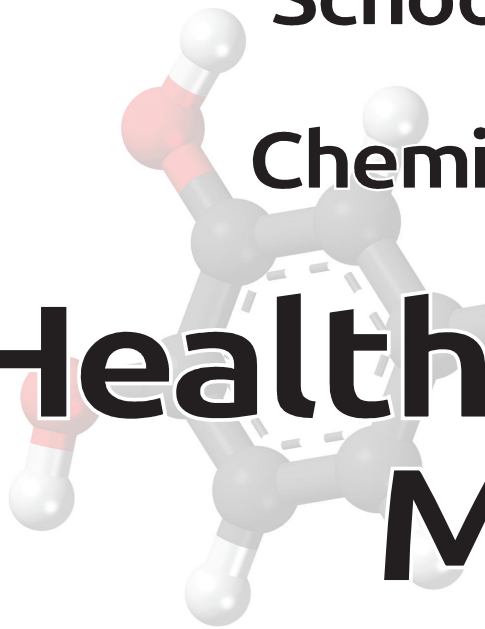
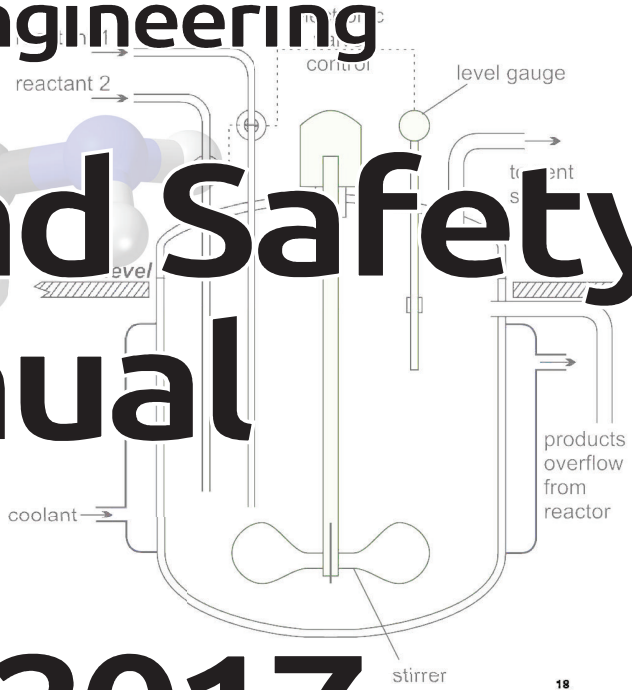
Queen's University Belfast

School of Chemistry and Chemical Engineering





Health and Safety Manual

2016-2017

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All Accidents Are Avoidable

The aim of the School is to ensure the health safety and welfare of all its staff and students and all members of the School (staff, students and postdoctoral workers) have a duty to take care of their own health and safety and that of others.

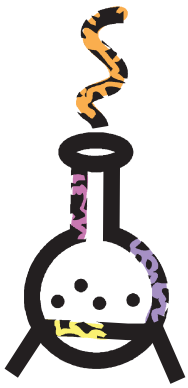
Please read this Safety Hand-out carefully and familiarize yourself with its contents.

Important Issues Covered Include:

- Good laboratory practice
- School working hours and lone working policy and arrangements
- Personal Protective Equipment – choice and correct use
- Emergency procedures: fire evacuation, toxic gas release etc
- Reporting Accidents, Injuries and Dangerous Occurrences
- Safe disposal methods for waste including packaging, paper and chemicals

You should read all sections but pay particular attention to those which specifically relate to the type of work you normally carry out.

PLEASE SEE AND USE THE SAFETY QUIZ ON PAGE **43**



Useful Websites dealing with Health & Safety:

QUB Policies: http://www.qub.ac.uk/directorates/HumanResources/OccupationalHealthandSafety/

Health & Safety Executive NI: http://www.hseni.gov.uk/

Health & Safety Executive GB: http://www.hse.gov.uk/

School of Chemistry and Chemical Engineering

EMERGENCY TELEPHONE NUMBER
2222

SAFETY HANDOUT
(2016/2017)

[Issued by the School Health & Safety Committee]

This document (Master source file:safety-manual-qub-cce-2016-printed.odt) has been revised and updated by William Houppy in July-August 2016 from the 2015/2016 version provided by the School Security Officer Jackie O'Connor

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Introduction

Without due care and attention accidents can occur in University chemical laboratories. Many have serious consequences and most are avoidable. It should be self-evident that everyone working in such a laboratory has a moral 'duty of care' towards others and themselves. Under the Health and Safety at Work (N.I.) Order 1978, and the Control of Substances Hazardous to Health (COSHH) Regulations N.I. 2000, this moral duty is closely allied with a legal responsibility

Chemical safety is a large and continuously evolving subject. You cannot get all the facts from any short handout. The aim here is to draw attention to the things we think it most important for you to know. We have been guided by 30 years of accident records in the School. If you do advanced work, particularly research, you will often need to seek additional safety information, references for which are given at appropriate points.

In compliance with the above Health and Safety at Work Act and the University Safety Policy, this School has a detailed Safety Policy Statement outlining the intention of the School to managing Health and Safety, those responsible for carrying through that intention and how that intention is fulfilled. The administrative structure of safety is also summarized in Appendix 1 of this handout. The School intends to follow, as far as is reasonably practicable, several recognized codes of safety practice for laboratories, offices and workshops. These are listed in the statement just mentioned. Those likely to be consulted most frequently are the Royal Society of Chemistry's ‘Guide to Safe Practices in Chemical Laboratories’ and ‘COSHH: Guidance for Universities and Colleges of Further and Higher Education’ (HSC). These are available in the office of the School Safety Adviser or on line.

At the outset, working practices should always be such as to minimize the possibility of accidents. Nevertheless, everyone, in the event of an accident, should be familiar with the procedures to be followed, including proper reporting of the incident.

SCHOOL OF CHEMISTRY AND CHEMICAL ENGINEERING STATEMENT OF SCHOOL SAFETY POLICY

1) In agreement with the *University Safety Policy*, it is the aim of the *School of Chemistry and Chemical Engineering* to protect and promote the health and safety of all its staff and students. Consequently, it complies with all current legal safety requirements and applies other appropriate measures to achieve a safe working environment and it expects the cooperation of all of its members in these procedures. The intention to promote health and safety at work of all members engaged in *School of Chemistry and Chemical Engineering* activities extends to visitors and contractors on School premises.

2) The *Head of School* has ultimate responsibility for the provision of a safe working environment within the *School of Chemistry and Chemical Engineering*.

3) The *Head of School* has nominated a *School Safety Adviser*, **Jackie O'Connor**, to advise on day to day maintenance of general safety. In addition the School has a *Laser Radiation Adviser*, **Professor Steven Bell** and a *Radiation Protection Supervisor*, **Dr. Neil Ogle**. The School also has an appointed *Biological Safety Adviser*, **Dr. Simon Murray**. The School has nominated members of staff for advising on matters of electrical safety and compressed gas safety.

4) All members of the School including all staff, students, postdoctoral workers and visitors have a duty to take care of their own health and safety and that of others who may be affected by their activities and to cooperate with the *Head of School* or representative in any matters relating to health and safety.
Health and safety matters within the S*chool of Chemistry and Chemical Engineering* are discussed at and recommendations made in the course of meetings of the *Safety Committee*. The *Safety Committee* is chaired by the *Head of School*, **Professor Peter Robertson** and consists of appointed *Trade Union Representatives*, **George Burton** and **Fiona Mulligan**, the *Safety Adviser*, **Jackie O'Connor**, postgraduate representatives from each research cluster (IMM, SYNBIOC and CenTACat) and representatives from associated units within the building. Decisions and recommendations made at this committee meeting are relayed via its minutes and reported at meetings of the *School Board*.

5) Local rules and recommendations have been drawn up in conjunction with decisions of the *Safety Committee*. These rules are available in the *Safety Handout Manual* and via internal memoranda and notices in specific laboratories.

6) Regular inspections of the premises (including laboratories and workshops) are carried out by the *Safety Adviser* and two other members of the *Safety Committee* with subsequent inspections to ensure that the issues have been addressed satisfactorily. Inspection findings are discussed at *Safety Committee* meetings and reported to the *School Board*.

7) Audits are carried out annually by *Safety Services* to examine compliance with the legal requirements.

8) The School encourages the reporting of all accidents, incidents and dangerous occurrences via the *School Safety Adviser* to *Safety Services*. Forms are available for this purpose from the *Safety Adviser* and can also be obtained from the *General Office*.

9) Communication between *Head of School* and School members is achieved via internal memoranda and notices, the Safety manual and any documentation posted on the *School Web Page* and Sharepoint under *Safety Information*.

The executive responsibility for safety is vested in the *Head of School*.

SAFETY ADVISER : Mrs Jackie O'Connor Date: 21st April 2016

HEAD OF SCHOOL : Professor Peter Robertson Review: Sept. 2016

School of Chemistry and Chemical Engineering
Out of Hours / Lone Working Policy

- The School's core working hours are **7:00 to 19:00 Monday to Friday. Safety support services (eg fire wardens, first aiders) are not available outside these hours.**
- Undergraduates (including final year project students) must not work alone in laboratories at any time. An experienced PHD student/member of staff must always be present. Undergraduates are only permitted to do practical work within the period **9:00 to 18:00** on weekdays during term time unless hired under various work experience schemes, for which special provisions apply. (The School Safety Adviser should be consulted in such cases)
- **Experimental work in laboratories** is permitted within the period **7:00 to 19:00 Monday to Friday** (*i.e.*, core working hours). If there are exceptional reasons why it is necessary to conduct laboratory work outside of the normal working hours, the following arrangements apply. Late working (19.00-23.00), and daytime working at week-ends or holidays – permission is required from both the supervisor and the School Safety Officer, and the appropriate School Out of Hours Working Permit must be signed PRIOR to work commencing. Permission will only be granted for low risk work activities and will be conditional upon having two persons always present in the laboratory. Anyone working outside the normal hours must comply with the requirements to sign in/out and notify University Security, as set out below. Overnight working (23.00 – 7.00) – this is not normally permitted, on safety grounds. If there are exceptional reasons why such work is required, it must be discussed in advance with the School Safety Officer, whose written permission is required. This applies to all forms of overnight working, including office-based work.
- Research Students may not work alone on experiments which, in the opinion of their supervisors and after conducting a risk assessment, present special hazards.
- No specific permission is required for office-based work which is carried out between the hours of **7.00** and **23.00**. Outside core working hours, staff must comply with the requirements to sign in/out and to notify Security on 5099.
- Anyone who is working on the premises outside core hours must comply with the following security procedures:

  Use the signing in/out book located **outside the General Office on the ground floor** – this may mean people leaving their offices at **19.00** to sign in; AND

  Inform Security via a telephone call to **5099** when commencing work (or at 19.00 hours if already at work) AND AGAIN when leaving the building.
- Anyone entering or leaving the building before **7.00** and after **19.00** pm during the week, and at any time at weekends/holidays, must sign in/out in the book outside the General Office on the Stranmillis Road entrance.

People should NOT be working in the building after **23.00** unless specific permission is sought.

Smoke - Free Policy

From January 2009 the University has been a smoke-free workplace. This means that:

Smoking is not permitted in any premises occupied or utilized by University staff, students and visitors, or in University vehicles;

Smoking is not permitted on any part of the University campus externally except in a limited number of designated areas;

Smoking is not permitted in individual study bedrooms.

The David Keir Building has a designated smoking area in the form of a smoking shelter which is located in the central quadrangle on the lower ground floor level. This is **THE ONLY PLACE IN THE BUILDING WHERE SMOKING IS PERMITTED**.

Smoking anywhere else in the building is a breach of policy and an offense under the Smoking (Northern Ireland) Order 2006 and the individual and the University are liable to penalties of up to £1,000 each.

Monitoring and implementation of this Policy is the responsibility of the Head of School and non – compliance can lead to disciplinary action being taken.

Laboratory Protocol

1. Tidiness and Hygiene

Untidiness is one of the main contributors to laboratory accidents. Tidy labs tend to have fewer accidents and also improve the morale of those who work in them.

Keep floors and passageways through lab clear from obstructions at all times and ensure that areas around emergency showers are kept free from clutter and are easily accessible.

Surplus packaging causes not only a trip hazard but also contributes to a fire hazard and should ALWAYS be removed and disposed of on a regular basis.

(a) Cardboard boxes should be flat packed and disposed of in the green cardboard Euro bins located at the top of the slope, in the goods yard, adjacent to the Sir Bernard Crossland Building.

(b) Other packaging materials - plastic wrapping/polystyrene etc can be disposed of in the standard blue Eurobins which are located up the slope in the goods yard adjacent to the Sir Bernard Crossland building.

(c) Waste Paper should be placed in SITA waste paper bags which are available from the General Office or Chemistry Stores. Once the fill level marked on the side of the bag has been reached, a cable tie (available from the General Office or Stores) is used to secure the bag. Bags are collected every WEDNESDAY morning from the Chemistry Stores, **so should be left there on a Tuesday evening** before Stores close. **All waste paper is treated as Confidential Waste** and can be securely stored here prior to collection by SITA

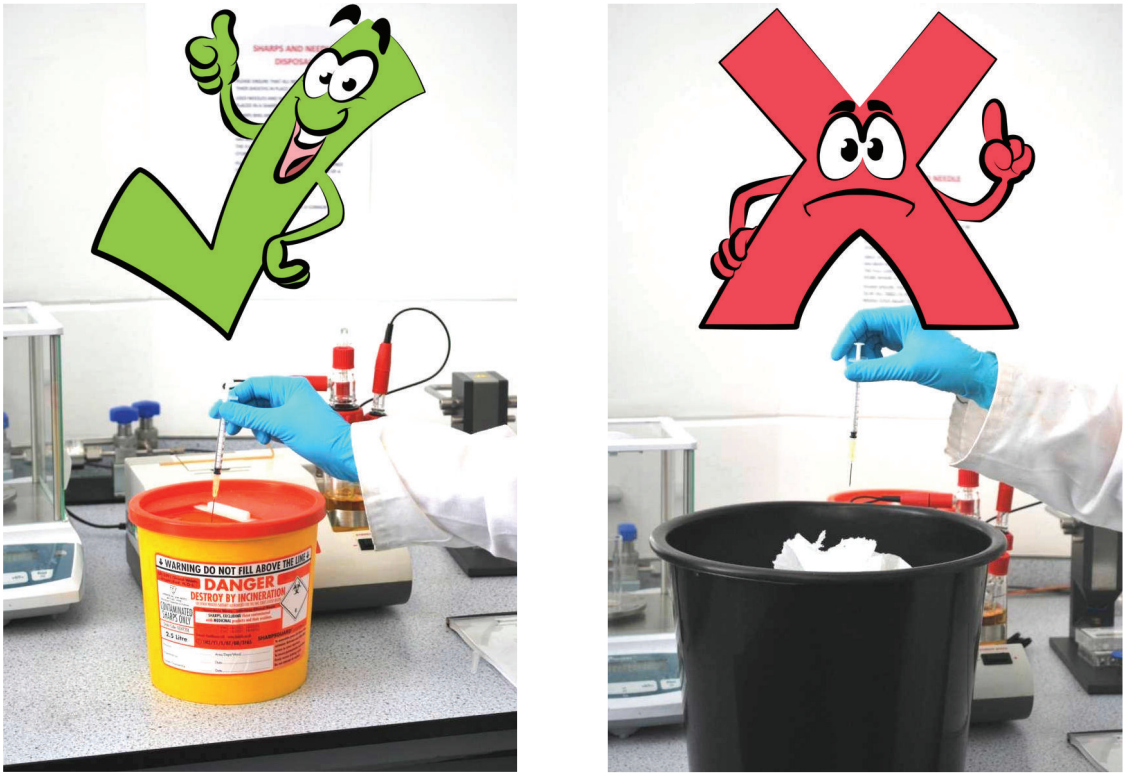
(d) ***BROKEN GLASS, INCLUDING BROKEN LABORATORY GLASS, SHOULD BE PLACED IN SUITABLE BROKEN GLASS BINS IN THE LAB AND NEVER ALLOWED TO OVERSPILL - THESE MUST BE EMPTIED ON A REGULAR BASIS BY PLACING INTO A STURDY CARDBOARD BOX, LABELLED "BROKEN GLASS" SEALED WITH TAPE AND PLACED WITH THE OTHER NORMAL WASTE IN THE STANDARD BLUE EUROBINS WHICH ARE LOCATED UP THE SLOPE IN THE GOODS YARD ADJACENT TO THE SIR BERNARD CROSSLAND BUILDING. THEY ARE NOT TO BE PLACED OUT WITH THE CHEMICAL WASTE BOTTLES OR LEFT IN THE GOODS YARD.***

(e) Spent Batteries are to be placed in the recycling spent battery receptacle which is located at the Stranmillis Road foyer.

(f) Spent Printer Cartridges are to be returned to Chemistry Stores for recycling.

(g) Scalpels and syringes inclusive of their plastic barrel MUST, IN NO CIRCUMSTANCES, BE DISPOSED OF IN THE STANDARD WASTE BINS IN THE LABORATORY. Yellow sharps bins obtainable from the Chemistry Store MUST be used, with the sharp (scalpel/syringe barrel+needle) discarded safely into this bin ensuring that the level indicator on the side of the bin is not overfilled. Once the level is reached, the lid is secured on the sharps bin and it is brought to Chemistry Stores for safe disposal/incineration and a new sharps bin obtained. (See Picture 1)

ALL SHARPS (NEEDLES, SYRINGE BARRELS AND SCALPELS) **MUST** BE DISPOSED OF IN THE YELLOW SHARPS BINS PROVIDED



PICTURE 1

Information on correct waste disposal is posted on laboratory doors and on the door of Chemistry Stores - please check

Safety Information for Working with Sharps

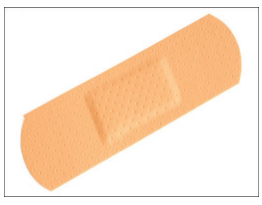
WORK PRACTICE CONTROLS

These controls aim to change the behavior of workers to reduce exposure to occupational hazards.

- No needle recapping or re-sheathing.
- Availability of portable sharps containers.
- Adequate number and placing of sharps containers within arm's reach.
- Disposing of sharps immediately at point of use in designated sharps containers.
- Sealing and discarding sharps containers when they are three quarters full.

Establishing means for the safe handling and disposal of sharps devices before the beginning of a procedure.

ACTION TO BE TAKEN IN THE EVENT OF A SHARPS INJURY



Allow it to Bleed
Puncture wounds should be encouraged to bleed freely by gentle squeezing
Wash it
Wash wound with soap and water
Cover it
Dry and apply dressing
Report it
Report incident to your line manager or supervisor

(h) Empty Chemical Bottles must be rinsed clean, have the top removed and discarded separately. The hazard label on the bottle must be either defaced or removed and "RINSED" written across the bottle or remainder of the label BEFORE placing in ONE of the empty waste chemical container bins located in the goods yard beside the flammable storage unit. ALL chemical bottles MUST be disposed of in this manner and further segregated into ALUMINIUM, GLASS or PLASTIC waste and disposed of in the appropriate bin. (See Picture 2)

Plastic Bottles

Glass Bottles

Aluminum Bottles

PICTURE 2

2. Do's and Don'ts

(a) Food and drink must not be consumed in the laboratory

(b) Applying cosmetics in laboratories is also forbidden.

(c) MP3 players are not allowed to be worn in the laboratories as they impair hearing of alarms or any noises in the lab which may indicate safety defects. Radios are permissible with the volume at an acceptable level provided that other lab users are not interrupted.

(d) Sensible footwear should ALWAYS be worn in laboratories especially when working with concentrated acids, bases and when using Liquid Nitrogen. Those involved on a regular basis with the movement and relocation of compressed gas cylinders must wear safety shoes and follow the School procedure (see Safety Adviser for further advice).

(e) Jewellery, particularly dangling necklaces, earrings and bracelets, should always be kept to a minimum. Scarves and clothing with tassels should NOT be worn in laboratories.

(f) Long hair should be tied back to avoid it getting contaminated with chemicals, catching fire from a lit Bunsen burner or entanglement in any rotating laboratory equipment

(g) Dirty glassware should NOT be allowed to accumulate. Stubborn grease and dirt may be removed by prolonged soaking (days) in a 3-5% solution of 'Decon' or 'Teepol' detergent in a plastic bucket. Chromic/sulphuric 'cleaning mixture' is an expedient which can cause cancer, serious injury by skin ulceration and damage to property if spilt. **The use of Chromic acid is prohibited and other corrosive cleaning agents such as caustic alkalis or concentrated nitric acid are only to be used in exceptional circumstances under strictly controlled conditions**. (speak to technicians in teaching labs for further information)

(h) Personal electrical equipment (kettles, toasters, heaters etc) must NOT be used in the School unless it has been **PAT** tested for electrical safety by one of the School's PAT testers (see Safety Adviser for further information).

3. Working Alone and Working Outside Regular Hours

(a) Working Alone.

(b) Undergraduates **MUST NOT** work alone in laboratories **at any time** and a member of staff must always be present. This rule also applies to Level 3/4 project students. Research Students may not work alone on experiments which, in the opinion of their supervisors and after conducting a risk assessment, present special hazards.

(c) Working outside regular hours.

(Evening, weekend and holiday working)

Undergraduates are only permitted to do practical work within the period **9:00 to 18:00** on weekdays during term time unless hired under various work experience schemes, for which special provisions apply. (The School Safety Adviser should be consulted in such cases)

Research students may only carry out **experimental work** within the period **7:00 to 19:00 Monday to Friday** (*i.e.*, core working hours).

Late/overnight working (19:00-7:00) and weekend (Saturday-Sunday) or holiday working will only be permitted for **LOW RISK** laboratory work after completion of an OUT OF HOURS WORK PERMIT which must be signed and dated by the academic supervisor AND the Safety Officer/Head of School. Permits in the first instance are only to be used for the period of time stated on the form (normally a one-off evening or weekend) and a new permit is required EACH time out of hours working is being requested. However, in some cases, a permit which lasts for a three month period may be issued. This is after consultation with the student and academic supervisor and will be dealt with on an individual basis. Out of Hours Work permit may be downloaded from the School intranet:

https://intranet.qol.qub.ac.uk/schools/schem/

or can be obtained from the School Safety Officer.

Anyone conducting laboratory work after hours MUST be accompanied by another individual. **LONE WORKING IS NOT PERMITTED.**

Anyone entering or leaving the building before **9.00am** and after **17:00pm** must DO SO USING THE Stranmillis entrance and sign the book outside the General Office hatch.

Please refer to the School's Lone Working Policy on page 7.

The book located outside the general office at Stranmillis Rd entrance–if available-must be signed by personnel staying in or entering the building after 17.00pm on weekdays and AT ALL TIMES on weekends and holidays. Personnel who are already in the building at 17.00 hours on weekdays with the intention of remaining there must still sign the book and sign out when leaving. This is a means of identifying where personnel are in the building should an incident occur.
SECURITY CONTROL ARE CONTACTABLE 24 HOURS A DAY ON EXT 5099. USE ANY TELEPHONE IN THE LAB/OFFICE OR ONE OF THE TELEPHONES IN THE CORRIDORS located beside the blue Toxic gas alarms

4. Personal Protective Equipment

(a) Eye Protection

Eye protection **MUST BE WORN BY EVERYONE FOR ALL LABORATORY WORK** (staff and students alike). This rule also extends outside of the laboratory e.g. replacing or moving compressed gas cylinders from the outside cages and MOST IMPORTANTLY when decanting, transporting, using Liquid Nitrogen.

Undergraduates will be provided with "wrap around" safety glasses which **must** be worn when conducting laboratory experiments. These are worn alone or over the top of reading glasses.

Postgraduate students, PDRAs and all other laboratory staff (academic and technical) must wear eye protection at all times when working in a laboratory. Safety glasses are obtainable **free of charge** from Chemistry Stores on presentation of a valid stores card.

Postgraduate students, PDRAs and all other laboratory staff **who currently wear prescription glasses may be entitled to free prescription safety glasses** (only if they require them to do a particular job and also have an existing contract of 1 year or more) by application to the School Safety Adviser after approval from their line manager.

All laboratory workers who normally wear reading glasses **MUST** either cover them with "wrap around" safety glasses or wear proper prescription safety glasses.

Contact lenses must not be worn in the laboratory.

For any operation involving the slightest risk of explosion or spurting, use of a **face shield (visor)** is recommended. A risk assessment should highlight the need for one to be used PRIOR to commencing the work. Visors are available on consultation with the School Safety Adviser.

A visor is also located in the flammable waste storage container to be used by those who experience difficulty/discomfort when wearing eye protection combined with a half mask respirator.

Visors should also be worn by technical staff trained in the use, transportation and decanting of liquid nitrogen. (See Appendix 8)

Any person working with ultraviolet light must comply with the eye protection rules. Although ordinary safety glasses, especially the plastic type, provide some protection, extended exposure requires the use of purpose designed protective glasses.

(**NOTE: Special regulations apply in the case of lasers – Please consult Professor Steven Bell, Laser Safety Adviser.**)

(b) Laboratory Coats

All staff and students must wear cotton laboratory coats when working in teaching or research laboratories or workshops. Such coats are an excellent first defense against splashes.

Undergraduates may purchase a lab coat from Chemistry Stores for a nominal charge.

Staff, PDRAs and post graduate students may obtain coats from Chemistry Stores on their Store account card. Usually purchase of two coats per person is recommended.

Laundering of lab coats: Please note that the School provides laundering of lab coats, with a turnaround time of approximately two weeks. Soiled coats can be left for cleaning in room **LG427** and once they have been laundered, collected from same. Please ensure before leaving your coat to be laundered that it has had all pockets checked and items such as memory sticks and store cards removed and that your name is clearly printed somewhere on the coat so that it may be returned to the wearer.

(c) Hand Protection

The appropriate glove should be worn when using substances that cause skin irritation or burns. Beware of dehydrating agents such as H_2SO_4 and CaO. In addition, gloves are required when using volatile and toxic solvents which are rapidly absorbed through the skin as liquid or vapor. Check that the gloves are of the right type for the material handled. This information is available from the Safety Service website:

http://www.qub.ac.uk/directorates/HumanResources/OccupationalHealthandSafety/GuidanceNotes/FullListofGuidanceNotes/

For more detailed guidance about the best type of glove for certain chemicals please refer to the link below:

https://intranet.qol.qub.ac.uk/schools/schem/

Stores have available to purchase a number of gloves suitable for different laboratory practices but, if after conducting a risk assessment, a non-stock item glove is identified as providing the best form of protection against a specific chemical/process this glove may be ordered in through Stores - please ensure adequate time is given to enable the purchase of such.

Gloves available in Stores include:

Disposable Nitrile, Heavy Duty Nitrile, Cryogenic, Butyl Rubber, Marigold.

Use of latex gloves within the School is prohibited EXCEPT where, after conducting a risk assessment, they are deemed the best form of defense against a particular compound/process.

Students are strongly advised not to wear hand jewellery while doing practical work. Leather clothing and watch straps can also absorb chemical and chemical vapors.

(d) Footwear

Sensible footwear should be worn when in laboratories. Open toed sandals and high heeled shoes should NOT be worn. When moving gas cylinders, steel toe capped shoes are recommended (staff can purchase such after consultation from the Safety Adviser). Such shoes should also be worn at ALL times by those working in the workshops or Stores or when transporting Liquid Nitrogen Dewars of 25L capacity and above. If it is deemed necessary, after conducting a risk assessment, that a student requires safety footwear for specific work then they will be provided with such (please consult with the Safety Adviser for further information).

