expected to be a low ingestion hazard.)**

Spill and Disposal Procedure

- Clear up any spilt laser dye or dye solution using a damp cloth and then wash the area thoroughly with water.
- Waste dye solution should be placed in the relevant departmental waste bottles within the laboratory, making sure that chlorinated and non-chlorinated solvents are put in the correct bottle.

References

LAMBDACHROME ® LASER DYES by Dr Ulrich Brackmann, Lambda Physik laser dye handbook.

RISK ASSESSMENT #21: USE, HANDLING AND CLEAN-UP PROCEDURES FOR MERCURY

Risk Category C

Properties

Properties of Mercury:

Symbol	Hg
Atomic weight	200.59
Melting point	-38.7°C
Boiling point	356.8 °C
Physical state	heavy, silver liquid at room temperature

Hazards

Mercury is a virulent poison that is readily absorbed through the respiratory tract or through unbroken skin. It acts as a cumulative poison since only small amounts of the element can be eliminated at a time. The present accepted threshold limit for Mercury in air is 0.05 mg m^3 (*NB.* air saturated with mercury vapour at 20°C exceeds the toxic limit by 100 times). High concentration of vapour may cause a metallic taste, nausea, abdominal pain, vomiting, diarrhoea and headache. Chronic effects from continual exposure to small concentrations can cause severe nervous disturbance, insomnia, loss of memory, irritability and depression. Loosening of teeth, dermatitis and kidney damage are possible in severe prolonged absorption.

Mercury can react with ammonia to produce an explosive solid. It can cause severe corrosion problems because of its ease in forming amalgams. Reacts violently with dry Bromine.

Operation

- Mercury must only be transported in small quantities in plastic **containers** (glass bottles are unsuitable because breakages will result in possible spillage over a large area).
- Always handle Mercury in a well-ventilated area and in a suitable plastic tray (mercury may react with a metal tray or may be absorbed into a porous tray *e.g.* wood). Do not breathe the vapour.
- Avoid skin contact, wearing disposable gloves would be advantageous. Wash hands thoroughly after using mercury, especially before eating, drinking or (worse) smoking, to avoid ingestion.
- Use secondary containment on all apparatus containing Mercury *e.g.* manometers, McLeod gauge. Mercury switches. Mercury diffusion pumps (generally phased out in favour of the safer oil diffusion pump). Take care with mercury in glass thermometers.
- The exhaust from vacuum pumps on systems containing mercury must always be vented either to the outside or into a ducted fume cupboard (this is good practice for all vacuum pumps).

Emergency Procedures

Spillages

- Report and clear up all spillages immediately using the recommended methods and the equipment kept solely for this purpose. When spilled, Mercury breaks into many small droplets covering a large area, avoid spreading the contamination by restricting access to the spill area and only use the designated cleaning tools (*e.g.* brush, floor mop or dustpan) obtainable from the technician in charge or superintendent (*NB.* walking on contaminated area could mean that you transport the contamination home!).

- If mercury has spilled onto a hot surface (hotplate, mantle, heating element) evacuate the room, as high concentrations of vapour could be present. Report the fact to a member of staff.

Spillage Decontamination

NB. ***TO MINIMISE CONTAMINATION USE ONLY THE SPECIAL EQUIPMENT KEPT FOR MERCURY DECONTAMINATION AND DO NOT USE THAT EQUIPMENT FOR ANY OTHER PURPOSE***

Spillages should first be cleaned up as far as practicable by mechanical means, e.g. by either the special hand operated sucker, or, for larger spills, by using the vacuum trolley designed for the purpose. Areas that have been affected by fine droplets of mercury (or have been identified as being contaminated by the Mercury "sniffer" meter) should then be treated with a slurry composed of equal parts of slaked lime (calcium hydroxide) and flowers of sulphur mixed with enough water to make a yellow wash. The slurry is normally left in place for between 24-48 hours after which it is cleaned away by careful sweeping with a dustpan and brush prior to washing with water to remove all traces of the slurry, (often several washes).
Before the area is allowed to be used again it is essential that a second "sniffer" test is performed to make sure that the contamination has been removed. Occasionally a second application is found to be necessary. Empty and clean all equipment after use.

Disposal of Waste

Dirty liquid mercury should be carefully transferred to a clearly labelled plastic bottle and returned to the stores (where it may be sent away for reclaiming).

Slurry and contaminated items *e.g.* tissues and small bits of broken glass (thermometer) should be sealed in a suitable, clearly labelled container and added to the chemical waste system.

Level of Risk Remaining

This should be low if the procedures outlined here are followed.

References

- CRC "Handbook of Chemistry and Physics" (Rubber Handbook).
- MSDS for Mercury.

RISK ASSESSMENT #22: USE OF HYDROFLUORIC ACID

Risk Category. A

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Hazards: - CORROSIVE - TOXIC

Described by Risk Phrases R35 and R26/27/28 *i.e.*

- **Causes severe burns.**
- **Very toxic by inhalation, in contact with the skin and if swallowed.**

Hydrofluoric Acid has a number of properties that make handling particularly difficult.

- HF attacks glass, concrete, some metals and organic compounds.
- While HF gas is one of the most acidic gases known, aqueous HF is technically a weak acid. However the definition "weak" bears no relation to hydrofluoric acid's ability to damage living tissue with fluoride ions rapidly absorbed through the skin and able to migrate through and destroy tissue until they are eventually sequestered in the bones. HF damage causes long term excruciating pain and burns which are slow to heal. Burns around the fingertips are reputed to be particularly painful and may require the surgical removal of fingernails.
- Fluoride ions are both acutely and chronically toxic so that even 1% solutions of HF (or metal fluorides) must be handled with care. However, the ability of HF to carry fluoride ions through intact skin increases greatly with increasing concentration. Thus, *5%* (2.5M) HF can be handled with about the same level of care that is appropriate for handling 10M H_2SO_4. Above 10% (5M), the dangers of handling HF increases sharply and any contact with the skin for more than a few seconds can result in latent burns which may take hours before they start to cause pain. Manufacturers commonly supply HF as 48% (28M) solution and sometimes as 73% (44M). Handling HF of these concentrations is far more dangerous than handling any other common concentrated acids.

Precautions

IMPORTANT SAFETY NOTE!!!!: All research workers intending to use Hydrofluoric acid must inform the Head of School, S.S.A. and A.S.S.A. of their intention to do so. No research worker will be permitted to work with Hydrofluoric acid without first completing a special risk assessment of their operation for intended use which needs to be approved, and that a hydrofluoric acid training course run by the A.S.S.A. is completed by the research worker.

- Hydrofluoric Acid of >10% (5M) concentration must be stored in a cool, well-ventilated area in a screw capped hi-density polyethylene (or equivalent) container. It is inadvisable to keep such acid at all in a laboratory unless an appropriate detailed Special risk assessments and training is completed by each of the workers in the laboratory has been made.
- Reference should be made to an up to date Material Safety Data Sheet or Laboratory Safety Sheet.
- A detailed **Risk Assessment-Experimental Method (p.45-46 this book)** must be completed and approved by the SSA before any use is made of hydrofluoric acid. Even if only dilute (5%) acid is to be used, the assessment must define how the commercially available concentrated acid is to be diluted safely. (The main danger in this operation is spilling or splashing the concentrated acid or breathing HF fumes as only a little heat is evolved during dilution.)
- First aiders must be informed and emergency services as appropriate.
- Technical staff to be informed.
- **Procedures using hydrofluoric acid must never be attempted by an untrained person.**
- **Procedures using hydrofluoric acid must never be attempted out of normal working hours and it is strongly advised that procedures are restricted over the lunch period when trained First Aiders may not be available.**
- **Procedures using hydrofluoric acid must never be attempted by someone working alone.**

- All procedures must be carried out in a fume hood.
- It is strongly advised that procedures, which are new to the HF user, should be practised as a "dry run" using water instead of hydrofluoric acid,and documented via risk assessment before involving the acid.
- Appropriate P.P.E. must be worn as per training.
    - Disposal-Use approporiate waste containers **as per training.**

Training

Training by a competent person is absolutely essential before this material is used.

Level of Risk Remaining

Constant vigilance is required in the use of these materials but risks should be low if the procedures outlined above are followed.

Emergency Procedures

As per Hydrofluoric acid training course.

References

- **School of Chemical Sciences safety awareness training programme for researchers**
- See any MSDS for HF.
- "Hazards in the Chemical Laboratory." ed. L. Bretherick, 4th Ed. RSC.

RISK ASSESSMENT #23: USE OF CYANIDE SALTS

Risk Category: Bp

Hazards: TOXIC

Described by Risk Phrases R26/27/28 and R32 *i.e.* Very Toxic by inhalation, by contact with the skin or eyes and if swallowed. Contact with acids liberates very toxic gas.