(e) Respiratory Protection

Respirators CANNOT be purchased from Stores

Staff and students who dispose of waste solvents using the flammable waste storage container in the goods yard MUST wear an organic vapor respirator. These respirators are available from the Safety Adviser AFTER completion of a face fit test. (See Safety Adviser for more information).

Other types of respiratory protection (dust, acidic, vapor) are available if, after conducting a risk assessment on a particular work practice, this is deemed the best form of control. Face fit testing is also required prior to issue of this type of respirator.

Face fit tests are provided by Safety Services at 5 Lennoxvale.

If a student/supervisor thinks that they may require a mask please consult with the School Safety Adviser in the first instance.

Please note that it is the responsibility of the wearer to ensure that the mask is kept in a clean condition and report any defects to the School Safety Officer. New masks will be issued when needed. (see RPE policy in Appendix 10)

(f) Hearing Protection

Any laboratory or workshop where mandatory hearing protection signs are displayed will have available for use suitable ear defenders that MUST be worn whilst conducting work in this area. Personal ear plugs are also available from the Safety Adviser on request.

5. FIRE PREVENTION

Remember that solvent vapours can be ignited by flames, the electric elements of heating mantles, hotplates, sparks in thermostat controls and switches, and even (ether and CS_2) the hot glass surface of electric light bulbs or (CS_2) surfaces at 100^{o}C.

(a) Storage and transportation of flammable solvents

Winchesters of flammable solvents must be stored in evacuated storage areas under fume cupboards. They must not be stored on a permanent basis on bench tops, shelves or windowsills. **NEVER STORE WINCHESTERS ON THE FLOOR**!! Keep well away from heat sources such as running vacuum pumps.

Winchester carriers must be used to transport Winchesters of solvents and all other reagents. You will not be allowed to obtain any Winchester from the Chemistry Store unless you have a suitable Winchester carrier or a trolley onto which they can be securely transported. **KEEP AMOUNT OF SOLVENT STORED IN LABS TO A MINIMUM. Ideally no more than 50L of highly flammable liquid with a flash point below the maximum ambient temperature of the workplace (nominally 32°C) or no more than 250L of other flammable liquids with a flashpoint of up to 55°C should be stored in any one lab.**

Further information is available from the HSE:

http://www.hse.gov.uk/fireandexplosion/storageflammliquids.htm

Sodium, potassium or calcium metal in solvent bottles must be destroyed and the bottles washed and dried before being disposed of using the School Waste Chemical bottle disposal procedure (page 10). Sodium or potassium wire should be destroyed by lifting it out of the bottle with a wire hook and adding it in small portions to propan-2-ol in a beaker. Calcium should be added gradually to water. **Oxide coating on potassium is explosive**. A COSHH risk assessment MUST be carried out before attempting to neutralise these types of highly flammable compounds and the best method to do so will be advised to you by your supervisor or laboratory technicians (e.g. .Mr Dave Coulter/Mr. Michael McCaffrey).

All thermostats should be fitted with safety cut-outs designed to switch off the supply in case of relay failure. The heater in a thermostat should not be capable of raising the temperature more than about 20°C above the intended temperature if left on all the time. Use a Variac to reduce the wattage to a suitable level.
Paper, cardboard or clothing fires should be tackled with a CO_2, water extinguisher or hose; flammable solvent fires with CO_2, dry powder or foam; electrical fires with CO_2 and dry powder.

Metals, hydrides and organometallics must be attacked with special dry powder extinguishers. (available upon request once a risk assessment has been conducted).

All labs should also have fire buckets containing sand or a special green absorbent material. These work well at smothering a fire e.g. small still fire in a fume cupboard. Fire blankets also serve to do the same. **FAMILIARIZE YOURSELF WITH EXTINGUISHER LOCATIONS - all labs should have at least one or more CO2 extinguishers and some will have in addition dry powder and foam depending on the type of work that is being conducted. All corridors will also have extinguishers wall mounted at various intervals.**

ONLY use an extinguisher if you have been trained how do so or if you are confident that the fire can be tackled safely by the use of one extinguisher. If in doubt raise the alarm instead by breaking the glass in the red break-glass located outside laboratory doors.

Dial the emergency number 2222 and request the fire brigade when you are in a place of safety.

Manual call point

Inform one of the fire wardens AFTER you have evacuated the building. See (How to cope with Emergencies section).

Fire extinguisher training is held annually. The Safety Adviser will send out emails informing of the dates. It is mandatory that staff and students attend fire safety training on a regular basis, especially those working in high risk labs or using lasers.

ALL Staff MUST ALSO complete the on-line fire safety training module at:

https://www.qub.ac.uk/qol/

6. TOXIC CHEMICALS including MERCURY

Routes into the body are: inhalation, ingestion, contact (skin, eyes) and injection (explosion). Read and heed the manufacturers' warning labels on bottles (see COSHH regulations) and check the manufacturers SDS for additional information. If you transfer any chemicals to new containers you must ensure that they are **PROPERLY LABELLED** with the name of the substance, ownership, laboratory No., date, and the warning information given on the original bottle. Use self-adhesive labels (from Stores), not gummed labels, and black pencil, not water-soluble or biro ink. Replace any label that is becoming detached or illegible.

Exposed surfaces of mercury give off vapor which can create a serious poisoning hazard, especially in a warm, congested or inadequately ventilated room. Neglected spilt mercury under benches etc. is particularly dangerous. Where possible, apparatus containing mercury should be set up on trays with raised edges in order to confine spills. All pouring of mercury is to be done inside or over such trays. Spilt mercury must be cleaned up at once and completely (see school Safety Adviser for further information). **Mercury Spill Kits** are available from the School Safety Adviser, Chemistry Stores and from the basement workshop. At regular intervals all under bench cupboards in research laboratories should be moved out and the floors under them inspected for mercury. The University Safety Adviser has a mercury vapor detector and will monitor any laboratory on request.

A service is available through the University Health Service to provide blood tests for specific toxic materials such as mercury and lead. Any individual who wishes to arrange a blood test for a given substance should notify the School Safety Adviser. This is conducted as part of the COSHH risk assessment under provision of Health Surveillance.

A list of exposure limits for toxic chemicals is given in Appendix 7. Beware of the reaction: HCHO + HCl $ClCH_2$-O-CH_2Cl. **AVOID INHALATION OF HF AND HNO_3**.

If particularly toxic or “smelly” compounds are being used, e.g. Thiols, effluents should be “scrubbed chemically” or “trapped physically”.

7. VENTILATION AND FUME CUPBOARDS LEVs (LOCAL EXHAUST VENTILATION

Do not work with toxic gases (or any other toxic material) on a larger scale than is strictly necessary and ensure that a COSHH risk assessment is carried out. Many preparations can be carried on a very much smaller scale than in the original literature description, with the advantages of economy, speed, safety and convenience. Disposal problems are also eased.

- Make sure that any fume cupboard you propose to use is switched on **and functioning.** (Check the airflow indicator on the right hand side of fume cupboard) A simple tell-tale ribbon (strip or piece of plastic bin liner) securely attached to the inside of the sash will give an instant visual indication that the fume cupboard is operating effectively.

- Ideally when working at a fume cupboard the sash should be opened to a height of 500mm and the air flow in the cupboard should be at a **MINIMUM** of 0.5m/sec. If the flow rate is **BELOW** this then **DO NOT USE IT** and report the defect to either the Safety Adviser or one of the Building Liaison Officers.

- If the controller indicating flow is not working - DO NOT USE and report immediately

- Do not set up apparatus/equipment close to the front edge of the fume cupboard or so far at the back that it obstructs the bottom “back baffle” or that the experimenter has to put his/her head in the working chamber to operate the equipment.

- Clean up spillages promptly and effectively (use trays to contain any potential liquid/mercury spills).

- Unattended processes should have a risk assessment and a completed “unattended apparatus” form, downloadable from the School website, securely attached to the front sash of the fume cupboard.

- Fume cupboards should NOT be used as a storage area for redundant equipment/chemicals. **Remember:** Airflow is inefficient in a cluttered cupboard.

- Except in those laboratories in which make-up air is provided, a window must be opened to enable fume cupboards to function properly. If you plan to use a fume cupboard extensively, have the airflow measured by the University Safety Officer or the School Safety Adviser. Do not evolve a vast amount of toxic material e.g. HF, Br_2, into the fume cupboard. It is not a vapor phase dustbin. You cannot be sure where the fumes will end up. If in doubt - TRAP.

- Monthly flow rate checks are carried out on all fume cupboards by the School Safety Officer.

8. GLASSWARE INSPECTION AND VACUUM LINES

Even minute flaws, stresses or cracks can have serious consequences. Glassware must be inspected regularly and discarded or repaired if there is any sign of a fault. Do NOT use broken/chipped flasks/beakers. INSPECT all glassware on removal from dishwashers.

9. EXPLOSION AND IMPLOSION HAZARDS

If you intend to work with quantities of a material with known or potential explosive properties exceeding about O.lg, ordinary personal protection described in Section 4 will not suffice. The risk assessment should recommend placing a Perspex explosion screen (available from the Stores/teaching labs) between yourself and the apparatus, and if necessary protect other workers by a second screen behind the apparatus. A plastic face visor should also be worn in conjunction with eye protection. (Contact the school Safety Adviser for further advice).

One of the most common explosion hazards is due to the use of peroxidized solvents. Some solvents, in particular ethers and olefins, form explosive peroxides on exposure to air and light. Before any solvent of this type is evaporated to dryness it must be tested for presence of peroxides with KI. Beware of peroxide encrustations around the caps of old ether bottles - diisopropyl ether is particularly notorious.

When glassblowing, particularly with bulbs, take great care that they are open to atmosphere and remove combustible or toxic gases or vapors before commencing operations. Explosive mixtures may be present in any glass bulb whose history is uncertain. If organic liquids are used to wash out glassware, followed by drying in an oven, always be sure to displace the organic vapor by a stream of air after removal from the oven, and always minimize flammable solvent introduction to ovens. Glassware to be repaired by the glassblowing shop must be handed over thoroughly clean and free from organic vapors, grease and mercury.

There is a danger of implosion when large glass vessels are evacuated. Do not use flat-bottomed flasks or suspect glassware for high vacuum work. Large glass bulbs on vacuum trains should be protected, for example, by sellotape or by enclosure in heavy polythene bags or by wire gauze. Vacuum desiccators must either be covered with strips of sellotape or placed in protective wire cages. After a vacuum distillation, cool the apparatus to room temperature before admitting air. Beware of scaling up - can the heat of reaction be dissipated?

If a trap cooled in liquid nitrogen is allowed to fill with air at atmospheric pressure, liquid oxygen will condense in it. In the presence of combustible materials an explosion may then occur.

A list of explosive chemical types and combinations is given in Appendix 6.

10. CHEMICAL WASTE DISPOSAL

Waste organic solvents must normally be placed in labelled organic waste solvent bottles fitted with a special lidded funnel (available to purchase from the Stores) and ***NOT*** poured down sinks in laboratories. Organic solvent waste MUST be segregated into HALOGENATED and NON-HALOGENATED. When full, these may be taken to the outside flammable waste storage container and disposed of in accordance with the School Procedure for Safe Disposal of Waste Solvents (see page 27).

(SUITABLE PPE-lab coat, gloves, glasses/visor and organic vapour respirator MUST BE WORN FOR THIS PROCEDURE)

Small amounts of harmless water-miscible solvents such as ethanol or acetone may be poured down the sink provided they are copiously diluted with COLD running water See Appendix 2.

The **safe disposal of other dangerous chemical wastes** is **THE RESPONSIBILITY OF THE PERSON WHO MADE THEM!**

The online CHEMICAL WASTE DISPOSAL FORM must be completed properly and emailed to the Safety Adviser BEFORE chemicals can be removed for disposal.

Waste products (solid and liquid) should be placed in a suitable, secure container adequately labelled with the **chemical name** and **hazard classification** of the compound as well as the **CONTAINER SIZE** and not merely the quantity of the compound.

Hazard Classifications include: **T**(toxic), **F**(flammable), **F+**(highly flammable), **C**(corrosive), **O**(oxidizing), **Carc**(carcinogenic), **X** (harmful), **Xi** (irritant), **N**(harmful to the environment), **E**(explosive). The person who wishes the waste to be removed must also include on the form their NAME, LAB NUMBER and CONTACT NUMBER.

The appropriate waste disposal forms available on-line or from the School Safety Adviser should accompany it. Copies must be sent electronically to the School Safety Adviser **BEFORE** placing in the outside waste chemical store to be collected. **NO PERSON OTHER THAN THE SCHOOL SAFETY ADVISER IS ALLOWED UNAUTHORIZED ACCESS TO THIS AREA AND NO WASTE IS TO BE PLACED THERE WITHOUT THEIR PERMISSION.** The School Safety Adviser will gladly advise on how to treat wastes. (See Appendix 2 page **45**)

Before signing the certificate the Safety Adviser must be satisfied that usable chemicals have been appropriately disposed of (or passed on to other researchers), that unusable surplus materials have been suitably destroyed or disposed of and that the student's glassware is clean and contains no unwanted reaction products. The research supervisor must ensure that these steps have been taken **before** the Safety Adviser is asked to organize the inspection.
Waste silica- double bagged or secure plastic lidded container and placed in the Waste Silica blue drum located at the side of the flammable storage container located in the goods yard.

11. DISPOSAL OF OTHER TYPES OF PACKAGING AND REDUNDANT ELECTRICAL ITEMS

(a) Wooden crates /pallets - contact one of the building liaison officers to put an application for its removal online BEFORE leaving in the goods yard.

(b) Broken fridges - contact one of the building liaison officers to put an application for its removal online BEFORE leaving in the goods yard. Fridges/freezers MUST have the door/s removed before leaving in the goods yard.

(c) Polystyrene and plastic packaging - can be disposed of in ordinary Eurobins adjacent to the Sir Bernard Crossland building.

(d) Redundant batteries - dispose of in special labelled red bins located in the ground floor foyer Stranmillis Road opposite the General Office.

(e) Redundant electrical equipment - must be disposed of in accordance with the WEEE Regulations. ALL electrical equipment for disposal must go through Mr Trevor Sewell who will advise on where it is to be stored before it’s removal. Waste electrical equipment MUST NEVER be disposed of in Eurobins or skips on the University premises.

(f) Redundant computers, printers, hard drives and the like must be disposed of using the School Waste computer disposal procedure and the appropriate waste disposal forms filled in prior to removal. Forms are downloadable at:

https://intranet.qol.qub.ac.uk/schools/schem/

under Disposal of Redundant/Scrap Equipment/Computers.

Waste Disposal Procedure

Chemical Bottles (Empty)

- Clean and rinse containers. Remove and discard tops.
- Remove/deface hazard warning labels.
- Bottles have to be separated between plastic/glass/aluminum and disposed of in their respective containers in the Goods Yard.

Plastic Bottles

Glass Bottles

Alu. Bottles

Silica Waste

- All silica waste should be dampened and placed in a secure lidded plastic container labelled as **"SILICA WASTE"**.
- Dispose of in the silica bin in locked cage outside *Stores* & fill waste book in *Stores* (LG.413).

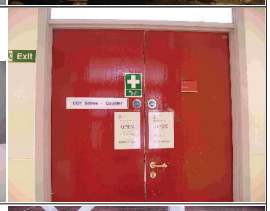
Broken Glass

- Broken glass must be placed in a sealed cardboard box
- Label **"BROKEN GLASS"** and dispose of in the general waste Eurobins.

Sharps Bin

- Sharps bins filled to line indicated should have the lid secured in place.
- Bring bins to *Stores* (LG.413), fill waste book & purchase an empty one.
- Do not overfill bins and empty regularly.

They must **NEVER** be placed in any of the general waste bins



Cardboard Only

- Cardboard has to be flat-packed and placed in the green cardboard recycling bins up the slopes in the Goods Yard.

All Other Packaging: polystyrene, plastic wrapping...

- All other packaging materials can be disposed of in the general waste Eurobins.

Paper (including confidential waste paper)

- Waste paper bags to be emptied by office/lab occupiers regularly.
- Do not fill past line on side of bag or it may be rejected as too heavy and bring to the *Stores* (LG.413) on Tuesday afternoon.

All IT equipment & Electrical Goods

To be reported to *Trevor Sewell* (Ext 5579) or *Kirin Hill* (Ext 4885) to arrange for their disposal.

They **MUST NOT** be placed outside or in general waste bins

Waste Metal including Cu, Al

Please contact *Trevor Sewell* (Ext 5579)
t.sewell@qub.ac.uk

Redundant Regulators & Brass

Please contact *Trevor Sewell* (Ext 5579)
t.sewell@qub.ac.uk

For further information or for any issues concerning waste disposal feel free to contact **Jackie O'Connor** (jackie.oconnor@qub.ac.uk Ext 4673)

June 2015 Jackie O'Connor Ext: 4673

PROCEDURE FOR SAFE DISPOSAL OF WASTE SOLVENTS

KEY TO WASTE SOLVENT STORAGE FACILITY IS AVAILBLE ONLY DURING CHEMISTRY STORES OPENING HOURS

THE FOLLOWING PERSONAL PROTECTIVE EQUIPMENT MUST BE WORN WHEN DECANTING WASTE SOLVENT INTO THE DRUMS **(LAB COAT, SAFETY GLASSES, GLOVES, RESPIRATOR). A SAFETY VISOR IS ALSO SUPPLIED ON THE WALL OF THE CONTAINER AND IT IS ADVISABLE THAT IT IS USED TO PROTECT AGAINST POSSIBLE SPLASHES ONTO THE FACE DURING FILLING.**

- **BEFORE FILLING** CHECK THAT THE CONTAINER/S TO BE USED HAS ADEQUATE SPACE FOR YOUR WASTE. **IF THEY ARE FULL OR APPROACHING FULL DO NOT ATTEMPT TO OVERFILL THEM-**YOU MUST CONTACT STORES PERSONNEL WHO WILL PROCURE YOU A NEW EMPTY DRUM FROM THE ADJACENT LOCKED CAGE. THE STORES PERSONNEL WILL AFFIX THE CORRECT HALOGENATED OR NON HALOGENATED LABEL TO THE FRONT OF THE DRUM
- WHEN THE CORRECT DRUM HAS BEEN SELECTED AND IS IN PLACE INSIDE THE CONTAINER BEFORE EMPTYING ANY WASTE SOLVENT CHECK THAT IT HAS A CROCODILE CLIP SECURELY ATTACHED TO THE TOP RIM TO EARTH BOND IT AND THEREBY ELIMINATE STATIC DISCHARGE.
- REMOVE THE CAP FROM THE CONTAINER CAREFULLY USING THE APPROPRIATE TOOL PROVIDED (IF THE CAP CANNOT BE REMOVED BY HAND)
- AND STAND WELL BACK TO ALLOW ESCAPE OF ANY POSSIBLE VAPOUR BUILD-UP
- PLACE THE DRUM FILLING FUNNEL SECURELY OVER THE OPENING OF THE CHOSEN DRUM AND PROCEED CAREFULLY TO DECANT WASTE SOLVENT INTO DRUM TAKING CARE TO AVOID SPILLAGE.
- **DO NOT FILL DRUMS TO THE MAXIMUM CAPACITY TO ALLOW ULLAGE SPACE FOR VAPOUR BUILD-UP.**
- SMALL SPILLS ARE ABSORBED ON THE CHEMICAL SPILL (YELLOW) MATS POSITIONED IN THE BASE OF THE STORAGE CONTAINER UNDERNEATH THE METAL LATTICE SUPPORT.

N.B. IF A LARGE SPILL OCCURS THIS MUST BE REPORTED TO STORES PERSONNEL FOR IMMEDIATE CLEAN UP.

- WHEN FINISHED REMOVE FUNNEL, REPLACE CAP ON DRUM SECURELY AND CLOSE AND LOCK OUTER DOOR.
- RETURN KEY TO STORES PERSONNEL

ALL WASTE SOLVENT CONTAINERS MUST HAVE THE TOPS REMOVED, BE RINSED AND ANY HAZARDOUS LABELS REMOVED/DEFACED BEFORE PLACING IN THE WASTE CHEMICAL CONTAINER BINS IN ACCORDANCE WITH THE SCHOOL'S WASTE DISPOSAL PROCEDURES.

12. RADIOACTIVE SUBSTANCES

These are subject to special government controls. Intending users of radioactive materials should consult the University Radiation Protection Adviser, Mrs Lindsey Smith **Ext 4612.** For day-to-day advice see the School Radiation Protection Supervisor, Dr Neil Ogle (Appendix 1).

13. EXPERIMENTS LEFT UNATTENDED OUTSIDE NORMAL WORKING HOURS

The following rules must be obeyed for experiments left unattended after 19:00 hours on weekdays or at any time at weekends or on holidays:

- Details of the experiment together with the name and telephone number of both student and supervisor should be entered on a form obtainable online or from the School Safety Officer. The form should be clearly visible on the outside sash of the fume cupboard.

- Rubber or plastic tubing must be checked for condition. Connections to glass must be secured by Collier clips and water flow switches (available from workshop) must be used for experiments in which the electricity supply should be cut off if the flow of water (for example through a condenser) diminishes seriously.

- Water pumps must **NOT** be left on except with special permission from the relevant supervisor.

- Ideally water cut-off devices should always be used.

- Experiments should be carried out in a fume cupboard where possible.

- The experiment should be left unattended **ONLY AFTER** steady-state conditions have been reached; this is particularly required when high temperature furnaces are used.

14. COMPLAINTS ABOUT SAFETY MATTERS

If you are dissatisfied with any aspect of safety in the School take your complaint, preferably in writing, to an appropriate member of the School Safety Committee, e.g. the representative of your section, laboratory or union rep (see Appendix 1).

15. WORK INVOLVING BIOLOGICAL AGENTS

Unauthorized microbiological experiments are not permitted.

Anyone wishing to conduct an experiment using biological agents must conduct a specific risk assessment and seek advice in the first instance from the School Biological Safety Adviser, Mr. Simon Murray in QUESTOR, Ext 5614. Please allow adequate time before beginning such work to allow for inoculations to be given and take effect. The brewing of alcohol is forbidden by the School rules.

Queen's University Belfast

BioCOSHH Risk Assessment

A BioCOSHH risk assessment is required for work with biological agents and hazards. The form should be completed and signed by the principal investigator. The possession or use of any Hazard Group 3 biological agent or the Hazard Group 2 biological agents *Bordetella pertussis*, *Corynebacterium diphtheriae* and *Neisseria meningitidis* requires permission from the University Safety Service.

Title/Aim of project	
Principal investigator/ Responsible person	
School	
Date of assessment	
Location of work (Buildings and room numbers)	

Section 1 Project or Activity

1.1: Brief description of project or activity

Section 2 Hazards

2.1: Biological agents or hazards	
Pathogens (ACDP/DEFRA Hazard Group 1)	
Pathogens (ACDP/DEFRA Hazard Group 2)	
Pathogens (ACDP/DEFRA Hazard Group 3)	
Toxins	
Carcinogens	
Allergens	
Human primary or continuous cell cultures	
Animal primary or continuous cell cultures	
Human cells or tissues	
Human blood or blood components	
Other human samples (Sputum, Pus, Urine, Faeces, Other bodily fluids)	
Patient contact	
Animals (Laboratory/Domestic/Farm/Wild)	
Animal cells or tissues	
Plants	
Soils	
Other biological hazards	
If a respiratory pathogen/risk of aerosols/freeze dried culture please provide details in Section 3.4	

2.2: Human diseases, illnesses or conditions associated with biological agents or hazards
Please consult the Health Protection Agency website http://www.hpa.org.uk/ or QUB Occupational Health for information regarding signs/symptoms

2.3: Potential routes of infection	
Inhalation ☐ Ingestion ☐ Injection ☐ Absorption ☐ Other ☐	Select all that apply

Section 3 Risks

3.1: Use of biological agents or hazards	
Small scale ☐ Medium scale ☐ Large scale ☐ Fieldwork ☐ Animals ☐ Plants ☐ Other ☐	Select all that apply
3.2: Frequency of use	
Daily ☐ Week ☐ Monthly ☐ Other ☐	Select one
3.3: Maximum amount or concentration used	
Negligible ☐ Low ☐ Medium ☐ High ☐	Select one
3.4: Levels of infectious aerosols	
Negligible ☐ Low ☐ Medium ☐ High ☐	Select one
3.5: Potential for exposure to biological agents or hazards	
Negligible ☐ Low ☐ Medium ☐ High ☐	Select one
3.6: Who might be at risk (*Contact the University Occupational Health Service)	
Staff ☐ Students ☐ Visitors ☐ Public ☐ Young people (<18yrs) ☐ *New and expectant mothers ☐ Other ☐	
3.7: Assessment of risk to human health of activity	
Level of risk **Effectively zero ☐ Low ☐ Low/medium ☐ Medium ☐ High ☐**	Select one
3.8: Assessment of risk to environment of activity	
Level of risk **Effectively zero ☐ Low ☐ Low/medium ☐ Medium ☐ High ☐**	Select one

Section 4 Controls

4.1: Containment	
Laboratory ☐ Animal facility ☐ Plant facility ☐ Other ☐	Select all that apply
4.2: Containment level	
Containment level (CL 1) ☐ Containment level (CL 2) ☐ Containment level (CL 3) ☐	Select one
4.3: Microbiological safety cabinets (MSC)	
Class 1 ☐ Class 2 ☐ Class 3 ☐ Other ☐	Select all that apply
4.4: Other controls	
4.5: Storage of biological agents or hazards	
Are any of the microorganisms / toxins "Schedule 5 Agents" as defined in Part 7 of the Anti-terrorism, Crime and Security Act 2001? **YES / NO**	
4.6: Transport of biological agents or hazards	
4.7: Inactivation of biological agents or hazards	
Disinfection ☐ Autoclave ☐ Fumigation ☐ Incineration ☐ Other ☐	

4.8: Personal protective equipment (PPE)	
Lab coat ☐ Lab coat ☐ Surgical scrubs ☐ Disposable clothing ☐ Apron ☐ Spectacles ☐ Goggles ☐ Face shield ☐ Gloves ☐ Special headwear ☐ Special footwear ☐ Other ☐	Select all that apply

4.9: Respiratory protective equipment (RPE)	
Disposable mask ☐ Filter mask ☐ Half face respirator ☐ Full face respirator ☐ Powered respirator ☐ Breathing apparatus ☐ Other ☐	Select all that apply
[ENTER DETAILS HERE]	

4.10: Health surveillance or immunization (If you need advice contact the University Occupational Health Service)

4.11: Emergency procedures

4.12: Instruction, training and supervision

4.13: HSE consent or DEFRA/DARD license

4.14: Emergency contacts

Name	Position	Telephone

Section 5 Signatures

5.1: Principal investigator/Responsible person

Name	Signature	Date

5.2: Signatures to demonstrate that this assessment has been read and understood by all those undertaking this work:

Name	Signature	Date

Risk Estimation Matrix

Severity of harm	Likelihood of harm			
	High	Medium	Low	Negligible
Severe				
Moderate				
Minor				
Negligible				

Header=USS BIAAC/P/12/29

16. LABELLING OF CHEMICALS

Staff and research students must put their name, lab. Number and date clearly on all containers e.g. bottles, ampoules, flasks, glassware, cylinders etc. which contain research products and other chemicals for which they are responsible. They must also be labelled with a chemical name and where appropriate, as toxic, irritant, flammable, harmful etc.

17. SUPERVISION OF RESEARCH STUDENTS

Supervisors of research students are required to comply with the following:

(a) To provide, in collaboration with each student, a written COSHH and risk assessment for each type of experiment carried out - see Appendix 5,

(b) To name an alternative supervisor if they are to be absent from the School for **more than two days** and notify the Head of the School.

(c) To visit the laboratory where their student(s) is working **at least** three times per week.