As little as 50 to 150 mg of these salts or their aqueous solutions can cause death. Poisoning can occur by inhalation of mists of cyanide solution and by inhalation of HCN produced by the reaction of metal cyanides with acid and with water.

Symptoms of non-lethal poisoning include weakness, headache, dizziness, rapid breathing, nausea and vomiting. These compounds are not regarded as having good warning properties.

Precautions

- Metal cyanide salts and the more toxic organic cyanide salts must not be stored on open shelves in the laboratory.
- A **Risk Assessment-Experimental Method** must be completed and approved by the SSA/ASSA before any new use of these materials. Material can be issued by the Chemistry Stores but only with the permission of the SSA.
- The appropriate First Aiders who are qualified in the treatment of cyanide poisoning must be informed by the potential user and prewarned of any planned work.
- Reference should be made to an up-to-date Material Safety Data Sheet or Laboratory Safety Sheet
- Procedures using these materials must never be attempted by an untrained person.
- Procedures using these materials must never be attempted out of normal working hours or over the lunch period when trained First Aiders may not be available.
- Procedures using these materials must never be attempted by someone working alone and for larger scale operations, workers should operate in pairs.
- All operations, including weighing material, must be carried out in a fume hood.
- Appropriate personal protective equipment, *i.e.* impermeable gloves, lab coat and safety glasses, must be worn.

Training

Training by a competent person is absolutely essential before this material is used.

Level of Risk Remaining

Constant vigilance is required in the use of these materials but risks should be low if the procedures outlined above rare followed.

Emergency Procedures

- **Skin Contact: Immediately wash with soap and water and remove contaminated clothing-seek medical attention.**
- **Eye Contact: Wash with copious amounts of water and obtain medical attention.**
- **Ingestion: Obtain urgent medical attention.**
- **Inhalation: If possible, move the person to fresh air and obtain urgent medical attention. See the procedures for "Aiding an Injured Person" in the School of Chemical Sciences Safety Handbook.**
- **Spillage: Follow the procedure described for the "Escape of Toxic Material" in the School of Chemical Sciences Safely Handbook.**

References

See any MSDS for Cyanide Salts.

- "Hazards in the Chemical Laboratory." ed. L. Bretherick, 4th Ed. RSC
- "Hazardous Chemical Handbook." P.A. Carson and CJ. Mumford, 1994.

Risk Assessment #24: Use of Pyrophoric Reagents

Risk catagories A, and Bp or Bu as applicable.

Hazards

Pyrophoric reagents are those reagents that can ignite spontaneously in air below about 45^0C. Consequently the main hazards arising from the use of such materials involve fire, either from direct contact with the pyrophoric material, or as a result of secondary fires following ignition.
For the purpose of this risk assessment, the term 'pyrophoric' will also be extended to those reagents which can readily ignite when in contact with water/atmospheric moisture.
For a list of pyrophoric reagents typically used in the School of Chemical Sciences see Appendix , this handbook.

Common classes of pyrophorics found in the School of Chemical sciences include alkali metals, metal hydrides, alkyl lithiums, and fine turnings of various metals such as aluminium and zinc.

Fires involving pyrophoric materials require a Class D fire extinguisher or dry sand. Be sure you are equipped with a proper extinguishing medium before attempting to handle a pyrophoric reagent.. For example, using a carbon dioxide extinguisher on an alkylmagnesium fire would actually cause the fire to burn more intensely!
Under no circumstances should water, dry powder, or carbon dioxide be used as a fire extinguishing medium for a fire involving pyrophoric material.

Precautions

- Use pyrophoric reagents on small scale quantities, and work with them in a fumehood.
- Wear protective clothing at all times.
- Pyrophoric reagents for research purposes may only be stored in a proper fire rated storage cabinet. Access to this cabinet is only available to researchers via the technical staff (Room X1-61/X1-64 Ext. 5111)
- Inform colleagues that you are working with these reagents.
- Follow the CoSHH assessment for the reagent closely.
- Work with materials under an atmosphere of nitrogen/argon as required. In the case of pyrophoric liquids, use techniques contained in the reference section of this assessment. **Seek training on handling pyrophoric materials from the project supervsor, S.S.A., or A.S.S.A.**
- In working with pyrophoric materials ensure there are no flammable materials present in the immediate vicinity and that a container of dry sand is present in the work area.
- Date all pyrophoric chemicals on opening.
- Do not use pyrophorics outside normal university working hours.
- Never work with pyrophoric materials alone.
- Ensure all apparatus and other reagents are dry before using the pyrophoric reagent.
- If a non-pyrophoric alternative can be found for a particular procedure, use it!

Emergency procedures:

If there is an accidental release of small amounts of material that can be easily treated with dry sand, then pour dry sand over the affected area and notify any member of technical staff. In some cases, small amounts of escaped material may not spontaneously ignite at all, but rather react with the surface it comes into contact with, without ignition. eg. n- Butyl lithium.

However, if the container of material has ignited then **EVACUATE THE LABORATORY IMMEDIATELY, ACTIVATE THE NEAREST FIRE ALARM, AND INFORM ANY MEMBER OF TECHNICAL STAFF OR SCHOOL FIRE WARDEN OF THE NAME OF THE REAGENT INVOLVED.**

Disposal of waste

On completion of reactions with pyrophoric materials, typically all of the material is used up and is neutralized in subsequent work up of the reaction mixture.

For glassware badly contaminated with pyrophoric reagent residue , seek advice from project supervisor, S.S.A., or A.S.S.A.

Glass syringes that have come into contact with liquid pyrophoric reagents such as n-butyl lithium should be immediately dissassembled after use and all parts dropped into a large beaker of iced water to neutralize the reagent. The syringe needle can then be purged of reagent by syringing water through it, followed by a syringe rinse in acetone. Place all parts in a glassware oven to dry.

Training

Training by a competent person is absolutely essential before any pyrophoric material is used.

Level of risk remaining

Constant vigilance is required in the use of these materials but risks should be low if the procedures outlined above are followed.

References

Aldrich Technical Bulletin AL-134, Handling Air-Sensitive Reagents
Aldrich Technical Bulletin AL-164, Handling Pyrophoric Reagents.
(these documents are usually supplied with the pyrophoric chemical.)

Experimental Organic Chemistry- Principles and Practices- by L.M. Harwood and C.J. Moody **BlackWell Scientific Publications** p.77-p.87

Risk Assessment #25: Cleaning of glassware contaminated with hazardous residues.

Risk category**: Bp, Bu, C where applicable, D**

For the purpose of this risk assessment, the term 'contaminated glassware' applies to the following: All laboratory glassware (which includes 'Quickfit' glassware), 2.5L Winchester bottles, and glass chemical reagent bottles of various sizes from 2.5l down to 5ml in capacity which are used to hold chemical reagents.

The term 'hazardous residues' shall apply to organic solvents, noxious/irritant organic or organometallic compounds, and pyrophoric materials.

Hazards:

For undergraduate students/researchers/technical staff:

- Cleaning contaminated glassware, which may result in accidental release of irritant/noxious fumes that the worker may be exposed to.
- Accidental discharge of residues from contaminated glassware to the sink/drains, resulting in the possible generation of noxious/irritant odours throughout the school building; generation of volatile vapours which may catch fire; and possible harm to the environment.
- Cleaning glassware contaminated with a combination of volatile organic residues and pyrophoric material, which may result in explosion.

For laboratory attendants:
Being given badly contaminated glassware to wash where:

- The nature of the contaminant is not known to the attendant.
- Badly contaminated glassware placed in a glassware washing machine may cause the emission of noxious/irritating odors from same.
- Hazardous side reactions may occur when the contaminated glassware comes in contact with cleaning agents or water.

Procedures:

For undergraduate students/researchers/technical staff:

Ascertain the nature of the contaminant that is generated. If the contaminant is soluble in a particular solvent, pre rinse the glassware with a minimum amount of solvent to dissolve the contaminant. Carry out this procedure in a functioning fumehood. Ensure that the washings are transferred to an appropriate solvent waste drum. Allow the glassware to air dry in the fumehood. When air dry, perform a final rinse at the laboratory sink with a liquid

detergent such as 'Teepol' (available from stores X1-64) and tap water. Use cleaning brushes, available from the service hatch. Allow glassware to dry in a glassware oven.

In the case of glassware containing pyrophoric material such as sodium wire etc. seek advice from the project supervisor, the SSA, ASSA, or any member of technical staff.

In the case of the nature of the contaminant not coming under those reagents as detailed in the **HAZARDS** section of this risk assessment, seek advice from the project supervisor, the SSA, ASSA, or any member of technical staff.