WHAT TO DO IN AN EMERGENCY

TO CALL THE EMERGENCY SERVICES, PLEASE DIAL 2222 FROM ANY TELEPHONE.

OTHER EMERGENCY CONTACT INFORMATION, INCLUDING FIRST AIDERS AND TRAINED BREATHING APPARATUS WEARERS, IS SUMMArizeD IN APPENDIX 4, PAGE 68

The David Keir building operates a fire detection system using heat and smoke detectors and manual alarm points. Due to the nature of work that is undertaken in some laboratories there is also a manually operated Toxic Gas Alarm system that is linked to the fire alarm.

The fire alarm is a CONTINUOUS Klaxon sound whereas the Toxic Gas alarm is an intermittent sounder. In both cases the emergency evacuation procedure is the same.

At an early opportunity research workers must attend one of the training sessions in firefighting held each autumn in the School. This is especially important for ALL staff/students working in high risk laboratories or involved in work with lasers.

Familiarize yourself with the location of fire alarms call points, fire extinguishers and fire blankets and be able to use where appropriate.

It is mandatory that ALL staff undertake annual fire safety training:

https://home.qol.qub.ac.uk/

Please note that any extinguishers or blankets which are deployed must be reported to the School safety Adviser so that they can be refilled/replaced.

1. FIRE EVACUATION - WHAT TO DO

If you discover a fire which cannot be controlled by **ONE** extinguisher or a fire blanket:

DO NOT LET THE FIRE GET BETWEEN YOU AND THE DOOR.

(a) RAISE THE ALARM by breaking the glass in the nearest fire alarm operating point.

(b) CALL THE FIRE BRIGADE (dial 2222). The fire alarm system in the David Keir Building is automatically relayed to the Queen's Main Security Office who will immediately ring the Fire Service. The emergency number 2222 can be used on ANY telephone in ALL offices and labs and also on the corridor telephones located beside the TOXIC gas alarms (See page **39** for locations).

(c) EVACUATE THE PREMISES by the nearest available route. Fire wardens (wearing yellow vests) will conduct a sweep of the building and advise on the nearest assembly point. All persons evacuated **MUST ASSEMBLE IN THE ASHBY BUILDING FOYER or THE TECHNOLOGY CENTRE/ SONIC ARTS CAR PARK**

Teaching staff are responsible for students in their own classes. When the fire brigade arrive the fire officer in charge will liaise with the Evacuation controller and other members of the fire evacuation team.

PLEASE NOTE THAT RED BEACONS ADJACENT TO ALL DOORS IN THE KEIR WILL FLASH DURING AN EVACUATION. PERSONS SHOULD NOT RE-ENTER THE BUILDING WHILE THEY ARE STILL FLASHING OR UNTIL THEY ARE TOLD TO DO SO BY EITHER THE WARDENS OF A MEMBER OF THE FIRE AUTHORITY

Note that fire alarm testing is carried out every Tuesday morning before 11am. Planned maintenance of the fire alarm system will be pre-warned to occupants and shall consist of intermittent operation of the alarm. Emergency repairs may not be pre-notified.

2. BOMB EVACUATION

The klaxon system will not normally be used in the event of a bomb. The following procedures will apply:

PROCEDURE A **- Suspect Explosive Device within the Building**

Warning will normally be given by Security Personnel or members of the Security Forces in attendance.

(a) In addition to any checks which may be carried out by the Security Forces or Security Personnel, individuals should check as quickly as possible offices/rooms/areas under their immediate control for the presence of suspicious objects or articles.

(b) If on inspection suspicious objects or articles are ***not*** discovered, individuals should remain in their respective areas until otherwise advised by Security Forces/Security Personnel.

(c) If on inspection a suspicious object or article ***is*** discovered the Security Forces/Security Personnel in attendance must be advised immediately so that (if necessary) the area can be quickly and safely evacuated.

PROCEDURE B **- Suspect Explosive Device External to Building**

Warning will normally be given by Security Personnel or members of the Security Forces in attendance.

On receipt of a verbal warning, personnel must move away from windows and assemble in corridors in preparation for evacuation of the building (or parts of the building) by routes advised by the Security Forces. Personnel should ***NOT*** leave the building until advised to do so. Having left the building personnel should move away to a safe location sufficiently distant to avoid injury from flying glass or other debris. Emergency Services routes must not be obstructed.

SCHOOL EMERGENCY EVACUATION PROCEDURE

Upon hearing the Klaxons sounding continuously all personnel should:-

1. Where possible switch off equipment provided this DOES NOT cause undue delay and risk.

2. Evacuate the building as quickly and calmly as possible using the nearest convenient exit (familiarize yourself with these). Emergency Exit signs are green with a running figure. **DO NOT USE LIFTS**.

3. Go directly to and assemble at either :

   The Ashby Building foyer (next building to the Keir on the right, Stranmillis Road) or

   The Technology Building/Sonic Arts Building car park (at the rear of the Keir)

4. Inform either the Fire Evacuation Controller, Evacuation Officer or a Fire Warden (wearing yellow vests) if a potentially dangerous experiment or piece of equipment has been left running.

DO NOT:

Congregate at entrances to the Keir building as this prevents egress of others and restricts access for the emergency services

Do not stand immediately outside the building in case gas cylinders explode or toxic fumes are omitted

Return to the building until the red flashing beacons at all exit doors cease to flash and you are told to do so by a Fire Warden, The Evacuation Officer or The Fire Safety Officer who will have taken advice from the Senior Fire Brigade Officer in attendance

TOXIC GAS RELEASE EMERGENCY PROCEDURE

PROCEDURE FOR POTENTIAL GAS RELEASE

1. INTRODUCTION

Due to the nature of the work within the David Keir Building, there is the potential for the release of gases or noxious fumes from laboratories and storage areas. Hazardous releases are likely to be localized to within these areas and the majority of fumes that will be detected outside of these areas will have no or minimal health and safety effects. There are some compressed gases used which can pose a serious health risk including those, such as carbon monoxide, which are toxic on inhalation and those, such as nitrogen, which can cause asphyxiation when released in large quantities. Chemical reactions undertaken in laboratories may also have the potential to generate harmful fumes.

2. DKB GAS ALARM – ACTION ON HEARING THE ALARM

An emergency gas alarm has been installed within the David Keir Building for emergencies involving hazardous gases. On hearing the Gas Alarm (a single frequency intermittent tone transmitted through the fire alarm sounders) evacuate the building using the nearest available safe exit which may not necessarily be the closest exit to you. Whilst all fire protected corridors and stairwells should be safe, evacuation should be away from the main research laboratories and basement areas, particularly the following:

Basement (Block 4, south)	Workshop, 0B.436 – Liquid Nitrogen Storage
Basement (Block 4, north)	Main Stairwell – Liquid Nitrogen Storage
First Floor (Block 4, south)	Laboratory, 01.430 –Various Compressed Gases
First Floor (Block 0)	Laboratory, 01.201 –Various Compressed Gases
Second Floor (Block 4, south)	Laboratory, 02.435 – Various Compressed Gases
Third Floor (Block 4, south)	Laboratory, 03.404 – Various Compressed Gases

The normal evacuation procedure should then be followed.

3. ACTION ON CATASTROPHIC RELEASE – ACTIVATION OF THE GAS ALARM

In the event of the catastrophic failure of containment such as gas cylinder rupture and a known hazardous gas has been released, the room should be immediately evacuated and the building gas alarm activated (BLUE alarm call point) located in the corridor outside the laboratory. The break-glass is operated by pressing the front face firmly until the alarm sounds.

If it is safe to do so, remain outside the laboratory and identify the source of the danger to those approaching. If you feel it is unsafe to remain by the call point, evacuate by the nearest safe exit and then go immediately and report to the Evacuation Control Team on the Stranmillis Road.

4. ACTION IF A GAS LEAK IS SUSPECTED

If a hazardous gas leak is suspected make contact with one the emergency contacts from the School of Chemistry and Chemical Engineering using the phone adjacent to the gas alarm call point:

School Safety Officer	Press 'Dial' followed by '2'	(Jackie O'Connor Ext 4673)
School Office	Press 'Dial' followed by '3'	(Ext 5418)
QUESTOR Safety Officer	Press 'Dial' followed by '4'	(Julie Anne Hanna Ext 4675)
QUILL Safety Officer	Press 'Dial' followed by '5'	(Maggel Deetlefs Ext 4863)
Security Control	Press 'Dial' followed by '6'	(Ext 5099)

If there is no response, dial 2222.

Follow the instructions given by the School contacts or Security Control. If no assistance is available, operate the Toxic Gas Alarm (Blue Call Point). The break-glass is operated by pressing the front face firmly until the alarm sounds. Following activation of the alarm, evacuate the building by the nearest available safe route to fresh air and then immediately go to the Stranmillis Road and report to the Evacuation Control Team.

The Gas Alarm (Blue Call Point) must only be activated on the instructions of the School Contacts or Security UNLESS there is an obvious sign of serious or imminent danger. This would include persons experiencing difficulty breathing or coming across an unconscious casualty etc.

5. GAS ALARM (BLUE CALL POINT) LOCATIONS

Block 0 (East side, Stranmillis Road)

Ground Floor	Lobby - outside DKB General Office
First Floor	Corridor - outside Laboratory 01.201

Block 4 (West side, Malone Road)

Basement	Corridor (south end) – opposite Chem/ Chem Eng Workshop
Lower Ground	Stairwell landing (main south stairwell)
Ground Floor	Stairwell / Exit to Goods Yard (main south stairwell)
First Floor	Corridor (south end) – at doors to Psychology, outside Lab 01.430
Second Floor	Corridor (south end) - at doors to Psychology, outside Lab 02.435
Third Floor	Corridor (south end) - at doors to Psychology, outside Lab 03.416

DEALING WITH CASUALTIES

Do not become a casualty by choice. If a toxic gas or vapor escapes into your laboratory in amounts large enough to cause discomfort or danger **GET OUT** first and report to an evacuation warden. Four sets of Breathing Apparatus are available on the Lower Ground Floor opposite the Mass Spec Laboratory but these must be used only by trained personnel. See Appendix 4.

N.B. Only persons qualified in the use of breathing apparatus are permitted to attempt to rescue a casualty from a room filled with toxic fumes.

First-aid treatment for minor injuries should be given on the spot, if possible by a trained First Aider (see Appendix 4). Notify a member of academic staff /technical staff immediately and remember to use the emergency number 2222

Where medical attention is required, the casualty should be taken to the University Health Service for treatment without delay, provided that it appears safe to do so. If possible the University Health Center should be notified by telephone (dial 5551) that the casualty/casualties are in transit. (If known, a ***brief*** description of the injuries sustained or ill-health condition can be given at this time). Very urgent cases (for example, major burns, severe hæmorrhage, cyanide poisoning) should be taken **IMMEDIATELY** to hospital.

NOTE: Casualty Department in the Royal Victoria Hospital is **ALWAYS OPEN**. **If transport is required dial 2222 and ask for an ambulance**.

After 17:00 and at week-ends and holiday periods.

If urgent medical attention is required telephone the emergency telephone number (2222) and ask for the Ambulance Service to be called. (***Speak clearly and give precise details about the location of the casualty*** i.e. name of building, address, floor, room number).

Alternatively telephone the (external) emergency number (999) and follow the instruction above.

CAUTION: The ‘999’ number can be obtained ***only*** from telephone extensions which have appropriate levels of access but the ‘2222’ number can be obtained from ***any*** internal telephone (including - if fitted - telephones in passenger lifts).

One person should be instructed to meet the Ambulance Crew at the entrance to the building and bring them to the casualty.

REPORTING ACCIDENTS- AC1 FORM AND B1510 ACCIDENT BOOK

The School endorses reporting of **ALL** accidents, near misses and dangerous occurrences which occur within the Keir building not just in laboratory settings.

Definition of accident/dangerous occurrence/near miss is:

An unplanned event, including physical violence, which may or may not result in injury or ill health to individuals, damage or loss of property, plant, materials or damage to the environment.

The proper recording of accidents is important and is **required by law** (RIDDOR, see http://www.riddor.gov.uk/info.html). Such records help us to improve our safety arrangements and may be needed in the event of insurance claims or legal proceedings.

Trivial cuts and burns which can be adequately treated on the spot and do not cause the victim to cease work need not be reported but written reports are required on ALL other accidents causing **EITHER** personal injury serious enough to require medical attention OR severe and unusual damage to property (e.g. by fire, flood or explosion).

Report **PERSONAL INJURIES AND/OR DANGEROUS OCCURENCES** on the accident report form **AC1** obtainable from the General Office, the School Safety Adviser or online at:

http://www.qub.ac.uk/directorates/HumanResources/OccupationalHealthandSafety/AccidentReporting/

N.B AC1 Forms should ONLY be completed by the supervisor/line manager/senior member of staff in charge or present at the incident and NEVER by the injured person.

Completed **AC1** forms should be filled in without any unnecessary delay and passed to the School Safety Adviser who will in return report the incident to Safety Services. All such incidents are reported at the School Safety Committee meetings for comment and in turn discussed at School Board meetings.

If an injury has been sustained by an individual then in addition to completion of the AC1 form the **individual concerned** must also complete the Accident Report Book **B1510** which is held in Room LG014 (Safety Advisers Office). The completed accident record **B1510** will be held confidentially in accordance with the *Data Protection Act 1998.* **PROPERTY DAMAGE** requires a brief signed - and - dated statement for which no special form need be used.

GUIDANCE FOR PREGNANT EMPLOYEES & STUDENTS

The School is committed to protecting the health of new and expectant mothers. A “new” or “expectant mother” is an employee or student who is pregnant, or who has given birth within the previous six months, or who is breast feeding.

1. SCHOOL RESPONSIBILITY

The School is legally required to conduct generic and specific risk assessments to ensure that any significant risks to women of child bearing age are identified and minimized. Once a member of staff or student advises that they are pregnant, a specific individual risk assessment must be made of the work carried out by that person to ensure that they are not put at risk during and immediately after their pregnancy.

The majority of health and safety issues concerning new and expectant mothers should already be addressed by good health and safety management procedures and practices such as COSHH, however special attention must be made to **high risk** environments such as work with **teratogens, carcinogens, cytotoxic drugs, steroids, certain biological agents, ionizing radiation and chemicals contra-indicated for pregnancy and/or breast feeding.**
Risks to be considered in **low risk** environments include manual handling, use of computer equipment, slips and falls, lone working, stress and potential for violence.

More information is available from:

http://www.qub.ac.uk/directorates/HumanResources/OccupationalHealthandSafety/NewandExpectantMothers/Overview/

2. EMPLOYEE/STUDENT RESPONSIBILITY

It is essential that staff and students inform their Line Manager/Supervisor/Tutor as early as possible that they are pregnant, have given birth in the previous six months or are breast feeding to enable the necessary risk assessment to be undertaken.
This is particularly important if there are known personal or work activity risks. Further advice may be obtained from the Occupational Health Service Ext 5520.

Staff and students who become aware that they are suffering from infectious diseases such as chickenpox, mumps or rubella should not return to work or classes until they are recovered and are no longer infectious. Staff bringing visitors, particularly children, into the university should ensure that those known to be suffering from and infectious disease do not attend until recovered.

Self-Assessment Quiz on Safety

What is the emergency telephone number?

Do you know what to do when...

1. A fire breaks out in your laboratory?
2. You hear the continuous sound of the alarm system?
3. A student in your laboratory is seriously injured and needs medical attention?
4. There is an escape of toxic gases or fumes in your laboratory and someone falls unconscious to the ground?

Where are:

1. The assembly points for the building?
2. The chemical waste glass bins located?
3. What does PPE stand for?
4. What must you always wear when working in a laboratory?
5. What do you need to do if you become pregnant?
6. Where do you get safety glasses, lab coats and gloves?
7. How and where do you dispose of waste solvents
8. What is a sharps bin used for?

IF YOU CANNOT ANSWER ALL THESE QUESTIONS IMMEDIATELY YOU NEED TO STUDY THIS HANDOUT AGAIN!!

APPENDIX 1

School of Chemistry & Chemical Engineering
Health and Safety Committee Membership and phone extension

Prof. Peter Robertson	(Chairman, School Health & Safety Committee)
Mrs Jackie O'Connor	(Safety Officer, School of Chem. & Chem. Eng., 4673)
Ms Fiona Mulligan	(Secretary)
Prof. S.E. J. Bell	(Laser Safety Adviser 4470, 4460)
Mr Ciaran Coney	Research Student Representative (Centacat)
Mr. James McClory	Research Student Representative (Centacat)
Ms. Katherine McBride	Research Student Representative (IMM) 4073
Mr. T. Sewell	Laboratory Manager, ASEP, 5579, 5580
Mr George Burton	Trade Union Representative 4433
Dr Maggel Deetlefs	QUILL Asst Director, 4863
Dr Julie Anne Hanna	Questor Manager ATU 4675
Representative	ALMAC 028 9022 5588

SOME OTHER PERSONS WHO MAY NEED TO BE CONTACTED REGARDING SAFETY

Head of School	Prof. Peter Robertson	4627
School Safety Adviser	Mrs Jackie O Connor	4673
Radiation Protection Supervisor	Dr. N. Ogle (SPACE)	4908/4906/4956
Laser Safety Adviser	Prof Steven Bell	4470
University Safety Service (Manager)	Mr. Robin Butler	5559
University Safety Officer /RPA	Ms Lindsey Smith	4612
University Safety Officer	Mrs. Julie McConkey	4739
University Safety Officer	Mr. C. Richardson	4608
University Fire Safety Officer	Mr. Ciaran Connolly	1112
Assistant Fire Safety Officer	Mr. Nigel Dunlop	1092

APPENDIX 2

CHEMICAL WASTE DISPOSAL IN THE SCHOOL OF CHEMISTRY AND CHEMICAL ENGINEERING

The primary responsibility for disposal of dangerous chemical wastes lies with the producer ***NOT*** the School Safety Officer, the University Safety Service or the technical staff.

'Members of staff in charge of teaching or research in which dangerous chemicals are used are personally responsible for arranging the safe storage or consignment to waste of surpluses of these chemicals on completion of any course or project.'

As for reaction products and residues arising from research, the research supervisor concerned obviously has responsibility for their safe disposal or conversion to harmless materials, and would often be the only person with the specialist knowledge required for the job. The following general suggestions for waste management are offered. Buy in as little as possible. **Do not let** your chemical waste accumulate in quantities or forms which will make treatment **difficult**: for instance, don't dump filter papers, mercury, cotton wool, glass wool, or broken glass **AND** chemicals in the same container. Do not include with dangerous chemical wastes large quantities of harmless wastes which could alternatively go into a sink or dustbin. Clean up your glassware immediately after use, before the stoppers get stuck.

CHEMICAL WASTE (SOLID AND LIQUID)

Solid and liquid waste chemicals which cannot be disposed of in house MUST be sent for disposal using the University Waste Disposal contractor.

Before this waste can be removed the following procedure must be followed:

1. Waste is placed in a suitable sealed waste container with an appropriate fitting lid- NO round bottomed flasks or other such receptacles are permitted.

2. The waste disposal inventory form must be filled in correctly on line. One copy has to be attached to the item for disposal and a copy emailed to the Safety Officer. Forms can be obtained at https://intranet.qol.qub.ac.uk/schools/schem/ entitled Chemical Disposal Inventory.

3. The waste disposal form MUST include the name of the compound, the CONTAINER SIZE in which it is held and not merely the amount of compound and the hazard classification of the compound e.g Xi(irritant), Xn(harmful), C(corrosive), F(flammable) O(oxidizer), T(toxic), N(harmful to the environment) etc.

4. Once the form is emailed to The Safety Officer he/she will supply a box number to be used with the form and this can then be brought down to Chemistry Stores for safe storage. Waste which has not been dealt with in this manner will be refused storage by Stores personnel and will not be permitted to be lifted.

WASTE OIL (inc vacuum pump and silicone oils)

Same procedure as waste Chemicals to be used

SILICA (see also SOP Appendix 13 page 124)

Waste silica requires special handling and must be disposed of carefully. Any waste silica generated from research work must be placed in a suitable lidded container and dampened well with water BEFORE being placed in the waste silica bin in the locked cage at the back of Chemistry Stores. Key is available form Stores personnel. Please familiarize yourself with this process or ask one of the Store personnel. Undergraduates will not be permitted to handle any waste silica. Technical staff will deal with its waste disposal.

Packed Silica Waste

PICTURE 3

LITHIUM ALUMINIUM HYDRIDE

Specific guidelines on the disposal of this compound are available from the School Safety Advisor. This MUST be carried out in a fume cupboard using appropriate eye protection(goggles or visor). The reagent, both solid and solution, should be disposed of by cautiously adding it to a solution of ethyl acetate in dry THF(1:2) under an atmosphere of nitrogen. NEVER add reagent residues to water or alcohols: there might be a violent explosion. Contaminated apparatus may be treated with ethyl acetate. Later(after at least 1 hour) wash the apparatus in water and dilute HCL, then re-rinse with water.

BUTYL LITHIUM

Must only be disposed of be a member of technical/academic staff using a prescribed safe procedure – contact Dave Coulter on Ext 4464/4067 for advice.

WASTE ORGANIC SOLVENTS

Apart from those listed under (1), waste organic solvents must be collected and disposed of by a professional waste disposal firm. (see Waste Disposal Procedure page 27)

DISPOSAL VIA DRAINS

The following wastes, not exceeding 2 liters, may be put down drains **IF, AND ONLY IF**, copiously diluted with many times their volume of COLD water:

- water-miscible (<3%) organic substances of relatively low toxicity including methanol, ethanol, glycol, glycerol and other lower alkanols; formic acid, acetic acid and other lower alkanoic acids; formaldehyde and acetaldehyde; acetone and other lower alkanones; tetrahydrofuran and the 'glyme' ethers; dimethylformamide; dimethylsulphoxide: with the exception of chlorites, cyanides, sulphides, azides, borohydrides, and any other compounds capable of generating highly toxic or explosive gases in contact with acids, for which see Section (5) below. Large amounts of acid or base should be neutralized. "Chemical Safety Matters" quotes harmless cations and anions as : Al^{3+}, Ca^{2+}, Cu^{2+}, $Fe^{2+,3+}$, Li^{+}, Mg^{2+}, Na^{+},$NH4^{+}$, Sn^{2+}, Sr^{2+},$Ti^{3+,4+}$, H^{+}, Zn^{2+}, Zr(IV); Br^{-}, CO_3^{2-},$BO_3^{3-,}$ Cl^{-}, HSO_3^{-} I^{-}, $NO3^{-}$,PO_4^{3-} ,SO_4^{2-} SCN^{-}, OH^{-}.

OTHER WASTE

Materials which cannot be disposed of safely by the user, these include ‘flash’ and TLC silica, should be stored (in a safe manner) and reported on list to be given to the safety advisor. A university-wide waste collection will then organized, usually in the summertime. All items for disposal must be clearly and permanently labelled as to identity, amount and user. Since these collections are very expensive, responsibility must be exercised in what is left for collection. Toxic metals such as Hg^{2+}, Cd^{2+} in dilute solution should be precipitated e.g. as sulphide, filtered off and treated as in **(3)**

TO SUM UP: PLEASE design experiments to produce as little waste as possible. If you produce hazardous waste **DESTROY IT** by e.g. hypochlorite oxidation (Safety Adviser will advise). Use option (3) as a last resort. Do not leave materials lying about unlabelled in expensive containers like 3-necked quickfit flasks.

It is good practice to survey chemical stocks regularly to dispose of obsolete items, illegibly labelled containers and any chemicals that show signs of decomposition.

APPENDIX 3

GUIDELINES FOR WORK WITH CHEMICAL CARCINOGENS

1. INTRODUCTION

Cancer is the generic name for a group of diseases that affect humankind, animals and plants. In humans, almost every organ in the body can be affected. It is a disease in which some of the cells of the body have an unlimited power of disordered reproduction and show some loss of structural differentiation. This usually results in the formation of malignant tumours, which are non-encapsulated (i.e. not benign) and which are able to invade other parts of the body to form secondary tumours or metastases that are commonly responsible for death.

In the UK on average each year from 1996 to 2000 there were more than 150,000 cancer deaths, making it second only to coronary heart disease as a major cause of death. Worldwide, it has been estimated that in excess of ten million new cases of cancer are diagnosed each year. These cases are split almost equally between the developed and developing world. It has also been estimated that cancer accounts for 40% of all deaths in the age range 20-64 years (i.e. the typical working years of life).

Although this disorder remains far from well characterised, three environmental risk factors are implicated in the development of cancers : exposure to radiation, exposure to chemicals and exposure to biological agents. Also included are risk factors related to personal behaviour (in particular smoking and certain dietary factors) and to occupation. Since the time delay between first exposure to a carcinogenic agent and the onset of symptoms can vary from 5 to 40 years, it is extremely difficult to establish in retrospect the proportion of cancers attributable solely to occupational exposure. However, this proportion is likely to be small. Sir Richard Doll estimated (1992) that about 4% (up to maximum of 6%) of cancer deaths are occupationally related compared with 33-35% and 10-60% of cancer deaths related to tobacco and dietary factors respectively.

Irrespective of the "actual" proportion of cancers attributable to occupational exposure to known or putative carcinogenic agents, it is widely accepted that they are largely avoidable by the adoption of good occupational practices.

It is considered that if the practices set out in this guidance note are scrupulously adhered to, the potential risk to health from the use of carcinogenic agents in the laboratory should be reduced to a level well below that commonly and unquestioningly accepted in everyday life outside the laboratory environment.

However there is no room for complacency. Although, recent (1990-1993) retrospective studies have confirmed that the overall cancer incidence rates in laboratory workers were lower than those found in the general "age-matched" population, there was also a suggestion of elevated rates for certain types of cancer, notably lymphatic and hæmatopoietic cancers.

1.1 Carcinogenic Agents

Although the vast majority of recognised occupational carcinogens are chemical substances, various physical agents and some biological agents are capable of inducing cancer.

1.2 Chemical Carcinogens

This group includes reactive substances that are capable of directly binding to and mutating cellular DNA e.g. bis (chloromethyl) ether, dimethyl sulphate; inert substances which are metabolised by the body into reactive species capable of exerting a carcinogenic effect e.g. benzo [a] pyrene is metabolised into an epoxide and this functions as the active carcinogenic species; and substances which are not conveniently categorised by either chemical structure or mode of action e.g. polycyclic aromatic hydrocarbons, aromatic amines, aromatic nitro compounds and N-nitroso compounds.

Some inorganic compounds are also known human carcinogens. These include compounds of arsenic, beryllium, cadmium, chromium and nickel. The mechanism of action of these largely remains to be elucidated.

1.3 Physical Carcinogens

This diverse group includes ionising and non-ionising radiation, (ultraviolet, x-rays and γ-radiation) and irritants such as hard wood dust and asbestos. Whilst the damaging effects of both types of radiation can be linked to chemical modification of cellular DNA, the mode of action of other physical carcinogens is less well understood.

1.4 Biological Carcinogens

Viral Agents: The proportion of all human cancers attributable to viral agents has proved difficult to assess as the evidence is generally less conclusive than that for physical and chemical agents. However, some associations have been clearly established. For example, the Epstein-Barr virus can cause Burkitt's lymphoma in a subject whose immune system is stressed by malarial infection; a human papilloma virus, which normally causes genital warts has been implicated as the cause of cervical cancer; and hepatitis B infection has been found to induce cancer of the liver.

Oncogene: This is a gene either present in a cell or carried by a virus (usually a homologue of the cellular oncogene) capable of progressing cells through a stage in the multistage cancer process. The Advisory Committee on Genetic Modification (ACGM) defines oncogenic DNA sequences as those which induce tumours in experimental animals or which cause transformation of cells in vitro leading to an escape from normal growth control, immortalisation of cells or induce anchorage independent growth.