The above procedures will also apply to broken glassware. As a guideline, broken glassware placed in glassware disposal bins must not contain more than 1% chemical contamination. If broken glassware contaminated with chemical residues is difficult to treat, seek advice from the project supervisor, the SSA, ASSA, or any member of technical staff.

Under no circumstances should badly contaminated glassware be given to laboratory attendants for cleaning!!!

For laboratory attendants:

Do not attempt to clean glassware that is badly contaminated with unknown and/or noxious smelling residues without first consulting any member of the technical staff.

Pre-soak glassware to be cleaned in a basin of warm water and liquid detergent (such as 'Teepol'), rinse under warm running water and place in a suitable oven to dry. Glassware washing machines may be used where possible.

Training:

Everyone who uses glassware in the School of Chemical Sciences must read this assessment

Level of Risk Remaining:

Slight, if the outlined procedures are followed.

Risk Assessment # 26-Procedures for preparative thin layer (TLC) and flash chromatography.

Risk category Bp, Bu, C, or D as applicable to all of the following:

Hazards:

Preparing glass sample' spotters' for TLC:
Sustaining burns to the hand while using gas burners to pull TLC spotters.
Fire hazards when using bunsen burners.

Cutting aluminium foil backed silica plates for TLC:
Inhalation of fine silica particles while manually cutting plates for TLC.
Sustaining cuts while manually cutting TLC plates.

Preparing and using glass chromatography columns for flash chromatography purposes:
Inhalation of fine silica powder while packing glass columns.
Excessive backpressures on column due to blockages.
Such backpressures may lead to glass column breaking or worse still shattering while pressure is being applied.

Precautions:

Preparation of sample TLC ' spotters' using glass pasteur pippettes:
Exercise usual caution when using bunsen burners. Ensure there are no flammable materials or solvents in the immediate work area. Exercise caution where hot glass pasteur pipettes are cooling down. If possible, use micro-burners or equivalent, where possible.

Cutting aluminium foil backed silica plates for TLC:
Work in a fume hood when cutting aluminium foil backed TLC plates or alternatively use a dust mask available from X1-61. Cut TLC plates with the silica side facing upwards.
Cut TLC plates using a straight edge e.g. ruler etc. and appropriate scalpel blade obtainable from X1-61. Ensure scalpel blade is sufficiently sharp to cut TLC plates. If not replace with a fresh blade available form X1-61.
Use a suitable wooden board for cutting TLC plates.

Preparing and using glass chromatography columns for flash chromatography purposes:

Work in a fume hood when dispensing silica powder for use in packing columns for flash chromatography. Work in fume hood when preparing and packing chromatography columns. Pack columns in accordance to sample size and/or suitable references.
Visually inspect glass columns before use, checking for obvious cracks or defects in the glass.
If using compressed air or other gas supply to move solvent mobile phases through a glass column, ensure column is clamped securely and that emergency venting (in the case of excessive column back pressure) is possible.

Emergency procedures:

In the event of chronic silica inhalation contact first aider as per the school's emergency contact numbers - remove victim from working area to fresh air- seek professional medical help immediately. Remove any items of contaminated clothing.

In the event of lacerations sustained by cutting TLC plates, contact first aider as per the school's emergency contact numbers. Outside hours contact security 5999

Disposal of waste:

Dispose of all silica waste in appropriate waste containers available from X1-61 lab stores. This includes used TLC plates.

All excess glass from TLC spotter manufacture to be disposed of in broken glassware bins as appropriate.

All excess mobile phase wastes to be placed in appropriate solvent waste containers provided.

Training:

Training to be given by competent person ie. Lab supervisor, postgraduate students etc.. Using the above techniques forms a standard part of undergraduate degree training programmes.

Level of risk remaining:

Low if procedures outlined above are followed.

References:

Any books on experimental organic or inorganic chemistry will deal with the practical aspects of the above.
eg. *Experimental organic chemistry-principles and practice* by L.M. Harwood, C.J.Moody (Blackwell scientific publications)

For flash chromatography see:
Still W.C., Kahn M., Mitra A.J.- *J.Org. Chem*- 1978, **43**, 2923

Appendix 6

Reference list of safety literature available from the ASSA (X1-61)

A guide to Safety, Health and Welfare at Work (Pregnant Employees etc.) Regulations 1994- HSA

Radiation Protection Procedures Safety series No.38 - Int. Atomic agency

Toxicology and Biochemistry of Aromatic Hydrocarbons- H.W. Gerarde- Elsevier

Handbook of Reactive Chemical Hazards by L. Bretherick - Butterworths

Handbook of Laboratory Safety 2nd Edition CRC Press Inc.