In this Guidance Note only laboratory work with chemical carcinogens is considered. Those intending to work with ionising or non-ionising radiation should consult Departmental local rules and seek advice from their local Radiation Protection Supervisor and the University Radiation Protection Advisor. Others intending to work with oncogenes are referred to the publication, ACGM/HSE
Guidance Note 1: Guidance on construction of recombinants containing potentially oncogenic nucleic acid sequences and should seek further guidance from their local Biological Safety Officer and the University Biological Safety Advisor.

2. RECOGNITION OF CHEMICAL CARCINOGENS

In Reg 2(1) of The Control of Substances Hazardous to Health Regs (NI) 2003 ("COSHH") a carcinogen is defined as:

(a) any substance or preparation, which when classified in accordance with the classification provided for by Reg 4 of the Chemicals (Hazard Information and Packaging) Regs (NI) 2002 ("CHiP"), would be in the category of danger, carcinogenic (category 1) or carcinogenic (category 2) whether or not the substance or preparation would be required to be classified under those Regs;

These regulations have been replaced by the Chemicals (Hazard Information and Packaging for Supply) Regs 2009. The Approved Supply List has been discontinued. The list of harmonised classifications and labelling requirements have been incorporated into Table 3.2 of Part 3 of Annex VI of the CLP Regulation;

(b) any substance or preparation listed in Schedule 1 and any substance or preparation arising from a process specified in that Schedule which is a substance hazardous to health.

Chemical substances which currently meet that definition are listed in Appendices 1, 2 and 3 (respectively).

It should be noted that under the CHiP Regs substances may be classified carcinogenic, mutagenic or toxic to reproduction (formerly teratogenic) or combinations thereof. In addition these classifications are subdivided into 3 categories with corresponding risk phrases, (R45, R49 etc). For example, carcinogenic substances are categorised as follows.

Category 1 (R45, may cause cancer and R49, may cause cancer by inhalation)

- substances known to be carcinogenic to humans. There is sufficient epidemiological evidence to establish a causal association between human exposure and the development of a cancer.

Category 2 (R45 and R49)

- substances which should be regarded as carcinogenic to humans. The classification is based on appropriate long-term animal studies and other relevant information.

Category 3 (R40, little evidence of a carcinogenic effect)

- substances which may be carcinogenic to humans. This category includes substances, which have been fully tested and which have failed to display sufficient carcinogenicity for a Category 2 classification, as well as substances which have not been fully investigated.

Although Category 3 carcinogenic substances and substances, which have been classified as exclusively mutagenic (Muta) or toxic to reproduction (Repr) (Appendices 4, 5 & 6) are not included in the COSHH definition of "carcinogen", work with these substances should be controlled in accordance with this guidance note.

Therefore it must be stressed that the substances in Appendices 1 - 6 do not represent a definitive list of chemical carcinogens. Of the 100,000 chemical substances registered in The European Inventory of Existing Commercial Chemical Substances (EINECS) between 1.1.71 and 18.9.81, only a small fraction have been fully tested for carcinogenicity and classified under CHiP. Similarly, "new" substances (ie those not listed in EINECS) remain to be tested and classified. To date about 3000 substances have been shown to ellicit some kind of carcinogenic effect in man or animals, of which only 1% are universally regarded as definite human carcinogens. Obviously, the list of proven chemical carcinogens will grow as results from epidemiological and other studies become available.

In addition, certain classes of substances (including medicines, drugs, pesticides, "new" substances and substances either used or synthesised in research and development) are exempt from classification under CHiP. Such substances may, however, be tested and/or classified under other schemes and legislation (Appendix 7). It is therefore vitally important to consult as many sources of toxicological information as possible (Appendix 8) in assessing the possible carcinogenicity of a given substance. Unknown substances or new substances for which there is no toxicological data should be controlled as potential carcinogens until there is sufficient evidence to the contrary.

3. ASSESSMENT OF WORK WITH CHEMICAL CARCINOGENS

Under Reg 6 of COSHH, there is a requirement to conduct a 'suitable and sufficient' assessment of the health risks posed by work with substances hazardous to health prior to commencement of that work. Advice and guidance on assessment is available from each Departmental COSHH Supervisor.

Detailed information, instruction and training in assessment is available through the University Safety Service.

Although a project worker may conduct the assessment if deemed competent it is the duty of the project supervisor to ensure that all his/her projects involving substances hazardous to health are properly assessed. (CVCP Guidance Note: Responsibilities of Supervisors towards Postgraduate and Undergraduate Students).

In view of the insidious nature of cancer, the assessment of work with carcinogens must be rigorous.

A rigorous assessment must be fully documented and include the following details:

- duration and nature of the project

- persons at particular risk from exposure to the carcinogen

- nature and quantities of carcinogenic substances to be used
  e.g. physical state (vapour, powder, aqueous/non-aqueous solution), physicochemical properties (volatility, lipophilic/lipophobic)

- nature, degree and route of possible exposure to the carcinogen
  e.g. inhalation of gases/vapours, absorption of liquids/vapours through the skin or other mucosal surfaces, penetration of the skin, contamination of the eyes, accidental ingestion

- practicability of preventing exposure to the carcinogen by substitution with non-carcinogenic substance or by total enclosure of the process
  e.g. use of glove-box

- steps taken to achieve adequate control where prevention is not practicable
  e.g. use of a fume cupboard, good laboratory practice

- use of personal protective equipment
  e.g. laboratory coats, dust masks, gloves etc.

- precautions to be adopted in an emergency
  e.g spills, fume cupboard failure

- safe storage and eventual disposal of the carcinogen

- arrangements for monitoring exposure (below)

- arrangements for health surveillance (below)

- information, instruction, training and supervision arrangements for those involved in storage, handling or use of carcinogenic substances

- assessment review period

3.1 Monitoring Exposure

Routine exposure monitoring should not be necessary for most research projects provided that the reliability and suitability of chosen control measures are carefully considered and the control measures are properly used and maintained. Further information about monitoring may be obtained from the University Safety Service.

3.2 Health Surveillance

Health Surveillance is appropriate for all persons working with carcinogens unless their exposure to the carcinogens is not significant. Therefore, all projects likely to entail significant exposure to carcinogenic substances should be referred to the Occupational Health Physician, Occupational Health, by the project supervisor.

3.3 Prohibited Substances

Finally, it should be noted that work with the following chemical carcinogens is prohibited under Reg 4 of COSHH: 2-naphthylamine, benzidine, 4-aminodiphenyl, 4-nitrodiphenyl, their salts and substances containing the above compounds in a total concentration exceeding 0.1%. Only the Health and Safety Executive may grant exemptions to these prohibitions.

4. PREVENTION AND/OR CONTROL OF EXPOSURE TO CHEMICAL CARCINOGENS

Under Regulation 7(5) of COSHH, if it is not reasonably practicable to prevent exposure to carcinogens by using alternative substances or processes, then adequate control of exposure to the carcinogen must be achieved by application of all of the following measures:

- totally enclose the process and handling systems unless this is not reasonably practicable
  e.g. use a glove-box

- minimise generation of, or suppress and contain, spills, leaks, dusts and vapours from carcinogens by partially enclosing the process and handling systems and using local exhuast ventilation
  e.g. work in a fume cupboard. Minimise aerosol production by avoiding, if possible, use of blenders, sonicators, vigorous mixing or shaking. Avoid grinding operations which generate dust. Use spill trays. Fit cold traps to vacuum lines.
  In addition, minimise the risk of exposure to carcinogens (via absorption through the skin, accidental ingestion and accidental injection) by wearing the appropriate personal protective equipment, by prohibiting mouth pipetting, by avoiding the use of sharps and by covering all cuts and abrasions.

- limit the quantities of carcinogens used
  e.g. consider reaction scales. Keep stocks accurately but to a minimum

- minimise the number of persons who may be exposed to carcinogens
  e.g. restrict access to the laboratory to authorised personnel only

- prohibit eating, drinking, smoking and the use of cosmetics in areas that may be contaminated with carcinogens. Exclude personal items (coats, bags, radios etc.) which would be difficult to decontaminate.

- provide and maintain adequate hygiene measures, both general and personal

- designate those areas and installations which may be contaminated by carcinogens, and use suitable and sufficient warning signs

- store, handle and dispose of carcinogens safely. Carcinogens should be stored in tightly sealed and appropriately labelled containers. They should be segregated from other substances when not in use and should be stored securely in appropriately labelled refrigerators, cupboards or rooms. Safe disposal of carcinogens should be arranged with the University Safety Service.

The application and use of the above control measures in work with carcinogens should be incorporated into a written protocol, or local rules which contain standard operating procedures and give details of good laboratory safe working practices. Written protocols should be presented to the appropriate School Safety Committee for approval prior to commencement of the work.

5. MANAGEMENT OF WORK WITH CARCINOGENS

It is the supervisor's responsibility to ensure that his/her research workers receive adequate information, instruction and training. Workers should be aware of the risks to health involved in the work and the importance of using all the requisite control measures correctly.
It is also the supervisor's responsibility to ensure that the workers are following agreed procedures and written protocols or working to agreed local rules.
Workers must not deviate from documented procedures or stray beyond the limits of the project without the supervisor's knowledge or consent.

6. REFERENCES

Approved Code of Practice : Control of substances hazardous to health, 5th Edition, HSE
Hazardous Substances : Carcinogens Guide, Croner
Occupational Carcinogens : Croner's Health and Safety Special Report 1994
EH40/0X Workplace Exposure Limits 200X, HSE
COSHH: Guidance for universities, polytechnics and colleges of further and higher education: Education Services Advisory Committee, HSC
Laboratory Work with Chemical Carcinogens and Oncogenes, Specialist Inspector Reports No. 41, HSE
Health and Safety Responsibilities of Supervisors towards Postgraduate and Undergraduate Students CVCP

Prepared by: Dr John Wilson, Radiation Protection Advisor/Occupational Hygienist
Approved by: Chemical Agents Advisory Committee

APPENDIX 1 CATEGORY 1 CARCINOGENS

Category 1 Carcinogens: R45 May cause cancer

4-aminobiphenyl and its salts
arsenic acid and its salts
arsenic pentoxide
arsenic trioxide
asbestos
benzene (+ Muta Cat 2)
benzidine and its acetate, dihydrochloride, sulphate salts
bis (chloromethyl) ether i.e. BCME
1,3 – butadiene
butane containing > 0.1% butadiene, isobutane containing > 0.1% butadiene
chloromethyl methyl ether (usually contaminated with BCME)
erionite
lead hydrogen arsenate (+Repr. Cat 1 +Repr Cat 3)
2-naphthylamine and its acetate and hydrochloride salts
petroleum gases and substances (unrefined or mildly refined base oil)
triethylarsenate
vinyl chloride
zinc chromates, including zinc potassium chromate

Category 1 Carcinogens: R49 May cause cancer by inhalation

chromium trioxide (+ Muta Cat 2, + Repr Cat 3)
dinickel trioxide
nickel dioxide
nickel monoxide
nickel subsulphide
nickel sulphide

*Additional classifications: Repr - Toxic to Reproduction
Muta - Mutagenic
Cat - Category number 1,2 or 3

APPENDIX 2 CATEGORY 2 CARCINOGENS

Category 2 Carcinogens : R45 May cause cancer

acrylamide (+ Muta Cat 2, Repr Cat 3)
acrylonitrile
4-aminoazobenzene
2-amino-5-azotoluene
4-amino-3-fluorophenol
p-aminophenylether and its salts (+ Muta Cat 2, + Repr Cat 3)
ammonium dichromate (+ Muta Cat 2, + Repr Cat 2)
aziridine (+ Muta Cat 2)
azobenzene (+ Muta Cat 3)
Basic Red 9
Basic Violet 3 (> 0.1% of Michler's ketone)
benzidine based azo dyes
benz(e) acephenanthyrlene
benzo [a] anthracene
benzo [b] fluoranthene
benzo[j] fluoranthene
benzo [k] fluoranthene
benzo [a] pyrene (+ Muta Cat 2, Repr Cat 2)
benzo [e] pyrene
benzyl chloride
2,2'-bioxirane (+ Muta Cat 2)
4,4'-bis (dimethylamino) benzophenone (+ Muta Cat 3), Michler's keton
cadmium chloride (+ Muta Cat 2, Repr Cat 2)
cadmium oxide (+ Muta Cat 2, + Repr Cat 2)
cadmium sulphate (+ Muta Cat 2, + Repr Cat 2)
cadmium sulphide (+ Muta Cat 2, + Repr Cat 2)
cadmium fluoride (+ Muta Cat 2, Repr Cat 2)
calcium chromate
captafol
carbadox
4-chloroaniline
p-chlorobenzotrichloride (+ Repr Cat 3)
chloroprene
4-chloro-o-toluidine and its hydrochloride (+ Muta Cat 3)
chromium III chromate
chyrsene (+ Muta Cat 3)
coal tar products
p-cresidine
2,4-diaminoanisole and its sulphate (+Muta Cat 3)
4,4'-diaminodiphenylmethane (+ Muta Cat 3)
2,4-diaminotoluene
o-dianisidine, its salts, azo based dyes
diazomethane
dibenz [a,h] anthracene
1,2-dibromo-3-chloropropane (+ Muta Cat 2, Repr Cat 1)
1,2-dibromoethane
2,3 dibromo-1-propanol (+Repr Cat 3)
3,3'-dichlorobenzidine and its salts
1,4-dichlorobut-2-ene
1,3-dichloro-2-propanol
diethyl sulphate (+ Muta Cat 2)
dimethylcarbamoyl chloride
1,1-dimethylhydrazine
1,2-dimethylhydrazine
dimethylnitrosamine
dimethylsulfamoyl chloride

APPENDIX 2 (continued)

dimethyl sulphate (+ Muta Cat 3)
2,3-dinitrotoluene (+ Muta Cat 2, Repr Cat 3)
2,4-dinitrotoluene (+ Muta Cat 2, Repr Cat 3)
2,5-dinitrotoluene (+ Muta Cat 3, Repr Cat 3)
2,6-dinitrololuene (+ Muta Cat 2, Repr Cat 3)
3,4-dinitrololuene (+ Muta Cat 3, Repr Cat 3)
3,5-dinitrololuene (+ Muta Cat 3, Repr Cat 3)
Direct Black 38 (+ Repr Cat 3)
Direct Blue 6 (+ Repr Cat 3)
Direct brown 95
Direct Red 28 (+ Repr Cat 3)
Disperse Blue 1
epichlorohydrin
2,3-epoxypropan-1-ol (+ Muta Cat 3, Repr Cat 2)
1,2 epoxy propane-3-phenoxy propane (+ Muta Cat 3)
ethylene dibromide
ethylene dichloride
ethylene oxide (+ Muta Cat 2)
furan (+ Muta Cat 3)
hexachlorobenzene
hexamethylphosphoramide (+ Muta Cat 2)
hydrazine and its salts
hydrazine bis (3-carboxy-4-hydroxybenzenesulphonate)
hydrazine trinitromethane
hydrazobenzene
6-hydroxy-1-(3-isopropoxy propyl)-4-methyl-2-oxo-5-[4-(phenylazo)phenylazo]-1,2-dihydro-3-pyridinecarbonitrile
(6-(4-dhyroxy-3-(2-methoxyphenylazo)-2-sulphonato-7-naphthylamino)-1,3,5-triazin-2,4-diyl)bis[(amino-1-methylethyl) ammonium] formate
isobutyl nitrite (+ muta Cat 3)
2-methoxyaniline (+ Muta Cat 3)
methoxy-m-phenylenediamine (+ Muta Cat 3)
methylacrylamidomethoxy acetate (containing) ≥ 0.1% acrylamide) (+ Muta Cat 2)
methylacrylamidoglycolate (containing ≥ 0.1% acrylamide (+ Muta Cat 2)
2-methylaziridine
methylazoxymethanol acetate (+ Repr Cat 2)
4-methylbenzene-sulphonate(s)-oxiranemethanol (+ Muta Cat 3)
4,4'-methylenebis (2-chloroaniline) and its salts
4,4'-methylene-di-o-toluidine
1-methyl-3-nitro-1-nitrosoguanidine
5-nitroacenophthene
2-nitroanisole
4-nitrobiphenyl
nitrofen (+ Repr Cat 2)
2-nitronaphthalene
2-nitropropane
nitrosodiethanolamine
nitrosodimethylamine
2,2[1]-(nitrosoimino) bisethanol
nitrosodipropylamine
2-nitrotoluene (+ Muta Cat 2, Repr Cat 3)
Petroleum Distillation Products
phenylhydrazine and its chloride and sulphate salts (+ Muta Cat 3)
potassium bromate
1,3-propanesultone

APPENDIX 2 (continued)

1,3-propiolactone
propylene oxide (+ Muta Cat 2)
safrole (+ Muta Cat 3)
strontium chromate
styrene oxide
sulfallate
N,N,N',N'-tetramethyl-4,4'-methylenedianiline
thioacetamide
4,4'thiodianiline and its salts
o-tolidine, its salts, its azo based dyes
2,4-toluenediammine
toluene-2,4-diammonium sulphate
o-toluidine
trichloroethylene (+ Muta Cat 3)
1,2,3,-trichloropropane (+ Repr Cat 2)
2,4,5-trimethylaniline and its hydrochloride
∝,∝,∝-trichlorotoluene
urethane (INN)
vinyl bromide

Category 2 Carcinogens : R49 May cause cancer by inhalation

beryllium
beryllium compounds except aluminium beryllium silicate
beryllium oxide
cadmium oxide (+ Muta Cat 3, Repr Cat 3)
chromic oxychloride
chromium (VI) compounds except barium chromate
cobalt dichloride
cobalt sulphate
potassium chromate (+ Muta Cat 2)
potassium dichromate (+ Muta Cat 2, Repr Cat 2)
refractory ceramic fibres
sodium chromate (+ Muta Cat 2, Repr Cat 2)
sodium dichromate and its dihydrate (+ Muta Cat 2, Repr Cat 2)

APPENDIX 3 **COSHH** **Schedule 1**

Other substances and processes to which the definition of "carcinogen" relates.

Aflatoxins
Arsenic
Auramine manufacture
Calcining, sintering or smelting of nickel copper matte or acid leaching or electrorefining of roasted matte
Coal soots, coal tar, pitch and coal tar fumes
Hard wood dusts
Isopropyl alcohol manufacture (strong acid process)
Leather dust (shoe manufacture)
Magenta manufacture
Mustard gas (β, β' - dichlorodiethyl sulphide)
Rubber fume and dust during processing
Used engine oils

Polychlorodibenzodioxins:

2,3,7,8 – TCDD*
1,2,3,7,8 – PeCDD
1,2,3,4,7,8 – HxCDD
1,2,3,6,7,8 – HxCDD
1,2,3,7,8,9 – HxCDD
1,2,3,4,6,7,8 – HpCDD

Polychlorodibenzofurans:

2,3,7,8 – TCDF
2,3,4,7,8 – PeCDF
1,2,3,7,8 – PeCDF
1,2,3,4,7,8 – HxCDF
1,2,3,7,8,9 – HxCDF
2,3,4,6,7,8 – HxCDF
1,2,3,4,6,7,8 – HpCDF
1,2,3,4,7,8,9 – HpCDF

**Where T=tetra, Pe=penta, Hx=hexa, Hp=hepta & O=octa*

APPENDIX 4 CATEGORY 3 CARCINOGENS

Category 3 Carcinogens: R40 Limited evidence of a carcinogenic effect

acetaldehyde
acetamide
alachlor
aldrin
allyl chloride (+ Muta Cat 3)
allyl 2,3-epoxypropylether (+ Muta Cat 3, Repr Cat 3)
allyl glycidyl ether (+ Muta Cat 3, Repr Cat 3
4-aminotoluene
amitrole
aniline and its salts
antimony trioxide
ANTU
atrazine (+ Repr Cat 3)
auramine and its salts
Basic Violet 3
benzal chloride
benzyl chloride
benzyl violet 4B
biphenyl-2-amine
bromoethane
1-bromo-3,4,5-trifluorobenzene
2-butanone oxime
butyl 2,3-epoxypropylether
cadmium sulphide
camphechlor
captan
carbaryl
carbon tetrachloride
chlordane
chlordecone
chlordimeform and hydrochloride
chloroalkanes C_{10} – C_{13}
chloroacetaldehyde
chloroethane
chloroform
1-chloro-4-nitrobenzene
chlorotoluron (+Repr Cat 3)
chlozolinate
daminozide
DDT
di-allate
2,2-dibromo-2-nitroethanol
1,4-dichlorobenzene
(+/-)2-(2,4-dichlorophenyl)-3-(1H-1,2,4-triazol-1-yl) propyl-1,1,2,2-tetrafluoroethylether
dichloroacetylene
dichloromethane
dieldrin
diethylcarbamoyl chloride
dihydroxybenzene
4-(4-(1,3-dihydroxyprop-2-yl) phenylamino)-1,8-dihydroxy-5-nitroanthraquinone
N,N-dimethylaniline
2,6-dimethylaniline
N,N-dimethylanilinium tetrakis (pentafluorophenyl) borate
3,5-dinitro-2,6-dimethyl-4^{t} butylacetophenone (Musk ketone)
1,4-dioxane

APPENDIX 4 (continued)

Disperse Yellow 3
diuron
epoxiconazole (+ Repr Cat 3)
1,2 epoxybutane
5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole
flusilazole (+ Repr Cat 2)
folpet
formaldehyde
2-furaldehyde
furmecyclox
heptachlor and its epoxide
hexachlorocyclohexane
hydroquinone (+ Muta Cat 3)
iprodione
isoproturon
kresoxim-methyl
lead acetate (+ Repr Cat 1, Repr Cat 3)
lead chromate (+ Repr Cat 1, Repr Cat 3)
lead chromate molybdate sulphate red (+ Repr Cat 1, Repr Cat 3)
linuron (+ Repr Cat 2, Cat 3)
methyl chloride
methyl iodide
4,4'-methylenebis (2-ethylaniline)
mineral wool
Mirex (+ Repr Cat 3)
Molinate
monuron and monuron – TCA
morpholine-4-carbamoyl chloride
Musk xylene (5^t butyl-2,4,6-trinitro-m-xylene)
naphthalene
1,5 naphthalene diamine
N-2-naphthylaniline
1-(1-naphthylmethyl) quinolinium chloride (+ Muta Cat 3)
nickel
nickel carbonate
nickel dihydroxide
nickel sulphate
nickel tetracarbonyl (+ Repr Cat 2)
nitrobenzene (+ Repr Cat 3)
5-nitro-o-toluidine and its hydrochloride
pentachloroethane
pentachlorophenol and its alkali salts
o-phenylenediamine and its hydrochloride
N-phenyl-2-naphthylamine
Pigment Red 104 (+ Repr Cat 1, Repr Cat 3)
Pigment Yellow 34 (+ Repr Cat 1, Repr Cat 3)
Propargite
propazine
propyzamide
pymetrazine
resorcinol diglycidylether (+ Muta Cat 3)
(2RS,3RS) -3-(2-chlorophenyl)-2-(4-fluorophenyl)-[(1H-1,2,4-triazol-1-yl)methyl]oxirane
simazine
sodium pentachlorophenate and potassium salts
solvent yellow 14 (+ Muta Cat 3)
tetrachloroethylene

APPENDIX 4 (continued)

tetrachloroisophthalonitrile
thiourea (+ Repr Cat 3)
TDI
p-toluidine and chloride and sulphate salts
tributyl phosphate
2,3,4-trichlorobut-1-ene
1,1,2-trichloroethane
trichloroethylene
3,5,5-trimethylcyclohex-2-enone
2,4,6-trichlorophenol
triphenyl tin and its acetate and hydroxide (+ Repr Cat 3)
tris (2-chloroethyl) phosphate
vinclozolin (+ Repr Cat 2)
vinylidene chloride
1-vinyl-2-pyrrolidone

APPENDIX 5 MUTAGENIC SUBSTANCES

Category 1: Substances known to be mutagenic to humans

R46 *May cause heritable genetic damage.*

None

Category 2: Substances which should be regarded as if they are mutagenic to humans.

R46 *May cause heritable genetic damage.*

benomyl (+ Repr Cat 2)
carbendazim (+ Repr Cat 2)
TGIC-triglycidyl isocyanurate
1,3,5-tris-[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione

Category 3: Substances which cause concern for humans owing to possible mutagenic effects.

R68 *Possible risk of irreversible effects.*

allyl epoxypropylphenol mixtures
2-aminophenol
4-aminophenol
1,3-bis (vinylsulphonylacetamido) propane
bromomethane
2 butenal
(3-chlorophenyl)-(4-methoxy-3-nitrophenyl) methanone
cresylglycidyl ether
crotonaldehyde
cycloheximide (+ Repr Cat 2)
2,3-dichloropropene
5-(2,4-dioxo-1,2,3,4-tetrahydropyrimidine)-3-fluoro-2-hydroxymethyltetrahydrofuran
DNOC
2,3-epoxypropyl-o-tolyl ether
4-ethoxyaniline
4^1-ethoxy-2-benzimidazoleanilide
1-ethyl-1-methylmorpholium bromide
1-ethyl-1-methylpyrrolidinium bromide
Fenthion
Glyoxal
hexahydrocyclopenta[c]pyrolle-1-(1H)-ammonium N-ethoxy carbonyl-N-(p-tolylsulphonyl) azanide
(4-hydrazinophenyl)-N-methylmethanesulphonamide hydrochloride
2-(isocyanatosulphonylmethyl) benzoic acid methyl ester
2-methyl-m-phenylenediamine
monocrotophos
4-nitrosophenol
phenol
m-phenylenediamine and its hydrochloride
phosphamidon
pyrogallol
N,N,N^1,N^1-tetraglycidyl-4,4^1diamino-3,3^1-diethyldiphenylmethane
(+/-) tetrahydrofurfuryl (R)-2-[4-(6-chloroquinoxalin-2-yloxy)phenyloxy]propionate(+ Repr Cat 2, Repr Cat 3)
2,2^1-((3,3^1,5,5^1-tetramethyl-(1,1^1-biphenyl)-4,4^1-diyl)-bis(oxymethylene))-bis-oxirane
thiophanate-methyl
m- and p-tolyloxy methyl oxirane
trifluoroiodomethane
trisodium bis (7-acetamido-2-(4-nitro-2-oxidophenylazo)-3-sulphonato-1-naphthalato) chromate

vanadium pentoxide (+ Repr Cat 3)
9-vinylcarbazole

APPENDIX 6 SUBSTANCES TOXIC TO REPRODUCTION

Category 1: Substances known to impair fertility in humans.
Substances known to cause developmental toxicity in humans.

R60 *May impair fertility and may cause harm to the unborn child.*

2-bromopropane
tri lead bis (orthophosphate) (+ Repr Cat 3)

R61 *May cause harm to the unborn child.*

carbon monoxide
4-hydroxy-3-(3-oxo-1-phenylbutyl)-2-benzopyrone
lead alkyls (+ Repr Cat 3)
lead azide (+ Repr Cat 3)
lead di (acetate) (+ Repr Cat 3)
lead hexafluorosilicate (+ Repr Cat 3)
lead methanesulphonate
lead styphnate (+ Repr Cat 3)
lead 2,4,6-trinitroresorcinoxide (+ Repr Cat 3)
Warfarin

Category 2: Substances which should be regarded as if they impair fertility in humans.
Substances which are regarded as if they cause developmental toxicity.

R60 *May impair fertility and may cause harm to the unborn child.*

2,2-bis(4^1-hydroxyphenyl)-4-methylpentane
bis (2-methoxyethyl) ether
di –(2-ethylhexyl) phthalate
di-n-pentylphthalate
3-ethyl-2-methyl-2-(3-methybutyl)-1,3-oxazolidine
2-ethoxyethanol
methoxyacetic acid
2-methoxyethanol
2-ethoxyethyl acetate
fluazifop-butyl(ISO)
formamide
2-methoxyethyl acetate
N-methylacetamide
n-pentyl-isopentyl phthalate
n-propyl bromide (+ Repr Cat 3)

R61 *May cause harm to the unborn child.*

azafenden (+ Repr Cat 3)
benzene butyl phthalate (+ Repr Cat 3)
1,2-benzenedicarboxyli acids and dipentyl esters
binapacryl
bis (2-methoxyethyl) phthalate (+ Repr Cat 3)
dibutyl phthalate (+ Repr Cat 3)
N,N-dimethylacetamide
dimethylformamide
dinocap
dinoseb, and its salts and esters (+ Repr Cat 3)
dinoterb, and its salts and esters
diphenyl ether, octabromo derivative
2-ethylhexyl 3,5-bis(1,1-dimethyl)-4-hydroxyphenyl methylthioacetate
ethylene thiourea

APPENDIX 6 (continued)

etacelasil
flumioxazin
2-[2-hydroxy-3-(2-chlorophenyl) carbamoyl-1-naphthylazo]-7-[2-hydroxy-3-(3-chlorophenyl)carbamoyl-1-naphthylazo] fluorene-9-one
2-methoxypropanol
2-methoxypropyl acetate
N-methylformamide
tetrahydrothiopyran-3-carboxaldehyde
tridemporph
triethylene glycol dimethyl ether

Category 3: Substances which cause concern for human fertility.
Substances which cause concern for humans owing to possible developmental toxic effects.

R62 *Possible risk of impaired fertility.*

N-[2-(3 acetyl-5-nitrothiophen-2-ylazo)-5-diethylaminophenol] acetamide
benzyl 2,4-dibromobutanoate
bis(eta 5-cyclopentadienyl)-bis(2,6-difluoro-3[pyrrol-1-yl]-phenyl)titanium
bisphenol A
R-5-bromo-3-(1-methyl-2-pyrrolidmylmethyl)-1H-indole
2-(4-^{t}butylphenyl) ethanol
butylmethyl ketone
2-(4-tert-butylphenyl) ethanol
chinomethionat
2-chloroacetamide
chloro 1,3-dihydro-2H-indol-2-one
chlorotoluran
1-cyclopropyl-6,7-difluoro-1,4-dihydro-4-oxoquinoline-3-carboxylic acid
N,N^{1}-dihexadecyl-N,N^{1}-bis(2-hydroxylethyl) propanediamide
(S)-2,3-dihydro-1H-indole-2-carboxylic acid
1,3-diphenylguanidine
(ethylmethylsilylene) di [(4-methylpentan-2-one)oxime]
n-hexane
hexan-2-one
2-(2-hydroxy-3,5-dinitroanilino) ethanol
nonylphenol
octamethylcyclotetrasiloxane
(R) –a-phenylethylammonium(-)-(1R,2S)-(1,2-epoxypropyl) phosphonate monohydrate
5,6,12,13-tetrachloroanthra (2,1,9-def: 6,5,10-d^{1}e^{1}f^{1}) diisoquinoline-1,3,8,10(2H,9H)-tetrone
trans-4-cyclohexyl-L-proline monohydrochloride
trans-4-phenyl-L-proline
valinamide

R63 *Possible risk of harm to the unborn child.*

amitrole
bromoxynil and its octanoate
1-(4-chlorophenyl)-4,4-dimethyl-3-(1,2,4-triazol-1-ylmethyl) pentan-3-ol
cyproconazole
diethylene glycol monomethyl ether
2-ethylhexanoic acid

APPENDIX 6 (continued)

fenpropimorph
fluazifop-P-butyl(ISO)
ioxynil and its octanoate
isoxaflutole
malachite green and its oxalate
methylisocyanate
myclobutanil
oxadiargyl
propylenethiourea
toluene
1,2,4-triazole
1,2,5-trioxan

R62 and R63 *(as above)*

carbon disulphide
fenarimol
5-(3-butyryl-2,4,6-trimethylphenyl)-2-[1-(ethoxyimino) propyl]-3-hydroxycyclohex-2-en-1-one

APPENDIX 7 IARC CLASSIFIED CARCINOGENS*

Group 1: Carcinogenic to humans. Groups 2A: Probably carcinogenic to humans.

adriamycin
aristolochic acid
azacitidine
azathioprine
bischloroethyl nitrosourea
chlorambucil
chloramphenicol
chlornaphazine
1-(2-chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
chlorozotocin
cisplatin
cyclophosphamide
cyclosporin
dibenzo[a,l] pyrene
N-ethyl-N-nitrosourea
etoposide
gallium arsenide
glycidol
indium phosphide
IQ(2-amino-3-methylimidazo[4,5-f]quinoline
melphalan
methoxypsoralen
methoxysalen
methyl-CCNU
methyl methanesulphonate
N-methyl-N-nitrosourea
mustard gas
myleran
nitrogen mustard
N-nitrosodiethylamine
phenacetin
procarbazine hydrochloride
tamoxifen
teniposide
tetrachloroethylene
thiopeta
treosulphan
tris(2,3-dibromopropyl)phosphate
vinyl fluoride

Group 2B: Possibly carcinogenic to humans.

A-α-C(2-amino-9H-pyrido[2,3-b]indole
AF-2
amino-α-carboline
2-amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole
amsacrine
o-anisidine
antimony trioxide
aramite
azaserine
benzofuran
benzo[c]phenanthrene
2,2-bis(bromoethyl)propane-1,3-diol

**International Agency for Research on Cancer. Only substances not previously listed are included.*

APPENDIX 7 (continued)

bleomycins
bromodichloromethane
butylated hydroxyanisole
β-butyrolactone
caffeic acid
carbon black
catechol
chlorendic acid
3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone
1-chloro-2-methylpropene
chlorophenoxy herbicides
4-chloro-o-phenylenediamine
chloroprene
chlorothalonil
CI Acid Red 114
CI Direct Blue 15
Citrus Red No 2
cobalt and its compounds
p-cresidine
dacarbazine
dantron
daunomycin
NN'-diacetylbenzidine
2,4-diaminoanisole
4,4'-diaminodiphenyl ether
dibenz [a,h] acridine
dibenz [a,j] acridine
7H-dibenzo [c,g] carbazole
dibenzo [a,e] pyrene
dibenzo [a,h] pyrene
dibenzo [a,i] pyrene
dichloroacetic acid
1,2-dichloroethane
2,3-dibromopropan-1-ol
p-dichlorobenzene
3,3'-dichloro-4,4'-diaminodiphenyl ether
1,3-dichloropropene
Dichlorvos
diepoxybutane
1,2-diethylhydrazine
diglycidyl resorcinol ether
dihydrosafrole
diisopropyl sulphate
4-dimethylaminoazobenzene
trans-2-[(dimethylamino) methylimino]-5-[2-(5-nitro-2-furyl)-vinyl]-1,3,4-oxadiazole
3,7-dinitrofluoranthene
3,9-dinitrofluoranthene
1,6-dinitropyrene
1,8-dinitropyrene
ethyl acrylate
ethylbenzene
ethyl methanesulphonate
2-(2-formylhydrazino)-4-(5-nitro-2-furyl)thiazole
fumonisin B1
furothiazole
Glu-P-1

APPENDIX 7 (continued)

Glu-P-2
glycidaldehyde
griseofulvin
HC Blue No 1
hexachloroethane
1-hydroxyanthraquinone
indeno[1,2,3-cd]pyrene
iron-dextran complex
isoprene
lasiocarpine
MeA-α-C
medroxyprogesterone acetate
MeIQ
MeIQx
5-methylchrysene
methy mercury cpds
2-methyl-1-nitroanthraquinone
N-methyl-N-nitrosourethane
methylthiouracil
metronidazole
mitomycin C
mitoxantrone
monocrotaline
5-(morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone
nafenopin
naphthalene
nifuradene
niridazole
nitrilotriacetic acid
6-nitrochyrsene
2-nitrofluorene
1-[C5-nitrofurfurylidene)]-2-imidazolidinone
N-[4-(5-nitro-2-furyl)-2-thiazolyl]acetamide
nitromethane
nitrogen mustard N-oxide
1-nitropyrene
4-nitropyrene
N-nitrosodi-n-butylamine
3-(N-nitrosomethylamino) propionitrile
4-(N-nitrosomethylamino)-1-(3-pyridyl)-1-butanone
N-nitrosomethylethylamine
N-nitrosomethylvinylamine
N-nitrosomorpholine
N’-nitrosonornicotine
N-nitrosopiperidine
N-nitrosopyrrolidone
N-nitrososarcosine
ochratoxin A
oil orange SS
oxazepam
palygorskite
panfuran S
phenazopyridine hydrochloride
phenobarbital
phenolphthalein
phenoxybenzamine hydrochloride

APPENDIX 7 (continued)

phenyl glycidyl ether
phenytoin
PhIP
polychloropenols and their sodium salts
Ponceau MX
Ponceau 3R
progestins
propylthiouracil
riddelline
sodium-o-phenylphenate
sterigmatocystin
streptozotocin
styrene
tetrafluoroethylene
tetranitromethane
4,4’-thiodianiline
thiouracil
titanium dioxide
TDI
trichlormethine
Trp-P-1
Trp-P-2
Trypan blue
uracil mustard
vanadium pentoxide
vinyl acetate
4-vinylcyclohexene
4-vinylcyclohexene diepoxide
zalcitabine
zidovudine

APPENDIX 8

Toxicity Data: Sources of Information

Databases:

Registry of Toxic Effects of Chemical Substances (NIOSH)
Chemical Safety Newsbase (RSC)
Occupational Safety and Health (NIOSH)
Toxline (National Library of Medicine)
Medline (National Library of Medicine)
Sigma-Aldrich-Fluka, Material Safety Data Sheets on CD-Rom

Bibliography:

Sigma-Aldrich Library of Chemical Safety Data, Vols I and II
Handbook of Identified Carcinogens and Noncarcinogens, vols I and II, Soderman, CRC Press
Dangerous Properties of Industrial Materials, Vols I, II and III, Von Nostrand, Reinhold
The Merck Index, Merck and Co Inc
Registry of Toxic Effects of Chemical Substances, Vols I and II, NIOSH
Dictionary of Substances and their Effects (DOSE) Vols 1-7, Richardson and Gargoli, RSC
Biochem Coc, Special Publication No 5 “Safety in Biological Laboratories”

APPENDIX 4

Trained First Aiders

Name	Lab./Office	Direct Internal No.
Angela Orozco	OB.437	5613
Patrick Lyner	LG.201	4221
Jackie O'Connor	LG.014	4673
Kenneth Pringle	Recept° OG.005	4253
Julie Anne Hanna	Questor 02.007	4675
Maggel Deetlefs	Quill 02.102(a)	4863
Phillip McCarron	Quill 02.403	5509

Trained Breathing Apparatus Users

Four sets of breathing apparatus have been installed in the School. They are located at the bottom of the main stairwell Stranmillis Rd entrance lower ground floor opposite Mass Spec room **THIS EQUIPMENT IS STRICTLY FOR THE USE OF TRAINED PERSONNEL ONLY** who should be contacted in case of emergency. These are:

Name	Lab.	Internal Tel. No.
Mr. Conor McGrann	LG.007/ OG.414	4676/4435
Mr. Clive Murray	LG.420 (Stores)	4440
Patrick Lyner	LG.201	4221
Dave Coulter	OG.202	4067

Anyone who, after a COSHH/Risk Assessment, requires the use of breathing apparatus to have it on standby, should contact one of the above.

Emergency Telephone Numbers

Fire, Police, Ambulance, Cardiac Unit or Poisons Center, Dial 2222 from any telephone in the School.

Emergency telephones are also located in corridors beside the blue toxic manual break glasses - these can be used to contact the emergency services or:

Security Control 5099 (24hrs)

Other numbers:

School General Office 5418/4253

University Health Centre (5 Lennoxvale) **5551**

University Safety Service (5 Lennoxvale) **4613 or 4681**.

APPENDIX 5

COSHH & RISK ASSESSMENTS

The Control of Substances Hazardous to Health (COSHH) and the Management of Health and Safety at Work Regulations (and subsequent amendments) requires that work shall not be undertaken which is liable to expose staff or students to any substances or physical risks unless a suitable and sufficient assessment has been made of the risks to health and the steps taken to meet the requirements of the regulations.

The School of Chemistry and Chemical Engineering requires completion of a COSHH and risk assessment form (obtainable online or from Jackie O Connor) to be considered whenever a chemical which appears in various safety compilations or which features in the BDH, Aldrich or other catalogues with a hazard symbol and/or risk phrase is used. For all undergraduate practicals, completed COSHH forms relating to all experiments using hazardous compounds will appear on special notice boards in the laboratories.

With regard to project and research students, supervisors must complete COSHH forms for all experiments or related groups of experiments (and send a copy to the School Safety Advisor for filing). Students should be encouraged to carry out all COSHH and risk assessments as part of their training but final responsibility for the content rests with the supervisor.

A COSHH form must be submitted to the Safety Adviser before any new type of experimental work is carried out. The COSHH form must include a rating of the risk associated with the experiment, which may restrict the period during which the work can be carried out. The following ‘descriptors’ are intended as guides in assessing the risk index to be assigned to a given experiment:

Risk Rating Low: the work can be carried at any time, even working alone (typically computer-based work).

Risk Rating Medium: the work can only be carried out in the presence of another researcher.

Risk Reading High and Very High: are not permitted without further assessment of risk involved in conjunction with PI, Safety Officer and Head of School.

Further details are available from guidance notes issued to staff and research students. The School Safety Adviser will be pleased to offer additional advice and encouragement.

THE QUEEN'S UNIVERSITY OF BELFAST

CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH

GUIDANCE NOTES ON RISK ASSESSMENT

Introduction:

A COSHH risk assessment must be conducted before you carry out any work which could expose you to substances hazardous to health.

The aim of the COSHH risk assessment is:

- to identify the substances you are going to use in a particular procedure/process/ experiment
- to determine which of those substances are hazardous to health
- to determine how those substances are hazardous and what effects they could have on your health or others' health
- to estimate the risks of exposure to these substances when you use them in the procedure/ process/experiment.
- and then to decide the precautionary measures you must take to either prevent exposure or adequately control the risk of exposure.

The precautionary measures must be implemented before you carry out this work.

Separate risk assessments are not needed for each substance used in a particular procedure/process/experiment.

In fact, group (generic) risk assessments can be used satisfactorily where similar substances are used in similar jobs e.g. handling solvents in HPLC work, handling detergents in automatic dishwashers, research projects. In addition COSHH risk assessment can be used as a basis for drafting Safe/Standard Operating Procedures (SOPs).

The COSHH risk assessment form is subdivided into 14 sections. Guidance in completing these sections is given below.

1. What is the process/work activity and where will you be carrying it out?

Give a brief summary of the particular procedure/process/reaction eg floor cleaning, sterilising instruments, reaction type.

A full description of the work area including locality (indoors/outdoors), room/laboratory number, building name should be given.

The details should include:

- the substances to be used
- the properties of the substances (gas, vapour, volatile liquid, dust)
- the quantities of substances to be used
- how the substances are to be used (contained, released, sprayed, mixed, heated, or ground into powder)

2. What hazardous substances will you be using?

List all the substances you are going to use in the process/procedure/experiment you are risk assessing. Then find out if they are hazardous to health by gathering information from the manufacturers' safety data sheets, product labels or from the sources in Appendix 1.

Record the hazard classification(s) against groups 1-8 for each substance.

If none of the substances to be used are hazardous to health, the risk assessment is complete at this stage.

(a) Nature of the health hazard

From the information gathered above, record (if available) the following information for each substance used:

- the health effect, symptoms, area of body/organs affected
- the type of exposure (acute or chronic) that gives rise to the effect
- any risk phrases from council directive 67/548/EEC (Appendix 2) that have been assigned to the substances. For example, are the substances carcinogens, mutagens, teratogens or respiratory sensitizers? (The latter are identified in EH40 with SEN notation)
- any pre-existing health conditions that may affect the integrity of the immune system or make individuals more prone to the health effect (cystic fibrosis, splenectomy, diabetes, HIV, leukæmia etc).

(b) Route of entry into the body?

Substances can enter the body by four routes:

- inhalation (breathing in gases, vapors, fumes, dusts, aerosols, fibres)
- skin contact (direct uptake of gases, liquids, vapors through the unbroken skin)
- ingestion (accidental swallowing of solids/liquids)
- invasion (uptake via broken skin, misuse of hypodermic needles)

This is a vital part of the risk assessment, since the formulation of effective control measures is dependent on preventing entry of substances into the body.

Since inhalation is considered to be the major route of entry into the body consideration must be given to processes that could generate gases, vapors, aerosols, fumes, dusts and fibres. Will any liquids or solids be heated to such a degree that vapors or fumes are produced? Will liquids be sprayed or centrifuged so that aerosol formation is likely? Will solids be ground such that fine dusts of fibres are released?

Then any substances used which can be absorbed through the intact skin should be clearly identified and the possibility of skin contact in the process carefully evaluated. (Such substances are identified in EH40 with a skin 'Sk' notation.)

Finally, it should be verified that the likelihood of entry by ingestion and direct injection has been minimised. In the work environment, the risk of exposure from these routes is usually controlled by good working practices. For example, eating, drinking, smoking and the application of cosmetics should not be permitted in the workplace to prevent accidental ingestion. Similarly, cuts and abrasions should be covered with waterproof dressings to prevent invasion.

(c) WEL(mg/m^3 or ppm)

Finally, in this section, any current workplace exposure limit should be recorded.

Scientific bodies in several countries publish annual lists of occupational exposure limits (OELs) for a range of substances hazardous to health. In the UK, WELs are published by the HSE. In the USA, threshold limit values (TLVs) are published by ACGIH (Appendix 1). These OELs prescribe limits to personal exposure to airborne contaminants. These limits should be used in determining the adequacy of control of exposure by inhalation as required by the COSHH Regs.

3. How long will the process/work activity last? What will the exposure pattern be?

In other words consider how often the process will be carried out ie once, once/day, once/week etc. Consider if the process will take minutes, hours, days, weeks etc to perform. Also consider if exposure to substances hazardous to health will be continuous or intermittent when carrying out this process.

In addition a semi-quantitative (or at least a qualitative) estimate of potential exposure by inhalation to the substances hazardous to health used in the work activity must be made.

Consider the properties of the substances hazardous to health used (dustiness, volatility), the quantities used (µg, mg, kg or µl, ml, l) and the way the substances are used (heated, vaporised, volatilised etc). In addition, consider the degree of containment/protection provided by typical precautionary measures chosen in Sections 5 and 6. For example, a fume cupboard is estimated to have a protection factor of 10^5 when operating efficiently.

Semi-quantitative estimates of the airborne concentrations of the substances used may be calculated using the generic risk assessment scheme given in the HSE guidance note “COSHH Essentials” (Appendix 1). Further details may be obtained from the USS.

4. Can you prevent exposure to the hazardous substances?

Exposure to substances hazardous to health should be **prevented**, as a first priority.

Therefore, firstly consider if you can prevent exposure to the substances you have listed by using safer procedures/processes/experiments or by substitution of substances (eg toluene for benzene, water-based paints for solvent-based ones) or by using the substances in a safer form (eg pellets instead of powders, ready made-up solutions).

Where the procedure involves suspected carcinogens or mutagens, every effort must be made to substitute a non-carcinogenic or non-mutagenic alternative.

If exposure can be prevented, start the risk assessment process again stating the new conditions in Sections 1-4, then proceed to Section 5.

5. Which precautionary measures will you be using for the work process/activity?

If exposure cannot be prevented, consider the most effective precautionary measures needed to adequately control exposure, and that are proportionate to the risk eg

- Total containment (glove boxes, Class III biological safety cabinets, pipelines and vessels)
- Partial containment (fume cupboard, paint-spray booths, Class I & II biological safety cabinets)
- LEVs (fume canopies)
- Dilution Ventilation (open doors, windows)
- PPE (gloves, aprons)
- Others (good working practices [section 2(b)], restricting access to laboratory)

Control of exposure by inhalation is considered adequate only if any WELs for the substances involved are not exceeded.

Further specific information may be obtained from the Guidance Notes on work with chemical carcinogens, biological agents and asthmagens available on the University Safety Service (USS) web-site.

6. Which type of personal protective equipment will you be using?

PPE must only be considered as a last resort and must be used **in addition** to all other control measures, if the combination of all control measures fail to achieve adequate control of exposure.

PPE (except gloves and laboratory coats) and advice on its selection and use is available from the (USS). Details on the fit testing of respiratory protective equipment is also available from the (USS). Other types of PPE include aprons, gaiters, hard hats, coveralls etc.

7. Who is likely to be exposed to the hazardous substances that you will be working with?

Consider others, not directly involved in the work, who may be at risk from exposure. Are the risks adequately controlled for these people in local rules or standard operating procedures.

8. Is a “permit-to-work” required to prevent exposure to others?

In certain situations a permit-to-work may be required. For example, repair of a fume cupboard would require one to ensure it was fully decontaminated and could not be used while the contractors were carrying out repairs.

Details of the permit-to-work system and associated forms are available on the USS website.

9. Is air monitoring required?

Air monitoring should be conducted for processes/procedures/experiments which involve large quantities (g or litre) of airborne contaminants and which are carried out frequently over long periods of time. It is also necessary when failure or deterioration of the control measures could result in a serious health effect, either because of the toxicity of the substance or because of the extent of potential exposure, or both.

Air monitoring is not required when you can demonstrate by using the semi-quantitative generic risk assessment (Section 3) that the precautionary measures put in place adequately control exposure to a given Workplace Exposure Limit.

Air monitoring is mandatory when spray is given off from vessels at which an electrolytic chromium process (other than Cr III) is carried out. Monitoring must occur at 14 day intervals while the process is being conducted.

Further guidance may be obtained from the USS.

10. Is health surveillance required?

Health surveillance is appropriate when the work involves the use of substances known to cause occupational asthma or severe dermatitis. It is also appropriate where employees are exposed to carcinogenic and mutagenic substances, unless the risk assessment confirms that exposure is so adequately controlled that there is no reasonable likelihood of an identifiable disease or adverse effect resulting from the exposure. Health surveillance is however, required if there is contact with chrome solution, electrolytes containing chromic acid or chromium salts, and other substances which can cause skin cancer.

If the risk assessment indicates that health surveillance is required then advice on the nature of the health surveillance should be obtained from Dr D O Todd, Occupational Health Physician and appended to the risk assessment.

New, expectant, and breast-feeding mothers should also report their condition to their Line Manager/Dr Todd so that the risk assessment can be reviewed and the appropriateness of health surveillance considered/reconsidered.

11. What are the procedures for dealing with unplanned releases and spillages?

Consider what action is required if the precautionary measures (Section 5) fail.

Will evacuation be necessary?

How will the alarm be raised?

Will breathing apparatus or special RPE be required? Is it available?

Is someone trained to use it?

How will the area be ventilated?

Are there any special first-aid requirements?

If there is a spill or a leak of material, how can it be safely cleaned up and the area decontaminated?

12. What are the procedures for disposing of hazardous substances?

Water miscible solvents and other substances may be flushed to drain but only in very small quantities (< 100 ml at one disposal.)

Small quantities of vapours/gases/aerosols may be discharged into a fume cupboard for aerial dispersion. Similarly, small quantities of volatile liquids may be allowed to evaporate to atmosphere within a fume cupboard.

In general, most substances hazardous to health will be disposed of by arrangement with the USS.

13. What training is required for the work process/activity?

Training may be required to ensure that:

- the worker is competent to carry out the process/procedure/experiment safely
- precautionary measures are used properly (includes correct use of PPE)
- defects in precautionary measures are readily identified (eg fume cupboard failure, pin-holes in gloves) and dealt with
- emergency procedures are followed
- emergency precautionary measures are used properly (breathing apparatus)

14. Conclusions

Although the worker may complete the risk assessment, it is the duty of the project supervisor/line manager to ensure that risk assessments are carried out for all the processes/procedures experiments (under his/her control) which involve substances hazardous to health.

It is the duty of the COSHH Supervisor to ensure that the risk assessment is complete and that the precautionary measures to be taken are adequate to control the risk.

The COSHH risk assessment should be reviewed at a frequency of not more than 5 years. The assessment should be reviewed immediately when there is evidence to suggest it is no longer valid. For example:

- a change in the substances used, including the introduction of a substitute substance
- a modification made to engineering controls
- a change to the process or method of work
- complaints from workers about defects in the control systems.

Revised: June 2009

APPENDIX 1

Toxicity Data : Sources of Information

Databases

Registry of Toxic Effects of Chemical Substances (NIOSH)

Chemical Safety Newsbase (RSC)

Occupational Safety and Health (NIOSH)

Toxline (National Library of Medicine)

Medline (National Library of Medicine)

Sigma-Aldrich-Fluka, Material Safety Data Sheets on CD-Rom

Bibliography

Sigma-Aldrich Library of Chemical Safety Data, Vols I and II

Handbook of Identified Carcinogens and Noncarcinogens, Vol I and II, Soderman, CRC Press

Dangerous Properties of Industrial Materials, Vols I, II and III, Von Nostrand, Reinhold

The Merck Index, Merck and Co. Inc.

Registry of Toxic Effects of Chemical Substances, Vols I and II, NIOSH

Dictionary of Substances and their Effects (DOSE) Vols 1-7, Richardson & Gargoli, RSC

Biochem. Co., Special Publication No 5 “Safety in Biological Laboratories” D B Cater & E Martree 1977

EH40/200(x) Workplace Exposure Limits, Health and Safety Executive (HSE)

1996 TLVs and BEIs American Conference of Governmental Industrial Hygienists (ACGIH)

The Technical Basis for COSHH Essentials: easy steps to control chemicals (HSE)

COSHH Essentials: Easy steps to control chemicals. COSHH, HSG193 HSE 2003.

Control of Substances Hazardous to Health (5th Edition). Approved Code of Practice and Guidance.