Solvent Safety Sheets- H.Henning(Ed.)- Royal Society of Chemistry

Handbook of Toxic and Hazardous Chemicals and Carcinogens 2nd Ed. - M. Sittig.

Suspected Carcinogens- A sourcebook of the Toxic effects of Chemical Substances - E. Fairchild

Laboratory handbook of Toxic Agents- C.H. Gray

Patty's Industrial Hygiene and Toxicology Vo. 3a 2ND Ed., L.J. Cralley and L.V. Cralley

Hazardous Chemicals Data 1975, National Fire Protection Assoc.

Toxic Phosphorous Esters-Chemistry, Metabolism and Biological Effects- R.O'Brien

Laboratory Safety: Principles and Practices- Brinton M.Miller *et al.*

Fire Protection Guide on Hazardous Materials -9TH Ed. NFPA

Poisons and T.S.A. Guide 10th Ed. - The Pharmaceutical Press.

A Word of Warning-The quality chemical supplier's health ans safety information- Maurice Frankel

Laboratory Biosafety Manual 2nd Ed.- W.H.O. -Geneva

Safety with Cryogenic Fluids- M.G.Zabetakis- U.S.A. Dept. of the Interior

A Guide to Radiation Protection in the use of X-Ray Optics equipment- Science Reviews Ltd H&H Scientific Consultants Ltd.

Occupational Health and Safety Concepts- Chemical and Processing Hazards- Gordon R.C. Atherley

Drilling Machines: Guarding of Spindles and Attachments- Dept. of Employment (U.K.)

Controversial Chemicals A citizen's Guide- Ed. P. Kruus and I.M. Valeriote

Regulations for the Safe Transport of Radioactive Material- 1985 Ed.- I.A.E.A. Safety stds.

Dangerous Goods Regulations 35TH Ed.- I.A.T.A.

Guidelines on First-Aid at Places of Work- Health and Safety Authority

Appendix 7

BASIC LABORATORY SAFETY RULES

1. **Laboratory coat must be worn at all times and buttoned up properly. Offensive graffiti must also be removed from lab coat.**

2. **Safety glasses to be worn at all times. Notify supervisor if you are wearing contact lenses.**

3. **Students with long hair must tie it back when working in the laboratory.**

4. **Eating/smoking/drinking is forbidden. Chewing gum is also forbidden.**

5. **Pipetting by mouth is strictly forbidden. Use pipette fillers provided.**

6. **Keep all work areas/fumehoods clean at all times. Report any spillages of chemicals to supervisor/technician.**

7. **No running in the laboratory and absolutely no horseplay!!!!**

8. **Wear protective gloves where applicable.**

9. **Report all injuries to the technician or lab supervisor.**

10. **Report all equipment breakages to the technician.**

11. **Use of mobile phones in lab is strictly forbidden.**

12. **Use of personal stereo/mp3 players is forbidden when working in the laboratory.**

13. **On the sounding of the fire alarm, all students must vacate the laboratory and proceed to the nearest exit. Comply with instructions of university fire wardens at all times.**

Students who repeatedly break these rules will be banned from the laboratory for their own safety and the safety of their colleagues. The Student's name and number will also be referred to the Head of the School and the Registry Office with instructions to initiate the appropriate procedure in accordance with the University Code of Discipline.

Appendix 8

DCU Policy and Procedures for Lone/Out of Hours Working

1. Definitions

1.1 This policy is designed to guide all staff and postgraduate students of Dublin City University on the procedures required for lone or out of hours working.
NOTE: Unsupervised Out of Hours work by Undergraduate Students is strictly prohibited

1.2 Nothing in this policy shall supersede in whole or in part the duties of employers or employees under
(a) existing statutory provisions relevant to health, safety and welfare at work
(b) common law
(c) University Safety Statement

1.3 Dublin City University strongly recommends that in the interest of health, safety and personal security, lone / out of hours work should only be undertaken when absolutely necessary and no other alternatives are available

1.4 Lone working/out of hours working is defined as follows
Any Laboratory / Experimental work undertaken outside of 9am-5.15 pm Monday – Friday
Any other work undertaken outside of 7am-10pm Monday – Friday and during the hours of 9am -6pm on Saturday, Sunday & Bank Holidays.
NOTE: All buildings must be vacated by 6pm on Saturdays, Sundays and Bank holidays when they will be subject to full lock up
NOTE: At Christmas & Easter the campus will close down for a specified number of days and access will only be granted under exceptional circumstances .

1.5 The Following Risk Categories apply to Lone / Out of Hours Working

Category A Risk (Unacceptable)	Activities to be carried out 9am – 5pm Mon – Fri only
Category B Risk (High)	Activities to be carried out only by experienced researchers with competent 'Buddy' in attendance
Category C Risk (Medium)	Activities to be carried out by sufficiently competent researchers (may or may not require Buddy)
Category D Risk (Low)	Activities to be carried out by any postgraduate student / staff member (eg computer work)

2. PROCEDURES

2.1 The Head of each School/Unit is responsible for drawing up a master list of typical research activities, undertaking a risk assessment for each activity, and categorising the risk associated with those activities in accordance with the definitions contained in 1.5 above.

2.2 Based on an assessment of their experience and knowledge, each postgraduate student will be defined as competent for a range of activities within the risk categories established in 2.1 . This assessment will be completed by the postgraduate student's academic supervisor. (Note: This assessment may be reviewed/upgraded periodically)

2.3 Staff members in individual Schools / Units / centres will be considered competent to engage in Category D activities. Staff members must be authorised by the Head of School / Centre / Unit to engage in Category B & C activities out of hours.

2.3 All persons requiring 'Out of Hours' access must have completed an annual 'Safety/Security' Induction prior to gaining access.

2.4 The School Safety Officer will hold the master record of activities, associated risk categories and defined competencies. He/She will also retain an up to date listing of all of those who have attended the 'Safety/Security' Induction.

2.5 Once an activity is on the master list, and the user defined as competent, the simple approval form should be authorised by the School Safety Officer or his appointed representative and a listing of all those authorised for after hours access submitted to Security in order to permit lone/out of hours working.

2.6 Where a proposed 'out of hours' activity has not been previously risk assessed (not on Master list) the Academic Supervisor (or Head of School in the case of a staff member) must ensure a risk assessment is carried out, categorise the risk and assess the competence of the person. In consultation with the School Safety Officer, that activity & associated risk category can then be added to the School/Unit master list.

2.7 Security will hold the list of personnel approved for lone/out of hours working in each building. All authorised persons must log onto the 'Out of Hours' Website immediately on entering the building or as soon as their work activity is defined as 'out of hours' according to the definitions contained in 1.4 above. All persons leaving the building must log off the 'Out of hours' website, thus notifying security that they are no longer in the building.
Note: Where in exceptional circumstances, web access is unavailable to the researcher he/she must check in with Security on x8990 and similarly check out before he/she leaves the building.

2.8 Where the Fire alarm is activated in the building after hours, those evacuating the building must assemble at the building fire assembly point. Otherwise emergency services will assume that they are still in the building.

2.9 In order to ensure the safety and security of persons working in buildings 'out of hours', access to each building is strictly limited to those authorised by the School / Unit / Centre concerned. Authorised persons must not admit any other person to the building out of hours. Persons

claiming to be authorised but without a swipe access card or key should be referred to Security for access.

2.10 Researchers or Staff members who in exceptional circumstances, due to the nature of their research work, require access during 'Lock-Up' must seek authorisation for such access from the Dean of Research. The Dean of Research will liaise with DCU Security to arrange such 'once-off' access.

Breaches of the above procedure will result in sanctions including revocation of out of hours access rights

Approval Form for Out of Hours/Lone Working

This Form to be completed by Academic Supervisor / Head of School for each Postgraduate Student or Staff Member requiring 'Out of Hours' access

Approved Name			
School / Unit			
Category of Staff Member / Postgrad			
Locations where work will be conducted (*room nos)*		DCU Contact Extn:	
Listing of Authorised Activities		Risk Category	**Buddy Req'd Y/N**
Signature of Supervisor		Date	
Date Of Induction Training			
Signature of Staff Member/Postgraduate student		Date	
Signature of School Safety Officer		Date	
Received by Security			

Risk Assessment Form for Lone / Out of Hours Work

This form should be completed by a competent assessor for any procedure/system of work to be carried out 'out of hours' by any staff member, postgraduate, postdoctoral worker or visitor. This form should be completed and copied to the School Safety Officer.