Council Directive 67/548/EEC Annex III

APPENDIX 2

Risk Phrases, R20 etc

Indication of particular risks

20	Harmful by inhalation
21	Harmful in contact with skin
22	Harmful if swallowed
23	Toxic by inhalation
24	Toxic in contact with skin
25	Toxic if swallowed
26	Very toxic by inhalation
27	Very toxic in contact with skin
28	Very toxic if swallowed
33	Danger of cumulative effects
34	Causes burns
35	Causes severe burns
36	Irritating to eyes
37	Irritating to respiratory system
38	Irritating to skin
39	Danger of very serious irreversible effects
40	Limited evidence of a carcinogenic effect
41	Risk of serious damage to eyes
42	May cause sensitisation by inhalation
43	May cause sensitisation by skin contact
45	May cause cancer
46	May cause heritable genetic damage
48	Danger of serious damage to health by prolonged exposure
49	May cause cancer by inhalation
60	May impair fertility
61	May cause harm to the unborn child
62	Possible risk of impaired fertility
63	Possible risk of harm to the unborn child
64	May cause harm to breastfed babies
65	Harmful: may cause lung damage if swallowed
66	Repeated exposure may cause skin dryness or cracking
67	Vapours may cause drowsiness and dizziness
68	Possible risk or irreversible effects

Combination of particular risks

20/21	Harmful by inhalation and in contact with skin
20/21 /22	Harmful by inhalation, in contact with skin and if swallowed
20/22	Harmful by inhalation and if swallowed
21/22	Harmful in contact with skin and if swallowed
23/24	Toxic by inhalation and in contact with skin
23/24 /25	Toxic by inhalation, in contact with skin and if swallowed
23/25	Toxic by inhalation and if swallowed
24/25	Toxic in contact with skin and if swallowed
26/27	Very toxic by inhalation and in contact with skin
26/27 /28	Very toxic by inhalation, in contact with skin and if swallowed
26/28	Very toxic by inhalation and if swallowed
27/28	Very toxic in contact with skin and if swallowed
36/37	Irritating to eyes and respiratory system
36/37 /38	Irritating to eyes, respiratory system and skin
36/38	Irritating to eyes and skin
37/38	Irritating to respiratory system and skin

Appendix 2 continued

39/23	Toxic: danger of very serious irreversible effects through inhalation
39/23 /24	Toxic: danger of very serious effects through inhalation and in contact with skin
39/23/ 24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
39/23/ 25	Toxic: danger of very serious irreversible effects through inhalation and if swallowed
39/24	Toxic: danger of very serious irreversible effects in contact with skin
39/24/ 25	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed
39/25	Toxic: danger of very serious irreversible effects if swallowed
39/26	Very Toxic: danger of very serious irreversible effects through inhalation
39/26/ 27	Very Toxic: danger of very serious irreversible effects through inhalation and in contact with skin
39/26/ 27/28	Very Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
39/26/ 28	Very Toxic: danger of very serious irreversible effects through inhalation and if swallowed
39/27	Very Toxic: danger of very serious irreversible effects in contact with skin
39/27/ 28	Very Toxic: danger of very serious irreversible effects in contact with skin and if swallowed
39/28	Very Toxic: danger of very serious irreversible effects if swallowed
68/20	Harmful: possible risk or irreversible effects through inhalation
68/20/ 21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin
68/20/ 21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed
68/20/ 22	Harmful: possible risk of irreversible effects through inhalation and if swallowed
68/21	Harmful: possible risk of irreversible effects in contact with skin
68/22	Harmful: possible risk of irreversible effects if swallowed
42/43	May cause sensitisation by inhalation and skin contact
48/20	Harmful: danger of serious damage to health by prolonged exposure through inhalation
48/20/ 21	Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin
48/20/ 21/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed
48/20/ 22	Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
48/21	Harmful: danger of serious damage to health by prolonged exposure in contact with skin
48/21/ 22	Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
48/22	Harmful: danger of serious damage to health by prolonged exposure if swallowed
48/23	Toxic: danger of serious damage to health by prolonged exposure through inhalation
48/25	Toxic: danger of serious damage to health by prolonged exposure if swallowed

AND
CHEMICAL ENGINEERING

General and COSHH RISK ASSESSMENT

THE COSHH GUIDANCE NOTES MUST BE READ BEFORE COMPLETING THE RISK ASSESSMENT

Section 1: Project Details

Undergraduate Practical / Project	Masters	Postgraduate	Postdoctoral	Staff	Other

Group or teaching year: (if applicable)	
School / Centre:	
Title of project or activity:	
Location of work: (building and room number)	
Principal Investigator / Supervisor:	
Person carrying out assessment:	
Assessment Date:	**Review Date:**
Detailed description of work activity: (Include quantities of substances to be used and how they are to be used i.e. mixed, heated etc.	

Section 2: Other Hazard factors involved

Please list all of the risk factors relating to the process in addition to the hazardous substances which are covered from page 2 onwards. For example, is there a risk of electrocution, exposure to biological pathogens, production of noxious gases or aerosols, explosion risk or exposure to UV or laser beams.

Hazard Factor Identified *e.g. exposure to UV radiation e.g. risk of electrocution*	**Severity** (1-5)	**Likelihood** (1-4)	**Risk Level** (L, M, H, VH)	**Control Procedure** *Use of full face mask and hand protection Avoid contact between solutions and electrical connections*

	Risk Likelihood			
Hazard Severity	Unlikely (1)	Possible (2)	Likely (3)	Very Likely (4)
Minor (1)	**1**	**2**	**3**	**4**
Moderate (2)	**2**	**4**	**6**	**8**
Serious (3)	**3**	**6**	**9**	**12**
Very Serious (4)	**4**	**8**	**12**	**16**
Extreme (5)	**5**	**10**	**15**	**20**

	Risk Rating
1 – 5	**Low**
6	**Medium**
8 – 10	**High****
12 - 20	**Very High*****

*** High and very high risk activities are **not permitted** without further assessment of risks involved in conjunction with PI, Safety Officer and Head of School.

Section 3: Hazard Summary Section

Hazard pictograms – select all that apply to the work activity								
								
Health Hazard	Toxic	Corrosive	Irritant	Flammable	Oxidising	Explosive	Compressed Gas	Dangerous for the environment

	
Biological	Radioactive

Section 4: Hazardous Substances Information

List all the substances you are going to use in the procedure you are assessing. All the information required to populate the table below can be found on the manufacturer's safety data sheet.

If none of the substances to be used are hazardous to health, the risk assessment is complete at this stage and should be signed off.

Name of substance	**Hazard Classification**	**Physical form** e.g. powder, dust, liquid, gas	**Route of exposure** e.g. ingestion, inhalation, absorption, injection	**WEL (mg/m3) or (ppm)**

* Please detail the level of health hazard i.e. Hazard statements and Carcinogenic / Mutagenic categories.

Note A separate BioCOSHH / GM / Radiation Risk Assessment may be required depending on the work taking place.

Hazards produced during / after reaction / experiment
List all the substances (if any) you are going to produce in the procedure you are assessing and the associated hazards. Samples and gels become incorporated, waste contained to waste bottle and waste plate.

How often will this work activity be carried out?			
Daily	**Weekly**	**Monthly**	**Other** (please specify)

How long will the process / work activity last?
Setting up the samples and machine only takes maximum ~30minutes

Who might be at risk?	**Staff**	**PG**	**UG**	**New and Expectant Mothers**	**Cleaners**	**Contractors**	**Public**

Risk matrix can be found in Note 1.

Assessment of risk PRIOR to the use of controls	**Severity (1-5)**	**Likelihood (1-4)**	**Overall Risk Rating (Severity x Likelihood)**

Section 5: Controls

If exposure cannot be prevented by using a different process, alternative substances or different forms of the same substance, consider the most effective precautionary measures needed to adequately control exposure which are proportionate to the risk.

Physical or Engineering controls:	**Glove Box**	**Fume Cupboard**	**Local Exhaust Ventilation**	**Open Doors / Windows**	**Other** (please specify)
Administrative controls: (including training requirements					
Out of hours controls: (if required)					

Personal Protective Equipment:							
	Lab Coat	Apron	Safety Footwear	Gloves*	Face Shield	Glasses / Goggles	RPE**
Storage requirements:							
Disposal procedures:							

*If protective gloves are required, please indicate which type is the most suitable for the substance handled.
**A person requiring RPE must be 'face-fit tested' to the RPE (Further advice on the selection of suitable RPE and face-fit testing is available from the Occupational Health and Safety Service).

	Yes	**No**	**Describe the findings of exposure monitoring or health surveillance**
Is exposure monitoring required? (See Note 2)			
Is health surveillance required?* (See Note 3)			

*If yes, please state date of referral to Occupational Health: _____

Assessment of risk AFTER the application of controls	**Severity (1-5)**	**Likelihood (1-4)**	**Overall Risk Rating (Severity x Likelihood)**

Section 6: Emergency Procedures

The purpose of this section is to provide easy access to emergency information for First Aid, Spillage and Fire.

First Aid	
If inhaled:	
In case of skin contact:	
In case of eye contact:	
If swallowed:	

Spillage	
Personal precautions, protective equipment and emergency procedures:	
Environmental precautions:	
Methods and materials for containment and clean up:	.

Fire	
Suitable extinguishing media:	
Special hazards arising from the substances or mixture:	

Section 7: Contacts

Contact in the event of an emergency: (first aid, spillage, fire):	
Out of hours contact:	

Section 8: Approval

I confirm that this is a suitable and sufficient risk assessment for the above described work activity	**Name**	**Signature**	**Date**
Assessor:			
Principal Investigator / Supervisor:			
COSHH Supervisor:			

I have read and understood the information contained in this COSHH Risk Assessment and I agree to adopt the control measures and precautions as stated above:

Name (Printed)	Signature	Date

This assessment should be reviewed at regular intervals and immediately if there is reason to suspect that it is no longer valid (for example after any accidents or incidents) or if there is a significant change in the work to which it relates.

Note 1: Risk Matrix

	Risk Likelihood			
Hazard Severity	Unlikely (1)	Possible (2)	Likely (3)	Very Likely (4)
Minor (1)	**1**	**2**	**3**	**4**
Moderate (2)	**2**	**4**	**6**	**8**
Serious (3)	**3**	**6**	**9**	**12**
Very Serious (4)	**4**	**8**	**12**	**16**
Extreme (5)	**5**	**10**	**15**	**20**

	Risk Rating
Low	**(1-5)**
Medium	**(6)**
High	**(8-10)**
Very High	**(12-20)**

Note 2 – Exposure Monitoring

Exposure monitoring provides assurance on the adequacy of your controls. It has nothing to do with the state of a workers health.

Note 3 – Health Surveillance

Health surveillance is appropriate where employees are exposed to carcinogenic and mutagenic substances, unless the risk assessment confirms that exposure is so adequately controlled that there is no reasonable likelihood of an identifiable disease or adverse effect resulting from the exposure or the quantities used are so small that even if control measures fail, the exposure is likely to be insignificant. It is also appropriate when the work involves the use of substances known to cause occupational asthma or severe dermatitis or if there is contact with chrome solution, electrolytes containing chromic acid or chromium salts and other substances which can cause skin cancer.

APPENDIX 6

THESE COMPOUNDS ARE EXPLOSIVE:

Acetylenics especially Cu, Ag, Hg salts, organic nitrates and nitrate esters, organic nitrites, alkyl chlorates(VII), amine metal oxosalts e.g. $CO(NH_3)_6$ $(ClO_4)_3$ or $Co(N_2H_4)_x$ $(MnO_4)_3$, azides, chlorate(III), (V) and (VII) salts of heavy metals, R_4N^+,ClO_4^-, diazo compounds, silver fulminate AgCNO, hydrogen peroxide >30% especially in presence of traces of transition metals, N-halogen compounds, N-nitro compounds, oxo salts of nitrogenous bases, organic peroxides and hydroperoxides, metal peroxides e.g. K_2O_2 crust on metallic K, picrates, polynitroalkyl compounds, polynitroaromatics.

THESE COMBINATIONS ARE EXPLOSIVE:

Acetone + chloroform in the presence of a base. Acetylene + Cu, Ag, Hg or salts. Ammonia + Cl_2, Br_2, I_2. CS_2 + NaN_3. Alcohols + Cl_2. $CHCl_3$ or CCl_4 + powdered Al or Mg. Decolourising carbon + oxidising agent. Ether + Cl_2.	DMSO + acyl halide, $SOCl_2$, $POCl_3$ or CrO_3. Ethanol + ClO^- or $AgNO_3$. HNO_3 + acetic acid or acetic anhydride. AgO + NH_3 + ethanol. Na + chlorinated hydrocarbon. ClO^- + amine. Chlorsulphonic acid + water.

Any OXIDANT + Any REDUCTANT should be treated with caution.

APPENDIX 7

List of approved workplace exposure limits

This list is legally binding, as it reproduces the list of maximum exposure limits which has been approved by the Health and Safety Commission. The limits are given in ppm and $mg.m^{-3}$. The conversion method is given on page 45 of the H.S.E. EH40/2005 Document. The Control of Substances Hazardous to Health Regulations 2002 impose requirements by reference to this list.

However, the entries in the column headed ‘CAS Numbers, Notes, MDHS, OEL Summary and other guidance and Health R-phases’ are not part of the approved list of MELs. The workplace exposure limits of the dusts included in the list below refer to the **total inhalable dust fraction**, unless otherwise stated.

List of approved workplace exposure limits

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
Acetaldehyde	75-07-0	20	37	50	92	R12, 36/37, 40
Acetic anhydride	108-24-7	0.5	2.5	2	10	R10, 20/22, 34
Acetone	67-64-1	500	1210	1500	3620	R11 36, 66, 67
Acetonitrile	75-05-8	40	68	60	102	R11, 20/21/22, 36
o-Acetylsalicylic acid	50-78-2	-	5	-	-	
Acrylaldehyde (Acrolein)	107-02-8	0.1	0.23	0.3	0.7	R11 24/25, 26, 34, 50
Acrylamide	79-06-1	-	0.3	-	-	Carc Sk R45, 46, 20/21, 25, 36/38, 43, 48/23/24/25, 62
Acrylonitrile	107-13-1	2	4.4	-	-	Carc Sk R45, 11, 23/24/25, 37/38, 41, 43, 51/53* HSC/E plans to review the limit values for this substance
Allyl alcohol	107-18-6	2	4.8	4	9.7	Sk R10, 23/24/25, 36/37/38, 50
Aluminium alkyl compounds		-	2	-	-	R14, 17, 34
Aluminium metal	7429-90-5					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Aluminium oxides	1344-28-1					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Aluminium salts, soluble		-	2	-	-	
2-Aminoethanol	141-43-5	3	7.6	6	15	R20/21/22, 34*
Ammonia, anhydrous	7664-41-7	25	18	35	25	R10, 23, 34, 50*
Ammonium chloride, fume	12125-02-9	-	10	-	20	R22, 36
Ammonium sulphamidate	7773-06-0	-	10	-	20	
Aniline	62-53-3	1	4	-	-	Sk R23/24/25, 40, 41, 48/23/24/25, 68, 50*
Antimony and compounds						
except stibine (as Sb)		-	0.5	-	-	
p-Aramid respirable fibres	26125-61-1	0.5 fibres/ml		-	-	
Arsenic and arsenic compounds except arsine (as As)		-	0.1	-	-	Carc HSC/E plans to review the limit values for this substance
Arsine	7784-42-1	0.05	0.16	-	-	R12, 26, 48/20, 50/53
Asphalt, petroleum fumes	8052-42-4	-	5	-	10	
Azodicarbonamide	123-77-3	-	1.0	-	3.0	Sen R42, 44

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m^{-3}	ppm	mg.m^{-3}	
Barium compounds, soluble (as Ba)		-	0.5	-	-	
Barium sulphate	7727-43-7					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Benzene	71-43-2	1	-	-	-	Carc Sk R45, 46, 11, 36/38, 48/23/24/25, 65*
Benzyl butyl phthalate	85-68-7	-	5	-	-	R61, 62, 50/53*
Benzyl chloride	100-44-7	0.5	2.6	1.5	7.9	Carc R45, 22, 23, 37/38, 41, 48/22
Beryllium and beryllium compounds (as Be)		-	0.002	-	-	Carc
Bis(2-ethylhexyl) phthalate	117-81-7	-	5	-	10	R60, 61
Bis(chloromethyl) ether	542-88-1	0.001	0.005	-	-	Carc R45, 10, 22, 24, 26
Bornan-2-one	76-22-2	2	13	3	19	
Boron tribromide	10294-33-4	-	-	1	10	R14, 26/28, 35
Bromacil (ISO)	314-40-9	1	11	2	22	
Bromine	7726-95-6	0.1	0.66	0.3	2	R26, 35, 50
Bromomethane	74-83-9	5	20	15	59	Sk R23/25, 36/37/38, 48/20, 68, 50, 59
Butane	106-97-8	600	1450	750	1810	Carc (only applies if Butane contains more than 0.1% of buta-1, 3-diene) R12
Buta-1,3-diene	106-99-0	10	22	-	-	Carc R45, 46, 12 HSC/E plans to review the limit values for this substance
Butan-1-ol	71-36-3	-	-	50	154	Sk R10, 22, 37/38, 41, 67
Butan-2-ol	78-92-2	100	308	150	462	R10, 36/37, 67
Butan-2-one (methyl ethyl ketone)	78-93-3	200	600	300	899	Sk BMGV R11, 36, 66, 67
2-Butoxyethanol	111-76-2	25	-	50	-	Sk BMGV R20/21/22, 36/38
2-Butoxyethyl acetate	112-07-2	20	-	50	-	Sk R20/21
n-Butyl acrylate	141-32-2	1	5	5	26	R10, 36/37/38, 43
n-Butyl chloroformate	592-34-7	1	5.7	-	-	R10, 23, 34
sec-Butyl acetate	105-46-4	200	966	250	1210	R11, 66
tert-Butyl acetate	540-88-5	200	966	250	1210	R11, 66
Butyl acetate	123-86-4	150	724	200	966	R10, 66, 67
Butyl lactate	138-22-7	5	30	-	-	

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
2-*sec*-Butylphenol	89-72-5	5	31	-	-	Sk
Cadmium & cadmium compounds except cadmium oxide fume, cadmium sulphide & cadmium sulphide pigments (as Cd)		-	0.025	-	-	Carc (cadmium metal,* cadmium chloride, flouride and sulphate)
Cadmium oxide fume (as Cd)	1306-19-0	-	0.025	-	0.05	Carc R45, 26, 48/23/25, 62, 63, 68, 50/53*
Cadmium sulphide and cadmium sulphide pigments (respirable dust (as Cd)		-	0.03	-	-	Carc (cadmium sulphide*)
Caesium hydroxide	21351-79-1	-	2	-	-	
Calcium carbonate	1317-65-3					
inhalable dust		-	10	-	-	
respirable		-	4	-	-	
Calcium cyanamide	156-62-7	-	0.5	-	1	R22, 37, 41
Calcium hydroxide	1305-62-0	-	5	-	-	
Calcium oxide	1305-78-8	-	2	-	-	
Calcium silicate	1344-95-2					
inhalable dust		-	10	-	-	
respirable		-	4	-	-	
Captan (ISO)	133-06-2	-	5	-	15	R23, 40, 41, 43, 50
Carbon black	1333-86-4	-	3.5	-	7	
Carbon dioxide	124-38-9	5000	9150	15000	27400	
Carbon disulphide	75-15-0	10	32	-	-	Sk R11, 36/38, 48/23, 62, 63 HSC/E plans to review the limit values for this substance
Carbon monoxide	630-08-0	30	35	200	232	Bmgv R12, 23, 48/23, 61
Carbon tetrachloride	56-23-5	2	13	-	-	Sk R23/24/25, 40, 48/23, 52/53, 59*
Cellulose	9004-34-6					
inhalable dust		-	10	-	20	
respirable		-	4	-	-	
Chlorine	7782-50-5	0.5	1.5	1	2.9	R23, 36/37/38, 50
Chlorine dioxide	10049-04-4	0.1	0.28	0.3	0.84	R6, 8, 26, 34, 50*
Chloroacetaldehyde	107-20-0	-	-	1	3.3	R24/25, 26, 34, 40, 50*
2-Chloroacetophenone	532-27-4	0.05	0.32	-	-	
Chlorobenzene	108-90-7	1	-	3	-	Sk R10, 20, 51/53*
Chlorodifluoromethane	75-45-6	1000	3590	-	-	
Chloroethane	75-00-3	50	-	-	-	R12, 40, 52/53
2-Chloroethanol	107-07-3	-	-	1	3.4	Sk R26/27/28

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m^{-3}	ppm	mg.m^{-3}	
1-Chloro-2,3-epoxypropane (Epichlorohydrin)	106-89-8	0.5	1.9	1.5	5.8	Carc R45, 10, 23/24/25, 34, 43
Chloroform	67-66-3	2	9.9	-	-	Sk R22, 38, 40, 48/20/22
Chloromethane	74-87-3	50	105	100	210	R12, 40, 48/20
1-Chloro-4-nitrobenzene	100-00-5	-	1	-	2	Sk R23/24/25, 40, 48/20/21/22, 68, 51/53*
Chlorosulphonic acid	7790-94-5	-	1	-	-	R14, 35, 37
Chlorpyrifos (ISO)	2921-88-2	-	0.2	-	0.6	Sk R25, 50/53*
Chromium	7440-47-3	-	0.5	-	-	
Chromium (II) compounds (as Cr)		-	0.5	-	-	
Chromium (III) compounds (as Cr)		-	0.5	-	-	
Chromium (VI) compounds (as Cr)		-	0.05	-	-	Carc, Sen* BMGV
Cobalt and cobalt compounds (as Co)		-	0.1	-	-	Carc (cobalt dichloride and sulphate) Sen
Copper	7440-50-8					
fume		-	0.2	-	-	
dusts and mists (as Cu)		-	1	-	2	
Cotton dust	See page 29	-	2.5	-	-	
Cryofluorane (INN)	76-14-2	1000	7110	1250	8890	
Cumene	98-82-8	25	125	50	250	Sk R10, 37, 65, 51/53
Cyanamide	420-04-2	-	2	-	-	R21, 25, 36/38, 43
Cyanides, except HCN, cyanogen & cyanogen chloride		-	5	-	-	Sk
Cyanogen chloride	506-77-4	-	-	0.3	0.77	
Cyclohexane	110-82-7	100	350	300	1050	R11, 38, 65, 67, 50/53*
Cyclohexanol	108-93-0	50	208	-	-	R20/22, 37/38
Cyclohexanone	108-94-1	10	-	20	-	Sk BMGV R10, 20
Cyclohexylamine	108-91-8	10	41	-	-	R10, 21/22, 34
2,4-D (ISO)	94-75-7	-	10	-	20	R22, 37, 41, 43, 52/53
Dialkyl 79 phthalate	83968-18-7	-	5	-	-	
Diallyl phthalate	131-17-9	-	5	-	-	R22, 50/53*
Diatomaceous earth, natural, respirable dust	61790-53-2	-	1.2	-	-	
Dibenzoyl peroxide	94-36-0	-	5	-	-	R2, 36, 43
Dibismuth tritelluride	1304-82-1	-	10	-	20	
Diboron trioxide	1303-86-2	-	10	-	20	
1,2-Dibromoethane (Ethylene dibromide)	106-93-4	0.5	3.9	-	-	Carc, Sk R45, 23/24/25, 36/37/38, 51/53*

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
Dibutyl hydrogen phosphate	107-66-4	1	8.7	2	17	
Dibutyl phthalate	84-74-2	-	5	-	10	R61, 62, 50
Dichloroacetylene	7572-29-4	-	-	0.1	0.39	R2, 40, 48/20
1,2-Dichlorobenzene (*ortho*-dichlorobenzene)	95-50-1	25	153	50	306	Sk R22, 36/37/38, 50/53*
1,4-Dichlorobenzene (*para*-dichlorobenzene)	106-46-7	25	153	50	306	R36, 40, 50/53*
1,3-Dichloro-5,5-dimethyl-hydantoin	118-52-5	-	0.2	-	0.4	
1,1-Dichloroethane	75-34-3	100	-	-	-	Sk R11, 22, 36/37, 52/53*
1,2-Dichloroethane (Ethylene dichloride)	107-06-2	5	21	-	-	Carc, Sk R45, 11, 22, 36/37/38
1,2-Dichloroethylene, cis:trans isomers 60:40	540-59-0	200	806	250	1010	R11, 20, 52/53*
Dichlorofluoromethane	75-43-4	10	43	-	-	
Dichloromethane	75-09-2	100	350	300	1060	Bmgv Sk R40 HSC/E plans to review the limit values for this substance
2,2'-Dichloro-4,4'-methylene dianiline (MbOCA)	101-14-4	-	0.005	-	-	Carc Sk Bmgv R45, 22, 50/53
Dicyclohexyl phthalate	84-61-7	-	5	-	-	
Dicyclopentadiene	77-73-6	5	27	-	-	R11, 20/22, 36/37/38 51/53
Diethylamine	109-89-7	10	30	25	76	R11, 20/21/22, 35
Diethyl ether	60-29-7	100	310	200	620	R12, 19, 22, 66, 67
Diethyl phthalate	84-66-2	-	5	-	10	
Diethyl sulphate	64-67-5	0.05	0.32	-	-	Carc Sk R45, 46, 20/21/22, 34
Dihydrogen selenide (as Se)	7783-07-5	0.02	-	0.05	-	R23/25, 33
Diisobutyl phthalate	84-69-5	-	5	-	-	
Diisodecyl phthalate	26761-40-0	-	5	-	-	
Diisononyl phthalate	28553-12-0	-	5	-	-	
Diisooctyl phthalate	27554-26-3	-	5	-	-	
Diisopropylamine	108-18-9	5	21	-	-	R11, 20/22, 34
Diisopropyl ether	108-20-3	250	1060	310	1310	R11, 19, 66, 67
N,N-Dimethylacetamide	127-19-5	10	36	20	72	Sk BMGV R20/21, 61
N,N-Dimethylaniline	121-69-7	5	25	10	50	Sk R23/24/25, 40, 51/53
N,N-Dimethylethylamine	598-56-1	10	30	15	46	R12, 20/22, 34
Dimethoxymethane	109-87-5	1000	3160	1250	3950	
Dimethylamine	124-40-3	2	3.8	6	11	R12, 20, 37/38, 41
2-Dimethylaminoethanol	108-01-0	2	7.4	6	22	R10, 20/21/22, 34

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m^{-3}	ppm	mg.m^{-3}	
Dimethyl ether	115-10-6	400	766	500	958	R12
Dimethylformamide	68-12-2	10	30	20	61	Sk R61, 20/21, 36
2,6-Dimethylheptan-4-one	108-83-8	25	148	-	-	R10, 37
Dimethyl phthalate	131-11-3	-	5	-	10	
Dimethyl sulphate	77-78-1	0.05	0.26	-	-	Carc Sk R45, 25, 26, 34, 43, 68*
Dinitrobenzene, all isomers	25154-54-5	0.15	1	0.5	3.5	Sk R26/27/28, 33, 50, 53
Dinonyl phthalate	84-76-4	-	5	-	-	
1,4-Dioxane	123-91-1	25	91	100	366	Sk R11, 19, 36/37, 40, 66
Diphenylamine	122-39-4	-	10	-	20	R23/24/25, 33, 50/53
Diphenyl ether (vapour)	101-84-8	1	7.1	-	-	
Diphosphorus pentasulphide	1314-80-3	-	1	-	3	R11, 20/22, 29, 50
Diphosphorus pentoxide	1314-56-3	-	-	-	2	R35
Diquat dibromide (ISO)	85-00-7	-	0.5	-	1	R22, 26, 36/37/38, 43, 48/25, 50/53
Disodium disulphite	7681-57-4	-	5	-	-	R22, 31, 41
Disodium tetraborate, anhydrous	1330-43-4	-	1	-	-	
Disodium tetraborate, decahydrate	1330-96-4	-	5	-	-	
Disodium tetraborate, pentahydrate	11130-12-4	-	1	-	-	
Disulphur dichloride	10025-67-9	-	-	1	5.6	R14, 20, 25, 29, 35, 50
2,6-Di-*tert*-butyl-*p*-cresol	128-37-0	-	10	-	-	
6,6'-Di-tert-butyl-4,4'-thiodi-*m*-cresol	96-69-5	-	10	-	20	
Diuron (ISO)	330-54-1	-	10	-	-	R22, 40, 48/22, 50/53
Emery	1302-74-5					
inhalable dust		-	10	-	-	
respirable		-	4	-	-	
Endosulfan (ISO)	115-29-7	-	0.1	-	0.3	Sk R24/25, 36, 50/53
Enflurane	13838-16-9	50	383	-	-	
Ethane-1,2-diol	107-21-1					Sk
particulate		-	10	-	-	R22
vapour		20	52	40	104	
Ethanethiol	75-08-1	0.5	1.3	2	5.2	R11, 20, 50/53
Ethanol	64-17-5	1000	1920	-	-	R11
2-Ethoxyethanol	110-80-5	10	37	-	-	Sk R10, 20/21/22, 60, 61 HSC/E plans to review the limit values for this substance
2-Ethoxyethyl acetate	111-15-9	10	55	-	-	Sk R20/21/22, 60, 61