Activity being Assessed	
Name of Assessor	
Known or expected hazards associated with the activity (note also particular hazards if any due to lone working)	
Measures to be taken to reduce the level of risk (ie controls)	
Maximum possible harm with controls in place	
Training / Competence Prerequisite?	
Category of Risk Assigned	
Competent 'Buddy' Required Yes/No	
Emergency Action to be taken 'out of hours'	
References, if any	

Appendix 9

OVERNIGHT REACTION FORM

ROOM NUMBER: Researcher name (Block capitals):

I have carried out this experiment previously (Yes/No):

If NO, I am fully aware of the safety hazards in performing this reaction through consultation with my supervisor, and performing COSHH or special risk assessments as applicable.

Researcher signature:

List the name, quantity and CAS number of reagents used in this reaction (Do not write formulae!!):

Name of project supervisor:

Supervisor signature (only necessary for undergraduate students):

Contact telephone numbers in case of emergency:

Emergency shut off procedures:

Appendix 10

Research worker finishing up form-- CS RES 1

This form can be obtained from the school office/chief technical officer and should be completed by the postgraduate research student and signed by the relevant people below and a copy submitted to the Faculty of Science and Health office and the School Safety Advisor. The laboratory and facilities used should be left clean, tidy and safe on completion of research work within the School of Chemical Sciences.

PLEASE TICK RELEVANT BOX BELOW:

RESEARCHER CHECKLIST	**Y**	**N**
Is the bench space clean, cleared and left in a safe manner?		
Have the underbench units been cleaned and left in a safe manner?		
Have the drawers been cleared and cleaned and left in a safe manner?		
Donate any remaining chemicals/synthesized compounds to your colleagues/supervisor?		
Have you removed and disposed of your chemical waste in the correct manner?		
Have you tidied your fumehood workspace in a safe and correct manner?		
Have you cleared data stored on instruments/computers etc.?		
Have you cleaned equipment used in these areas?		
Have you returned keys for the building, laboratory, lockers etc.?		

Name: **Room no.:**

Laboratory room number/s used:

I understand that the forms relating to the examination of my thesis will not be presented to the appropriate Faculty Board for Research degrees, until such time as this form is signed by ALL persons indicated below, in the order given.

Student Name: **Signature:**

Supervisor: **Signature:**

School Safety Advisor: **Signature:**

Chief Technical Officer: **Signature:**

N.B. Signatures signify that all procedures required have been fully complied with.

A copy of this completed form should be given to the school safety advisor AND TO THE FACULTY OFFICE

NO RESEARCHER WILL BE ALLOWED GRADUATE WITHOUT FIRST COMPLETING THIS FORM.

Appendix 11.

CURRENT LIST OF SCHOOL OF CHEMCIAL SCIENCES STAFF

Prof Brett Paull	5060	X108

Science Education

Name	Phone Number	Room
Dr Odilla Finlayson	5409	X104

Analytical Chemistry

Name	Phone Number	Room
Prof Dermot Diamond	5404	L240B
Dr Brian Kelleher	5134	X123
Dr. Mirek Macka	5611	X125
Dr Gillian McMahon	5914	X127
Dr Fiona Regan	5765	X119

Chief Technical Officer

Name	Phone Number	Room
Ms Veronica Dobbyn	5840	X161

Inorganic Chemistry

Name	Phone Number	Room
Dr John Gallagher	5114	X121
Prof. Conor Long	8001	X112
Dr Mary Pryce	8005	X111
Prof Han Vos	5307	X107

Organic Chemistry

Name	Phone Number	Room
Dr Nick Gathergood	7860	X126
Dr Paraic James	5126	X118
Dr Peter Kenny	5689	X120
Dr Kieran Nolan	5913	X122
Dr Michael Oelgemoeller	5312	x124
Prof Albert Pratt	5310	X109

Physical Chemistry

Name	Phone Number	Room
Dr Dermot Brougham	5472	X124
Prof. Robert Forster	5943	X110
Dr Tia Keyes	8185	X113

Secretary

Name	Phone Number	Room
Ms Julie McArthur	5309	X105

Technical Officers

Name	Phone Number	Room
Mr Damien McGuirk		
Mr Vincent Hooper		
Mr John McLoughlin		
Mr Ambrose May		
Ms Ann Corcoran		
Ms. Mary Ross		