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
2-Ethylhexyl chloroformate	24468-13-1	1	8	-	-	-
Ethyl acetate	141-78-6	200	-	400	-	R11, 36, 66, 67
Ethyl acrylate	140-88-5	5	21	15	62	R11, 20/21/22, 36/37/38, 43
Ethylamine	75-04-7	2	3.8	6	11	R12, 36/37
Ethylbenzene	100-41-4	100	441	125	552	Sk R11, 20
Ethyl chloroformate	541-41-3	1	4.5	-	-	R11, 22, 26, 34
Ethyl cyanoacrylate	7085-85-0	-	-	0.3	1.5	R36/37/38
Ethyl formate	109-94-4	100	308	150	462	R11, 20/22, 36/37
Ethylene oxide	75-21-8	5	9.2	-	-	Carc R45, 46, 12, 23, 36/37/38
4-Ethylmorpholine	100-74-3	5	24	20	96	Sk
Ferrous foundry particulate	See page 29					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Flour dust	See page 30	-	10	-	30	Sen HSC/E plans to review the limit values for this substance
Fluoride (inorganic as F)	16984-48-8	-	2.5	-	-	
Fluorine	7782-41-4	1	-	1	-	R7, 26, 35
Formaldehyde	50-00-0	2	2.5	2	2.5	R23/24/25, 34, 40, 43 HSC/E plans to review the limit values for this substance
Formamide	75-12-7	20	37	30	56	R61
Formic acid	64-18-6	5	9.6	-	-	R35
2-Furaldehyde (furfural)	98-01-1	2	8	5	20	Sk R21, 23/25, 36/37, 40
Germane	7782-65-2	0.2	0.64	0.6	1.9	
Glutaraldehyde	111-30-8	0.05	0.2	0.05	0.2	Sen R23/25, 34, 42/43, 50
Glycerol, mist	56-81-5	-	10	-	-	
Grain dust	See page 30	-	10	-	-	Sen
Graphite	7440-44-0					
inhalable dust		-	10	-	-	
respirable		-	4	-	-	
Gypsum	10101-41-4					
inhalable dust		-	10	-	-	
respirable		-	4	-	-	

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m^{-3}	ppm	mg.m^{-3}	
Halogeno-platinum compounds (complex co-ordination compounds in which the platinum atom is directly co-ordinated to halide groups) (as Pt)	See page 30	-	0.002	-	-	Sen
Halothane	151-67-7	10	82	-	-	
Hardwood dust	See page 31	-	5	-	-	Carc Sen HSC/E plans to review the limit values for this substance
n-Heptane	142-82-5	500	-	-	-	R11, 38, 65, 67, 50/53
Heptan-2-one	110-43-0	50	237	100	475	Sk R10, 20/22
Heptan-3-one	106-35-4	35	166	100	475	Sk R10, 20, 36
n-Hexane	110-54-3	20	72	-	-	R11, 38, 48/20, 62, 65, 67, 51/53*
1,6-Hexanolactam	105-60-2					R20/22, 36/37/38
dust only		-	1	-	3	
dust and vapour		-	10	-	20	
Hexan-2-one	591-78-6	5	21	-	-	Sk R10, 48/23, 62, 67
Hydrazine	302-01-2	0.02	0.03	0.1	0.13	Carc Sk R45, 10, 23/24/25, 34, 43, 50/53
Hydrogen bromide	10035-10-6	-	-	3	10	R35, 37
Hydrogen chloride (gas and aerosol mists)	7647-01-0	1	2	5	8	R23, 35
Hydrogen cyanide	74-90-8	-	-	10	11	Sk R12, 26, 50/53
Hydrogen fluoride (as F)	7664-39-3	1.8	1.5	3	2.5	R26/27/28, 35
Hydrogen peroxide	7722-84-1	1	1.4	2	2.8	R5, 8, 20/22, 35*
Hydrogen sulphide	7783-06-4	5	7	10	14	R12, 26, 50
Hydroquinone	123-31-9	-	0.5	-	-	R22, 40, 41, 43, 68, 50
4-Hydroxy-4-methylpentan-2-one	123-42-2	50	241	75	362	R36
2-Hydroxypropyl acrylate	999-61-1	0.5	2.7	-	-	Sk R23/24/25, 34, 43
2,2'-Iminodi(ethylamine)	111-40-0	1	4.3	-	-	Sk R21/22, 34, 43
Indene	95-13-6	10	48	15	72	
Indium and compounds (as In)		-	0.1	-	0.3	
Iodine	7553-56-2	-	-	0.1	1.1	R20/21, 50
Iodoform	75-47-8	0.6	9.8	1	16	
Iodomethane	74-88-4	2	12	-	-	Sk R21, 23/25, 37/38, 40

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
Iron oxide, fume (as Fe)	1309-37-1	-	5	-	10	
Iron salts (as Fe)		-	1	-	2	
Isobutyl acetate	110-19-0	150	724	187	903	R11, 66
Isocyanates, all (as -NCO)		-	0.02	-	0.07	Sen HSC/E plans to review the limit values for this substance
Isoflurane	26675-46-7	50	383	-	-	
Isooctyl alcohol (mixed isomers)	26952-21-6	50	271	-	-	
Isopropyl acetate	108-21-4	-	-	200	849	R11, 36, 66, 67
Isopropyl chloroformate	108-23-6	1	5.1	-	-	
Kaolin, respirable dust	1332-58-7	-	2	-	-	
Ketene	463-51-4	0.5	0.87	1.5	2.6	
Limestone	1317-65-3					
total inhalable		-	10	-	-	
respirable		-	4	-	-	
Liquefied petroleum gas	68476-85-7	1000	1750	1250	2180	Carc (only applies if LPG contains more than 0.1% of buta-1, 3-diene) R12
Lithium hydride	7580-67-8	-	0.025	-	-	
Lithium hydroxide	1310-65-2	-	-	-	1	
Magnesite	546-93-0					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Magnesium oxide (as Mg)	1309-48-4					
inhalable dust		-	10	-	-	
fume and respirable dust		-	4	-	-	
Malathion (ISO)	121-75-5	-	10	-	-	Sk R22, 50/53*
Maleic anhydride	108-31-6	-	1	-	3	Sen R22, 34, 42/43
Manganese and its inorganic compounds		-	0.5	-	-	
Marble	1317-65-3					
total inhalable		-	10	-	-	
respirable		-	4	-	-	
Mercaptoacetic acid	68-11-1	1	3.8	-	-	R23/24/25, 34
Methacrylic acid	79-41-4	20	72	40	143	R21/22, 35
Methacrylonitrile	126-98-7	1	2.8	-	-	Sk R11, 23/24/25, 43*
Methanethiol	74-93-1	0.5	1.0	-	-	R12, 23, 50/53*
Methanol	67-56-1	200	266	250	333	Sk R11, 23/24/25, 39/23/24/25

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
2-Methoxyethanol	109-86-4	5	16	-	-	Sk R10, 20/21/22, 60, 61
2-Methoxyethyl acetate	110-49-6	5	25	-	-	Sk R20/21/22, 60, 61
(2-methoxymethylethoxy) propanol	34590-94-8	50	308	-	-	Sk
1-Methoxypropan-2-ol	107-98-2	100	375	150	560	Sk R10
1-Methoxypropyl acetate	108-65-6	50	274	100	548	Sk R10, 36
Methyl acetate	79-20-9	200	616	250	770	R11, 36, 66, 67
3-Methylbutan-1-ol	123-51-3	100	366	125	458	
Methyl cyanoacrylate	137-05-3	-	-	0.3	1.4	R36/37/38
4,4'-Methylenedianiline	101-77-9	0.01	0.08	-	-	Carc Sk Bmgv R45, 39/23/24/25, 43, 48/20/21/22, 68, 51/53
Methyl ethyl ketone peroxides (MEKP)	1338-23-4	-	-	0.2	1.5	
Methyl methacrylate	80-62-6	50	208	100	416	R11, 37/38, 43
2-Methylcyclohexanone	583-60-8	50	233	75	350	R10, 20
Methylcyclohexanol	25639-42-3	50	237	75	356	
N-Methylaniline	100-61-8	0.5	2.2	-	-	Sk R23/24/25, 33, 50/53
5-Methylheptan-3-one	541-85-5	10	-	20	-	R10, 36/37
5-Methylhexan-2-one	110-12-3	20	95	100	475	Sk R10, 20
2-Methylpentane-2,4-diol	107-41-5	25	123	25	123	R36/38
4-Methylpentan-2-ol	108-11-2	25	106	40	170	Sk R10, 37
4-Methylpentan-2-one	108-10-1	50	208	100	416	Sk Bmgv R11, 20, 36/37, 66
2-Methylpropan-1-ol	78-83-1	50	154	75	231	R10, 37/38, 41, 67
2-Methylpropan-2-ol	75-65-0	100	308	150	462	R20
1-Methyl-2-pyrrolidone	872-50-4	25	103	75	309	Sk R36/38
Methyl-*tert*-butyl ether	1634-04-4	25	92	75	275	R11, 38*
Mica	12001-26-2					
total inhalable		-	10	-	-	
respirable		-	0.8	-	-	
MMMF (Machine-made mineral fibre) (except for Refractory Ceramic Fibres and Special Purpose Fibres)		5 $mg.m^{-3}$ and 2 fibres/millilitre		-	-	HSC/E plans to review the limit values for this substance
Molybdenum compounds (as Mo)						
soluble compounds		-	5	-	10	
insoluble compounds		-	10	-	20	
Monochloroacetic acid	79-11-8	0.3	1.2	-	-	Sk R25, 34, 50

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
Morpholine	110-91-8	20	72	30	109	Sk R10, 20/21/22, 34
Nickel and its inorganic compounds (except nickel tetracarbonyl): water-soluble nickel compounds (as Ni) nickel and water-insoluble nickel compounds (as Ni)		 - -	 0.1 0.5	 - -	 - -	Sk Carc (nickel oxides and sulphides) Sen (nickel sulphate)
Nicotine	54-11-5	-	0.5	-	1.5	Sk R25, 27, 51/53
Nitric acid	7697-37-2	2	5.2	4	10	R8, 35
Nitrobenzene	98-95-3	1	5.1	2	10	Sk R23/24/25, 40, 48/23/24, 62, 51/53
Nitromethane	75-52-5	100	254	150	381	R5, 10, 22
2-Nitropropane	79-46-9	5	19	-	-	Carc R45, 10, 20/22
Nitrous oxide	10024-97-2	100	183	-	-	
Orthophosphoric acid	7664-38-2	-	1	-	2	R34
Osmium tetraoxide (as Os)	20816-12-0	0.0002	0.002	0.0006	0.006	R26/27/28, 34
Oxalic acid	144-62-7	-	1	-	2	R21/22
2,2'-Oxydiethanol	111-46-6	23	101	-	-	R22
Ozone	10028-15-6	-	-	0.2	0.4	
Paracetamol, inhalable dust	103-90-2	-	10	-	-	
Paraffin wax, fume	8002-74-2	-	2	-	6	
Paraquat dichloride (ISO), respirable dust	1910-42-5	-	0.08	-	-	R24/25, 26, 36/37/38, 48/25, 50/53
Pentacarbonyliron (as Fe)	13463-40-6	0.01	0.08	-	-	
Pentaerythritol inhalable dust respirable dust	115-77-5 	 - -	 10 4	 - -	 20 -	
Pentan-2-one	107-87-9	200	716	250	895	
Pentan-3-one	96-22-0	200	716	250	895	R11, 37, 66, 67
Pentyl acetates (all isomers)		50	270	100	541	R10, 66
2-Phenylpropene	98-83-9	50	246	100	491	R10, 36/37, 51/53*
Phenol	108-95-2	2	-	-	-	Sk R23/24/25, 34, 48/20/21/22, 68*
p-Phenylenediamine	106-50-3	-	0.1	-	-	Sk R23/24/25, 36, 43, 50/53
Phorate (ISO)	298-02-2	-	0.05	-	0.2	Sk R27/28, 50/53
Phosgene	75-44-5	0.02	0.08	0.06	0.25	R26, 34
Phosphine	7803-51-2	-	-	0.3	0.42	R12, 17, 26, 34, 50*

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
Phosphorus pentachloride	10026-13-8	0.1	0.87	-	-	R14, 22, 26, 34, 48/20
Phosphorus trichloride	7719-12-2	0.2	1.1	0.5	2.9	R14, 26/28, 35, 48/20
Phosphorus, yellow	7723-14-0	-	0.1	-	0.3	R11, 16, 52/53
Phosphoryl trichloride	10025-87-3	0.2	1.3	0.6	3.8	R14, 22, 26, 35, 48/23
Phthalic anhydride	85-44-9	-	4	-	12	Sen R22, 37/38, 41, 42/43
Picloram (ISO)	1918-02-1	-	10	-	20	
Picric acid	88-89-1	-	0.1	-	0.3	R2, 4, 23/24/25
Piperazine	110-85-0	-	0.1	-	0.3	Sen R34, 42/43, 52/53
Piperazine dihydrochloride	142-64-3	-	0.1	-	0.3	Sen
Piperidine	110-89-4	1	3.5	-	-	Sk R11, 23/24, 34
Plaster of Paris	26499-65-0					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Platinum compds, soluble (except certain halogeno-Pt compounds) (as Pt)		-	0.002	-	-	
Platinum metal	7440-06-4	-	5	-	-	
Polychlorinated biphenyls (PCB)	1336-36-3	-	0.1	-	-	Sk R33, 50/53*
Polyvinyl chloride	9002-86-2					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Portland cement	65997-15-1					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Potassium hydroxide	1310-58-3	-	-	-	2	R22, 35
Propane-1,2-diol	57-55-6					
total vapour and particulates		150	474	-	-	
particulates		-	10	-	-	
Propan-1-ol	71-23-8	200	500	250	625	Sk R11, 41, 67
Propan-2-ol	67-63-0	400	999	500	1250	R11, 36, 67
Propionic acid	79-09-4	10	31	15	46	R34
Propoxur (ISO)	114-26-1	-	0.5	-	2	R25, 50/53
Propranolol	525-66-6	-	2	-	6	
n-Propyl acetate	109-60-4	200	849	250	1060	R11, 36, 66, 67
Propylene oxide	75-56-9	5	12	-	-	Carc R45, 46, 12, 20/21/22, 36/37/38
Prop-2-yn-1-ol	107-19-7	1	2.3	3	7	Sk R10, 23/24/25, 34, 51/53
Pulverised fuel ash						
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Pyrethrins (ISO)	8003-34-7 121-21-1 121-29-9	-	5	-	10	10 R20/21/22, 50/53
Pyridine	110-86-1	5	16	10	33	R11, 20/21/22

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
2-Pyridylamine	504-29-0	0.5	2	2	7.8	
Pyrocatechol	120-80-9	5	23	-	-	R21/22, 36/38
Refractory Ceramic Fibres and Special Purpose Fibres			5 $mg.m^{-3}$ 1 fibre/millilitre	-	-	Carc R49, 38
Resorcinol	108-46-3	10	46	20	92	R22, 36/38, 50
Rhodium (as Rh)						
metal fume and dust		-	0.1	-	0.3	
soluble salts		-	0.001	-	0.003	
Rosin-based solder flux fume	8050-09-7	-	0.05	-	0.15	Sen
Rotenone (ISO)	83-79-4	-	5	-	10	R25, 36/37/38, 50/53
Rouge	1309-37-1					
total inhalable		-	10	-	-	
respirable		-	4	-	-	
Rubber fume	See page 30	-	0.6	-	-	Carc Limit relates to cyclohexane soluble material
Rubber process dust	See page 30	-	6	-	-	Carc HSC/E plans to review the limit values for this substance
Selenium and compounds, except hydrogen selenide (as Se)		-	0.1	-	-	
Silane	7803-62-5	0.5	0.67	1	1.3	
Silica, amorphous						
inhalable dust		-	6	-	-	
respirable dust		-	2.4	-	-	
Silica, respirable crystalline	see page 31	-	0.3	-	-	HSC/E plans to review the limit values for this substance
Silica, fused respirable dust	60676-86-0	-	0.08	-	-	
Silicon	7440-21-3					
inhalable dust		-	10	-	-	
respirable dust		-	4	-	-	
Silicon carbide (not whiskers)	409-21-2					
total inhalable		-	10	-	-	
respirable		-	4	-	-	
Silver (soluble compounds as Ag)		-	0.01	-	-	
Silver, metallic	7440-22-4	-	0.1	-	-	
Sodium azide (as NaN_3)	26628-22-8	-	0.1	-	0.3	Sk R28, 32, 50/53

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	
Sodium 2-(2,4-dichlorophenoxy) ethyl sulphate	136-78-7	-	10	-	20	
Sodium hydrogen sulphite	7631-90-5	-	5	-	-	R22, 31
Sodium hydroxide	1310-73-2	-	-	-	2	R35
Softwood dust	See page 31	-	5	-	-	Sen HSC/E plans to review the limit values for this substance
Starch	9005-25-8					
total inhalable		-	10	-	-	
respirable		-	4	-	-	
Styrene	100-42-5	100	430	250	1080	R10, 20, 36/38 HSC/E plans to review the limit values for this substance
Subtilisins	1395-21-7 (*Bacillus subtilis* BPN) 9014-01-1 (*Bacillus subtilis* Carlsberg)	-	0.00004	-	-	Sen R37/38, 41, 42
Sucrose	57-50-1	-	10	-	20	
Sulfotep (ISO)	3689-24-5	-	0.1	-	-	Sk R27/28, 50/53*
Sulphur hexafluoride	2551-62-4	1000	6070	1250	7590	
Sulphuryl difluoride	2699-79-8	5	21	10	42	R23, 48/20, 50*
o-Toluidine	95-53-4	0.2	0.89	-	-	Carc Sk R45, 23/25, 36, 50
Talc, respirable dust	14807-96-6	-	1	-	-	
Tantalum	7440-25-7	-	5	-	10	
Tellurium & compounds, except hydrogen telluride, (as Te)		-	0.1	-	-	
Terphenyls, all isomers	26140-60-3	-	-	0.5	4.8	
1,1,2,2-Tetrabromoethane	79-27-6	0.5	7.2	-	-	Sk R26, 36, 52/53*
Tetracarbonylnickel	13463-39-3	-	-	0.1	0.24	R11, 26, 40, 61, 50/53
Tetrachloroethylene	127-18-4	50	345	100	689	R40, 50/53
1,1,1,2-Tetrafluoroethane (HFC 134a)	811-97-2	1000	4240	-	-	
Tetrahydrofuran	109-99-9	50	150	100	300	Sk R11, 19, 36/37
Tetrasodium pyrophosphate	7722-88-5	-	5	-	-	
Thallium, soluble compounds (as Tl)		-	0.1	-	-	Sk
Thionyl chloride	7719-09-7	-	-	1	4.9	R14, 20/22, 29, 35

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m^{-3}	ppm	mg.m^{-3}	
Tin compounds, inorganic, except SnH_4, (as Sn)		-	2	-	4	
Tin compounds, organic, except Cyhexatin (ISO), (as Sn)		-	0.1	-	0.2	Sk
Titanium dioxide	13463-67-7					
total inhalable		-	10	-	-	
respirable		-	4	-	-	
Toluene	108-88-3	50	191	150	574	Sk R11, 38, 48/20, 63, 65, 67*
p-Toluenesulphonyl chloride	98-59-9	-	-	-	5	
Tributyl phosphate, all isomers	126-73-8	-	5	-	5	R22, 38, 40*
1,2,4-Trichlorobenzene	120-82-1	1	-	5	-	Sk R22, 38, 50/53
1,1,1-Trichloroethane	71-55-6	100	555	200	1110	R20, 59
Trichloroethylene	79-01-6	100	550	150	820	Carc, Sk R45, 36/38, 67, 52/53 HSC/E plans to review the limit values for this substance
Trichloronitromethane	76-06-2	0.1	0.68	0.3	2.1	R22, 26, 36/37/38
Triethylamine	121-44-8	2	8	4	17	Sk R11, 20/21/22, 35
Triglycidyl isocyanurate (TGIC)	2451-62-9	-	0.1	-	-	Carc R46, 23/25, 41, 43, 48/22, 52/53
Trimellitic anhydride	552-30-7	-	0.04	-	0.12	Sen R37, 41, 42/43
Trimethylbenzenes, all isomers or mixtures	25551-13-7	25	125	-	-	
3,5,5-trimethylcyclohex-2-enone	78-59-1	-	-	5	29	R21/22, 36/37, 40
Trimethyl phosphite	121-45-9	2	10	-	-	
2,4,6-Trinitrotoluene	118-96-7	-	0.5	-	-	Sk R2, 23/24/25, 33, 51/53
Tri-*o*-tolyl phosphate	78-30-8	-	0.1	-	0.3	R39/23/24/25, 51/53
Triphenyl phosphate	115-86-6	-	3	-	6	
Tungsten & compounds (as W)	7440-33-7					
soluble compounds		-	1	-	3	
insoluble compounds and others		-	5	-	10	
Turpentine	8006-64-2	100	566	150	850	R10, 20/21/22, 36/38, 43, 65, 51/53
Vanadium pentoxide	1314-62-1	-	0.05	-	-	R20/22, 37, 48/23, 63, 68, 51/53
Vinyl chloride	75-01-4	3	-	-	-	Carc R45, 12

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hour TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m^{-3}	ppm	mg.m^{-3}	
Vinylidene chloride	75-35-4	10	40	-	-	R12, 20, 40*
Wool process dust	See page 31	-	10	-	-	
Xylene, *o*-,*m*-,*p*- or mixed isomers	1330-20-7	50	220	100	441	Sk BMGV R10, 20/21, 38
Yttrium	7440-65-5	-	1	-	3	
Zinc chloride, fume	7646-85-7	-	1	-	2	R22, 34, 50/53*
Zinc distearate	557-05-1					
inhalable dust		-	10	-	20	
respirable dust		-	4	-	-	
Zirconium compounds (as Zr)		-	5	-	10	

APPENDIX 8

SAFE TRANSPORTATION AND USE OF LIQUID NITROGEN DEWARS

Properties and Hazards of Nitrogen

Colourless, odourless and tasteless, non-toxic and does not support life or combustion

Can produce local oxygen-deficient atmospheres which will cause asphyxia if breathed (especially in confined space areas such as lifts)

Asphyxia is often rapid with no prior warning to the victim

Prolonged contact with liquid nitrogen can cause severe skin damage.

Protective clothing should always be worn

Manual Handling

Dewars must only be transported if correctly and clearly labelled

Keep vessel upright at all times except when pouring from specifically designed Dewars

Try to avoid spillage during handling as this can lead to burns, O2 depletion and cause damage to labelling

Large Dewars 25litres and above must be moved using a suitable trolley

Protective Clothing

Eye protection:
Goggles or face mask should be used to protect the eyes and face where spraying or splashing of liquid may occur

Protective clothing preferably without pockets or turn-ups where liquid could collect should be worn
Trousers should be worn outside boots for the same reason

Gloves should be non-absorbent leather that are loose fitting so that they can easily be removed if liquid should splash into or on them. Gauntlet gloves ARE NOT recommended

Movement of Cryogenic Vessels in Lifts

Small dewars - 2litre and below MUST NEVER be transported in the lift. Movement between floors is via the STAIRS ONLY. If anyone is caught with Dewar containing liquid nitrogen in ANY of the lifts within the building they will be severely reprimanded

Transportation of cryogenic vessels through confined areas of lifts could potentially cause release of the product due to:
Spillage
Venting of the open Dewar or
Via the relief valve/ burst disc.

Hazards arising from such releases include:
Cold burns, frost bite or hypothermia, breathing difficulties or asthma attack also embrittlement to materials causing failure
A dramatic change in the surrounding atmosphere due to expansion of the evaporating liquid leading to oxygen deficiency and resulting in possible asphyxia

Before transporting in lift

1. All cryogenic dewars are transported on suitable well maintained trolleys
2. Pressurised vessels should be vented to atmosphere (in a suitable safe area) until the pressure falls below 50% of relief valve set pressure. All valves should then be closed and the pressure gauge monitored to ensure liquid stability before entering lift.
3. Check open dewars for excessive boil-off and ensure neck plug is fitted correctly

When in Lift

A key is available from the basement workshop which must be signed out and returned immediately after transportation has been completed.

The key should be used in the PRIORITY SERVICE lock to prevent access to the lift on any floors other than the basement and the floor onto which the dewar is being transported.

Vessels should be moved between floors **unaccompanied**

Where possible a buddy system should be used, one at the entry and one at the exit of the lift, to prevent public access
Signs shall be placed on the doors of the lift warning of the danger and preventing access
Personnel involved in the transportation of such Dewars are trained and aware of the potential hazard and of the actions to be taken in the event of an emergency

Liquid Nitrogen Emergency Procedure

Actions in the event of a spill

Evacuate the area as quickly as possible
Ensure personnel attending the incident are wearing the appropriate PPE
Close doors to prevent the gas flowing along the ground
Open windows and exterior doors to encourage safe evaporation of the nitrogen gas
Do not allow personnel to enter the cloud of condensed water vapour which will be created and restrict visibility
Make sure that the gas has completely dispersed and the air is safe to breathe before allowing anyone to re-enter the area. If in doubt use an oxygen monitor to check levels.

First Aid Treatment for Minor Burn Injuries:

Move victim to comfortable room if possible
Ensure clothing is loose to prevent unrestricted circulation
DO NOT remove clothing stuck to the body until thoroughly thawed
Place affected part in TEPID WATER or run TEPID WATER over for half and hour until skin changes from pale yellow to pink or red. DO NOT use hot water or any other form of direct heat
Cover affected part with bulky dry sterile dressing
Send victim to casualty department of hospital

First Aid Treatment for Asphyxia

If the casualty exhibits any of the following: rapid and gasping breath, rapid fatigue, nausea, vomiting, collapse or unusual behaviour they may be suffering from asphyxia.
Remove the casualty to the open air and follow up with artificial respiration if necessary. Arrange for transportation to hospital without delay

Major Injuries

Send for ambulance (RING 2222)
Follow minor injury procedure as much as possible

N.B All accidents, dangerous occurrences or near misses involving Liquid Nitrogen should be reported to Safety Services using an accident report form AC1 available from the Safety Officer or the General Office

APPENDIX 9

QUEEN'S UNIVERSITY BELFAST

GUIDELINES FOR WORK WITH NANOPARTICLES

1. Introduction

Nanoparticles (NPs) are engineered particles with at least one dimension in the range 1-10 nanometres (nm). They are produced deliberately to exploit the unique properties exhibited at these dimensions. This definition excludes incidental nanoscale or ultrafine particles originating from processes such as combustion and vapourization, cigarette smoke, diesel and welding fume.

Carbon nanotubes (CNTs), fullerenes, quantum dots and dendrimers are the main particles that exist in nanometric dimensions. Many inorganic products, metals and metal oxides and organic materials (PVC, latex) can, however, be reduced to nanometric dimensions. CNTs are a crystalline form of pure carbon, which consist of cylinders of graphite sheets wound around themselves in one or more layers. Fullerenes are another crystalline form of carbon existing in hollow spheres made up of 28-100 carbon atoms. Quantum dots are typically composed of elements from Group II and IV or Group III and V of the periodic table. They have been developed in the form of semiconductors, insulators, metals, magnetic materials or metal oxides. In the size range, 1-10 nm, they display unique optical and electronic properties. Dendrimers are synthetic 3-dimensional macromolecules developed from a monomer with new branches added, step by step in successive tiers until a symmetrical structure is synthesized. They are the basic building blocks for large-scale synthesis of organic and inorganic nanostructures ranging in size from 1-100 nm.

2. Health Effects

Nanotechnology is an emerging field and as such there are many uncertainties as to how the unique properties of engineered nanomaterials pose occupational health risks. The potential risk following exposure to any substance is generally associated with the magnitude and duration of exposure, the persistence of the material in the body, the inherent toxicity of the material and the susceptibility or health status of the person. However, more information is needed about the potential routes of entry, translocation of materials once they enter the body and interaction of these materials with the body's biological systems to predict the health risk associated with exposure to engineered nanomaterials. Results of existing studies on exposure and response to ultrafine or other respiratory particles provide a basis for preliminary estimates of the possible adverse effects. Experimental studies in rodents and cell cultures have shown that the toxicity of such particles is greater than that of the same mass of larger particles of similar chemical composition. In addition to particle surface area, other characteristics such as solubility, surface chemistry and shape may influence toxicity.

2.1 Exposure Routes

The most common route of exposure to airborne particles in the workplace is by inhalation. The deposition of discrete NPs in the respiratory tract is determined by the particles' aerodynamic diameter. NPs can agglomerate and these will deposit according to the diameter of the agglomerate and not its constituent particles. It has been estimated that the majority of particles in the range 1-10 nm will be deposited in the nose and throat, whereas more than 50% of those in the range 15-20 nm will be deposited in the alveolar region. Based on animal studies, it is believed NPs may enter the bloodstream from the lungs and translocate to other organs and tissues. Similarly, discrete NPs that deposit in the nasal region may be able to enter the brain by translocation along the olfactory nerve. This exposure route has not been evaluated in humans as yet.

The ingestion of NPs in the workplace should be greatly limited by the adoption of best working practices. However, incidental ingestion may also accompany exposure by inhalation because particles cleared from the respiratory tract via the mucociliary escalator could be swallowed. At this time little is known about the possible adverse effects from ingestion of NPs.

Some studies suggest that NPs could enter the body through the intact skin during occupational exposure. The UK Royal Society and Royal Academy of Engineering have reported that studies indicate NPs of titanium dioxide used in sunscreens penetrate to the epidermis but not beyond. However, more recent studies show that solutions of quantum dots of different size, shape and surface coatings were able to

penetrate the stratum corneum barrier of pig skin by passive diffusion and locate within the epidermal and dermal layers of the skin within 8-24 hours of the initial exposure. At this time, it is not known if skin penetration of NPs would result in adverse health effects.

2.2 Carbon Nanotubes (CNTs)

Since the adverse health effects of exposure to asbestos fibres are well documented and since some of the CNTs are similar in size and shape to asbestos fibres, and similar in their ability to persist in the lungs of laboratory animals, a number of toxicological studies of CNTs (single-walled, SW, and multi-walled, MW) have been performed in recent years. These studies have shown that the toxicity of CNTs may differ from that of other NPs of similar chemical composition. SWCNTs have been shown to produce granulomas in the lungs of mice and rats at mass doses at which ultrafine carbon black did not produce adverse effects. (Granulomas are small nodules of cells that form around foreign bodies that cannot be easily cleared from the lungs). In another study MWCNTs with a high aspect ratio produced a marked inflammatory reaction and the formation of granulomas, when injected into the abdominal cavity of mice. A similar reaction was observed with asbestos fibres of high aspect ratio. On the other hand, it was noted that when short asbestos fibres, nanoparticulate carbon black, or short or tangled MWCNTs were injected, there was little or no inflammation. It is known that the morphology of asbestos fibres is an important factor in the development of asbestos related diseases and these findings raise the level of concern regarding the potential of similar diseases being caused by exposure to CNTs.

3. Fire and Explosion

Although insufficient information exists to predict the fire and explosive properties of nanoscale powders, nanoscale combustible material could present a higher risk than coarser material of similar quantities. Decreasing the particle size of combustible materials can reduce minimum ignition energy and increase combustion potential and combustion rate, leading to the possibility of relatively inert materials becoming highly combustible. Dispersions of combustible nanomaterials in air may present a greater explosion risk than dispersions of non-nanomaterials of similar composition. In particular, for metallic substances, the explosion rate can increase significantly as particle size decreases.

It is therefore recommended that NPs are stored in closed containers in fire-resistant cabinets.

4. Assessment of Work with NPs

It is assumed that NPs are substances hazardous to health and therefore there is a requirement under regulation 6 of *The Control of Substances Hazardous to Health Regs (NI) 2003 (COSHH)* to conduct a “suitable and sufficient” risk assessment of the health risks posed by work with them.

Detailed guidance on COSHH risk assessment is available elsewhere ie from the University Safety Service, its website at www.qub.ac.uk/so and from local/departmental COSHH supervisors.

However, since so little information is available on the toxicity of these substances and no workplace exposure limits have, as yet, been established, the priority in the COSHH risk assessment must be to explore the practicability of preventing exposure to NPs by totally enclosing the process. If it is not possible to completely prevent exposure, the risk assessment must state clearly the control measures required to ensure that the exposure is kept as low as reasonably achievable. (Section 4 below).

In addition, the risk assessment must address the following:

- the identification of all people at risk, including research, technical cleaning and maintenance staff;
- the arrangements for monitoring exposure and for health surveillance;
- the arrangements for the provision of information, instruction, training and supervision for those in contact with NPs.

4.1 Air Monitoring

There are currently no national or international consensus standards on measurement techniques for NPs in the workplace. Current research indicates that mass and bulk chemistry may be less important than particle size, surface area and surface chemistry for evaluating NP exposure. Research is ongoing into the relative importance of these different exposure metrics and how to best characterize exposure to NPs in the workplace. The unique shape and properties of some nanomaterials may pose additional challenges. For example, phase contrast microscopy used in asbestos fibre counting cannot detect individual CNTs (diameter < 100 nm), nor bundles of CNTs with diameters < 250 nm. At this time there is no convenient or direct method by which exposure to NPs in the workplace can be measured or assessed.

4.2 Health Surveillance

Health surveillance is considered appropriate for all persons exposed to NPs.

Therefore all persons involved in a process or project using or generating NPs and exposed to them should be referred to the Occupational Health Physician by their supervisor/line manager for assessment prior to the work commencing. The Occupational Health Physician should be provided with full details of the process/project and the COSHH risk assessment in order that the nature and frequency of health surveillance can be determined. The Occupational Health Physician will provide advice on the records required to be kept by management. (Appendix 1).

5. Control of Exposure to NPs

At present there is insufficient information to predict all of the situations and workplace scenarios that are likely to lead to exposure to NPs. However, there are some workplace factors that can increase the potential for exposure, including:

- working with NPs in liquid media without adequate protection will increase the risk of skin exposure;
- working with NPs in liquid media during pouring or mixing operations or where a high degree of agitation is involved will lead to an increased likelihood of inhalable and respirable droplets being formed;
- handling NPs will lead to the possibility of aerosolization;
- maintenance on equipment and processes used to produce or fabricate NPs will pose a potential exposure risk to workers performing these tasks;
- cleaning of dust collection systems used to capture NPs will pose a potential for both skin and inhalation exposure.

In order to prevent exposure to NPs (as required by regulation 7(3) of COSHH) appropriate measures must be applied in the following order of priority:

(i) ***Design the work process to contain, limit and control the formation of airborne contamination.*** Use equipment that fully encloses the process, where possible, ie a glove box. Avoid the use of blenders, sonicators, high speed mixing or shaking. Transport dry NPs in closed containers. Use wet or vacuum methods for dealing with spills.

(ii) ***Control exposure at source by the use of local exhaust ventilation supplemented with appropriate organisational measures.*** For example, carry out manipulation of the NPs in a ducted fume cupboard fitted with a HEPA filter, or use a suitable and effective LEV which encloses the process as much as possible. (HSE considers ductless fume cupboards and recirculatory biological safety cabinets unsuitable for use with CNTs).

If possible keep the NPs damp or wet to reduce the risk of them becoming airborne. Limit the scale of the work to minimise the quantity of NPs used or generated.

Restrict the work to a clearly demarcated area. Minimise the number of persons who could be exposed to NPs by restricting access to the process area to authorised personnel only. Prohibit eating, drinking, smoking and the use of cosmetics in the process area and other areas that could become contaminated with NPs. Exclude personal items from the process area to prevent the spread of contamination outside that area. Provide and maintain adequate hygiene measures to prevent the spread of contamination.

(iii) ***Provide suitable personal protective equipment (PPE).*** This should include respiratory protective equipment (RPE), gloves and protective clothing (lab coats, aprons, coveralls). Advice on the choice, use of RPE and face-fit testing for negative pressure masks should be obtained from University Safety Service. It should be noted that under COSHH, RPE must be used in addition to other control measures and for emergencies and maintenance procedures. (HSE recommend the use of RPE with a minimum assigned protection factor of 40 for such work.) Protective clothing must be worn over personal clothing in the process area to prevent it becoming contaminated. The protective clothing provided should not retain dust. Therefore wool, cotton or other knitted material is not recommended. Tyvek disposable suits are suitable. Protective clothing should be stored separately from any personal clothing to prevent cross contamination. If it is re-usable, then the protective clothing should be laundered at regular intervals to prevent the build-up of NPs on it. Since NPs may penetrate commercially available disposable gloves, double gloving is recommended.

The application and use of the above control measures should be incorporated into standard operating procedures which outline safe working practices. Ideally these procedures should be presented to the local safety committee for ratification prior to the commencement of the work.

Finally, procedures should be in place to deal with spills, accidents and other emergencies.

6. Management of Work with NPs

It is the supervisor's/line manager's duty to ensure that adequate control measures are in place and properly maintained so that they remain effective. In addition, he/she must ensure that the workers receive adequate information, instruction and training before commencing work with NPs. The workers should be provided with information covering:

- the potential health hazards of working with NPs;
- the procedures for reporting any perceived adverse health effects;
- emergency procedures.

Appropriate training should be given in respect of:

- the correct use and maintenance of PPE and other control measures;
- work practices which prevent or reduce the emission of NPs into the process area or outside;
- emergency procedures for spills and clean up.

In consultation with the Occupational Health Physician, it is the supervisor's/line manager's duty to ensure that workers report in a timely fashion for appropriate health surveillance. It is also his/her duty to ensure adequate arrangements are in place for the maintenance of health records for each individual placed under health surveillance. Finally, it is his/her duty to ensure that workers are following agreed procedures to control exposure to NPs.

References

1. Risk Management for Carbon Nanotubes, WEB38, HSE.
2. Best Practice Guide to Synthetic Nanoparticle Risk Management, Report R-549, IRSST.
3. Progress towards Safe Nanotechnology in the Workplace, NIOSH.
4. Nano Alert Service, Newsletter issue 5, May 2008, HSE.

Prepared by Dr John Wilson
(Radiation Protection Advisor/Occupational Hygienist)

Approved by TSAC **June 2010**

APPENDIX 1

HEALTH RECORD PARTICULARS

The following particulars, approved by the HSE, must be kept for each individual place under health surveillance.

(a) Identifying details:

(i) Surname and forenames
(ii) Gender
(iii) Date of Birth
(iv) Permanent Address
(v) National Insurance Number
(vi) Date of when work with nanoparticles commenced and history of exposure to nanoparticles.

(b) Health surveillance results:

(i) Dates when carried out
(ii) By whom
(iii) Conclusions regarding fitness for work.

The health record must not contain clinical data.

The records must be kept for at least 40 years.

APPENDIX 10

School of Chemistry and Chemical Engineering Policy Statement on the Provision and Use of Respiratory Protective Equipment (RPE).

Respiratory protective Equipment (RPE) is available to all individuals on request and free of charge from Safety Services. Prior to issue needs shall be addressed by USS as it is essential to ensure:

(i) Items issued are suited to the intended use and
(ii) Recipient receives adequate instruction and training in their effective use and their limitations

The inhalation of any chemical or biological dust or organic vapour should firstly be avoided by handling technique or the use of air extraction e.g. work in a fume cupboard or under a ventilated hood.

Dust masks or respirators MAY be used as back up prevention in those instances when NO OTHER means of avoiding inhalation is practicable. One such scenario is when waste solvents are being deposited in the flammable storage facility in the goods yard. **RPE must be worn** in this instance, as well as the other suitable types of PPE outlined in the waste solvent disposal procedure, as no other suitable method of controlling inhalation is possible.

Care and attention is also needed when working with large quantities of light powders and when carrying out weighing, grinding and sieving operations. In these cases where direct extraction or handling techniques are deemed not to be totally sufficient then dust masks may be required as an additional control.

Before a dust mask or respirator is issued the individual concerned will have to attend Safety Services and undergo face fit testing to establish suitability and best fit of the respective mask/respirator. The School Safety Adviser can arrange such testing.

A suitable mask will be issued once the user has passed the face fit test and a certificate pertaining to that mask will be given to both the user and the School Safety Officer for record retention.

As the mask is defined as PERSONAL PROTECTIVE EQUIPMENT it thereby becomes the responsibility of the user/wearer to take care of it, inspect it for defects wear and tear etc., and immediately report any deficiencies to the School Safety Adviser for reissue of a new mask. Masks should also be cleaned immediately after use using alcohol wipes available from Chemistry Stores (3M alcohol cleansing wipes)

Masks when not in use MUST be stored in a dust free environment preferably in a sealed bag such as those that the respirator is issued in.

APPENDIX 11

Catalyst handling procedure

1. Purchasing catalysts

Catalysts in CenTACat are either

(a) purchased directly from catalyst companies such as Johnson Matthey, Robinson Brothers, World Gold Council, etc

or

(b) prepared within CenTACat using metal precursors purchased from catalysis companies such as Johnson Matthey, Robinson Brothers, World Gold Council or Sigma Aldrich

2. Storage of catalysts

Once a catalyst is within a CenTACat lab it is to be:

(a) labelled with the users name, date, and the quantity of catalyst. The user is responsible for the storage, use and disposal of the catalyst.

(b) purchased catalysts should be entered on the inventory for the lab where it will be stored and used

(c) catalysts from JM, Rob Bros, WGC are to be stored in plastic containers and catalysts prepared in QUB are to be stored in screw top vials

(d) hazards associated with the catalysts must be identified and clearly labelled at the point of storage. It is the responsibility of the labelled user to ensure other lab users are aware of the hazards associated with the material they have brought into the lab.

No catalysts should be used without the permission of the labelled user

3. Use of catalysts

Some catalysts can be used directly but others require a reduction to activate the catalyst. The reduction can be performed:

(a) in-situ within a reactor. In this situation, the catalyst, once activated will always be under a gas flow (reaction conditions or inert gas environment) or under solvent. The system must be purged before removal of the catalyst after reduction or at the end of the reaction.

(b) ex-situ in a furnace and then the reduced catalyst transferred to a reactor. In this situation, the standard operating procedure for reduction of a catalyst must be followed to allow safe transfer of an activated catalyst.

Once catalysts have been used they must be disposed of as in section 5 or stored (only if required) as outlined in section 4. No used catalyst must be stored without clear intent. The used catalyst storage cupboards must be inventoried and updated every 6 months.

4. Storage of used catalysts

When a used catalyst needs to be retained it must be:

(a) entered on used catalyst inventory (copy kept at point of storage)

(b) stored in a screw top vial – clearly labelled with user's name, date and the quantity of catalyst

(c) kept in a fire resistant cupboard separated from all other chemicals/solvents/ gas cylinders

5. Disposal of catalysts

For disposal of used catalysts:

(a) from liquid phase reactions, where the catalyst is separated from the waste solvent by use of a syringe filter, the used syringe filter must be kept under water for disposal through the university waste disposal

(b) from liquid phase reactions, where the catalyst is separated from the waste solvent by use of a pasteur pipettes filled with cotton wool, the pipette containing catalyst must be stored under water and the pipettes disposed of through the university waste disposal

(c) all collected catalyst waste must be kept in plastic containers; an individual container is required for each different metal.

(d) within each container the catalyst must be kept under water/solvent as a thick paste - used catalysts must not be allowed to dry out.

(e) the containers are to be stored in a metal cupboard/under a fume cupboard separated from all other chemicals/solvents/gas cylinders

(f) precious metal waste is to be returned to JM, non-precious metal waste is disposed of as inorganic waste through the University

(g) used quartz wool collected from reactors is to be collected in a plastic container, stored under water and disposed of through the university waste disposal.

Used catalysts must never be left on filter paper to dry or be stored on filter paper under water

APPENDIX 12

SAFE HANDLING AND USE OF LABORATORY GLASSWARE

Before using glassware it is important to:

Check the glassware for damage prior to use:

if damaged- scratched/ cracked dispose of in accordance with School Procedure using due caution when handling. Pay particular attention to star cracks which often occur in round bottomed flasks Some minor chipped or cracked items may be repairable- check with glassblowers.

DO NOT USE GLASSWARE THAT IS FLAWED

Check glassware for contamination/residue from previous use. Check cleanliness by spraying with distilled water- no beading should occur if the glassware is clean

Washing, Rinsing, Drying, Storing Glassware

Glassware may be **cleaned** by hand or in a dishwasher using a non -abrasive detergent. Ensure before hand washing any glassware that eye protection and heavy duty slip resistant gloves are worn. If chemicals such as Acetone or acid solutions are used, in addition, the gloves should be chemically resistant and the cleaning process, if necessary, conducted inside a fume cupboard.

Wash glassware as quickly as possible after use – the longer it is left unwashed, the harder it will be to clean. It may be necessary to leave harder to clean apparatus to soak in soapy water.

****Ensure that ANY residues remaining in the glass vessel to be washed are NON REACTIVE to water

Keep glassware clear of the sides of the sink and if washing pipettes and burettes do not let tips hit the sink or taps. Basin placed in sinks may reduce the risk of breakage.

Grease on glassware may be removed by using a boiling solution of weak sodium carbonate and then using Acetone as a fat remover. Grease can be removed from ground glass joints by wiping with a cloth soaked in Petroleum Ether. Before using caustic cleaning agents, aqua-regia or other reactive solutions specialist training must be received.

Alkaline liquids may be stored in stoppered volumetric flasks but be mindful that stoppers may stick! (See Safe Handling)

When cleaning pipettes, place pipettes tip down into a cylinder or tall jar of water with the appropriate cleaning solution. A pad of cotton or glass wool at the bottom will help prevent breakage of the tips. Ensure the water level is sufficient to adequately submerge the pipette.

Dry by hanging on peg boards or place in baskets/racks in oven with the temperature NOT exceeding 140°C.

Store glassware in racks/drawers with pads and separated from each other where mechanical damage (rolling around) is kept to a minimum. DO NOT store close to the front edge of a shelf or the front sash of a fume hood.

Selection and Suitability of Glassware for the Task

Before conducting any experiments where glassware is required check:

Is it the appropriate type of glass?

Is the grade suitable?

Do chemicals react with the glass?

Types of glass

Soda Lime- mostly used in storage containers and bottles/sample vails. Readily attacked by concentrated hydroxide solutions. **NOT suitable** for heating applications due to the high coefficient of thermal expansion which can cause moulded objects of soda lime to shatter easily.

Borosilicate (PYREX, QVF, DURAN, SCHOTT) - more chemically resistant than soda lime and is relatively insensitive to thermal shattering. It is resistant to all known acids (with the exception of Hydrofluoric where Polyethylene /Teflon is recommended)
Disadvantages: hot concentrated hydroxides attack it
Avoid acidic fluoride solutions which will etch the glass and can completely dissolve it away

Safe Handling

Proper handling of glassware can reduce the risk of injury and accident.

- Never carry a flask by its neck
- Never carry a beaker by its side
- Always use two hands carrying any glassware(position one hand under the glass for support)
- Appropriate gloves should be worn where there is a risk of breakage, (e.g. inserting a glass rod), chemical contamination, or thermal hazard (hot or cold).*

  *When handling hot or cold glassware always wear insulated gloves
- Avoid physical stresses to the glassware. Where necessary, stabilise using clamps and platforms to relieve pressure.

  *Avoid overtightening clamps. Always use coated clamps to avoid metal to glass contact and do not use excessive force to tighten.
  *Neck clamps should not be used as sole support for vessels larger than 500ml
- Ground glass joints may sometimes stick. To prevent this from occurring it is advisable in advance to lubricate stopcocks and vacuum taps well with vacuum grease

  *Never force a joint free- it can cause the glass to shatter.
  *Lubricate surfaces.
  *A heat gun can gently loosen the joints- ENSURE YOU POINT THE GUN AWAY FROM THE CONTENTS OF THE FLASK. If it is still difficult to loosen take item to glassblowers for assistance.

Heating and Cooling Glassware

Rapid temperature changes (heating and cooling) should only be applied to borosilicate (PYREX) glassware designed for such applications. Check with manufacturer to determine safe temperature usage.
Never heat glassware that is etched, cracked, chipped, nicked or scratched.
Glassware with thick walls (e.g. bottles or jars) should never be heated over a direct flame or on a hot plate. Never look down onto a vessel that is being heated.
Ensure vessels are vented sufficiently when heating to avoid over pressurisation.
For flat bottomed vessels, always use hotplates that are larger than the bottom of the vessel being heated. Consider using water baths/oil baths/Aluminium shaped blocks for heating round bottom flasks etc.
All glassware should be cooled slowly to prevent breakage- do NOT place it on cold or wet surfaces unless the glassware has been specifically designed for this purpose.
Use care when removing glassware from ultra-low temperature freezers or low temperature solvent baths as they may suffer thermal shock and crack. Rinse the bottle firstly under cold running water until thawing occurs. NEVER place bottles directly from the freezer into warm water baths.

Vacuum and Pressure Operations

Before conducting any work involving pressure or vacuum systems ensure that you have been trained to use the specialised equipment and techniques
Ensure that the glassware chosen is suitable for the task intended as container walls must be able to withstand pressure differences or they may IMPLODE. Round bottomed or thick-walled flasks must always be used. **FLAT BOTTOMED VESSELS ARE NOT SAFE TO USE FOR VACUUM WORK**. NEVER place glassware under pressure that it is not designed to withstand- it must be rated for specific pressure limits so check with the manufacturer FIRST.
Checking for flaws or defects before use is very important – glassware showing any signs of such SHOULD NOT be used in a vacuum system
When setting up vacuum apparatus please ensure:

- All vacuum apparatus is either behind a blast shield or inside a fume hood with the sash lowered- blast shields can also be used INSIDE the fume cupboard as an additional precaution
- Always wear appropriate protective equipment(safety glasses/goggles, face shield, gloves)
- Desiccator cages are available and should be used. Alternatively cover flasks, Dewars and desiccators with tape or mesh or alternatively use PVC coated glassware if available.
- If using a vacuum trolley pump, it is advisable that a blast shield be used.

Working with glass rods, tubing and pipettes
Inserting glass tubing or rods into a cork or rubber stopper carries a high risk of injury to your hands, if they break. So too does attaching tubing to any type of delicate glass tap such as a vacuum tap for instance. Tubing should be fire polished before inserting into a stopper etc.
Safe Technique for inserting glass tubing is as follows:

- Determine the holes are the correct size for the glass material.
- Never force the glass into place.
- Lubricate the hole and tube with a few drops of water, soapy water, glycerol - it is not advised to use oil or grease.
- Hold tubing close to where it enters the hole in the stopper. Protect hands with gloves and pieces of cloth.
- Palm of the hand holding the stopper should NOT be in line with emerging glass tube.
- Position the glass material close to the insertion point and using a gentle twisting motion push into the hole to the required depth- DO NOT FORCE.
- Wipe excess lubricant from tubing before continuing.
- Remove tubing immediately after the experiment- this may require the need to CUT the tubing using a glass cutter.

When attaching rubber tubing to fine glass outlets such as those on condensers try to use a screw thread adapter in the first instance as this will ensure no force is required when affixing the tubing. If adapters are not available ensure that the tubing chosen for the task is as malleable as possible – the tubing can be soaked in hot water first- ensuring care is taken not to sustain a scald injury- to make it more pliable.
DO NOT ATTEMPT TO REMOVE TUBING THAT HAS BEEN SHRUNK FIT ONTO GLASS OUTLETS/INLETS BY PULLING- INSTEAD CUT THE TUBING OFF CAREFULLY USING A BLADE AND CUTTING AWAY FROM THE BODY.

Disposal and Spill Clean up

Spills and broken glass

Glass is fragile and breaks easily. Extra care should be taken to reduce the risk of cuts.

- If something is falling- let it drop- do not attempt to catch it! Catching it may cause you to sustain a cut to your hand.

- Wear cut resistant gloves when handling broken glassware- disposable nitrile gloves are NOT suitable as glass will cut through them.
- When cleaning broken glass use mechanical means to pick up the pieces.
  - Tongs, tweezers, or forceps should be used to pick up large pieces of broken glass or use a dustpan and brush
  - Small shards can be picked up using wet paper towel or absorbent pad or by using rolled up sticky tape.

Disposal

Correct disposal ensures everyone's safety
Uncontaminated broken glass can be disposed of in the glass bins/s in the laboratory. When approaching full these can be transferred, using caution and wearing PPE, to a sturdy cardboard box. The box is taped securely, especially at the edges, to prevent fine glass items such as pipettes protruding. "BROKEN GLASS" should be written on the top of the box and disposed of in the EXTERNAL **standard waste Eurobins** coloured BLUE which are located up the slope from the goods yard.
Glassware containing heavy deposits of chemicals and in particular SILICA must NOT be disposed of in this manner
Chemically contaminated glass should be boxed as above but disposed of as chemical waste using the School Waste Chemical Disposal Procedure.
Glassware contaminated with silica can be disposed of as per School Waste Silica Disposal Procedure.

Dealing with injuries involving glassware

Splashes to the eyes- rinse for at least ten minutes using the emergency eye wash station or under a tap of cold running water.
Minor Cuts- allow to bleed for a short period of time. Wash injured area and use disinfectant wipes from First Aid Box. Inform a First Aider.
More serious cuts or puncture wounds may require medical help. Aim to control the bleeding by applying pressure to the wound. Do NOT attempt to remove any item of deeply embedded glassware from the wound as this may exacerbate the bleeding. Call a first aider and they will assist in wound management or advise if further medical help is required.

APPENDIX 13

STANDARD OPERATING PROCEDURE FOR DEALING WITH SILICA

IF A SPILL INVOLVING SILICA OCCURS IN THE LAB USE THE FOLLOWING PROCEDURE:

- CLOSE/LOCK OFF THE LAB AND DO NOT PERMIT ACCESS
- ONLY TRAINED STAFF USING RPE SHOULD BE INVOLVED IN THE CLEANUP
- A HALF MASK **PARTICULATE** RESPIRATOR MUST BE WORN BY THOSE INVOLVED IN THE CLEANUP- MASKS ARE EITHER **3M 4277** OR **SUNDSTROM SR100** WITH A PARTICULATE FILTER FITTED- **N.B ORGANIC RESPIRATORS ARE OF NO USE AND MUST NOT BE WORN**
- TRY TO CONTAIN THE SPILL INSIDE A FUME CUPBOARD IF POSSIBLE
- USE WELL DAMPENED TISSUES/TISSUE PAPER TO COVER THE SILICA AND CAREFULLY TRANSFER AS MUCH OF IT AS POSSIBLE INTO A SUITABLE LIDDED CONTAINER OR SEALABLE HEAVY DUTY PLASTIC BAG
- USE A HEPA FILTER VACUUM CLEANER- AVAILABLE FROM STORES- TO REMOVE ANY REMAINING TRACES OF SILICA
- REMOVE THE BAG FROM THE VACUUM CLEANER AND PLACE INSIDE A SEALABLE PLASTIC BAG
- THE CONTAINER/PLASTIC BAG CONTAINING THE SPILT SILICA AND CLEANUP MATERIALS INCLUDING THE VACUUM BAG MUST BE DISPOSED OF IN THE SECURE WASTE SILICA DRUM LOCATED OUTSIDE STORES
- RETURN VACUUM CLEANER TO STORES AND ENSURE A NEW BAG IS FITTED
- ACCESS TO LAB CAN BE REINSTATED ONCE ALL CLEANUP MATERIALS HAVE BEEN DISPOSED OFF