

UNIVERSITY OF ST ANDREWS



University
of
St Andrews

SCHOOL OF CHEMISTRY

SAFETY HANDBOOK

November 2020

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SAFETY PERSONNEL

| | Room No. | Tel. No. | E-mail |
|---|----------|----------|--------|
| Security and Response Team For EMERGENCIES only | | 8999 | |
| School Safety Coordinator Dr K Jones | 211b | 3689 | kj34 |
| Assistant School Safety Coordinators | | | |
| Dr B. E. Bode | 153 | 3869 | beb2 |
| Dr P. Kilian | 341 | 7304 | pk7 |
| Dr A. Stasch | 242 | 3382 | as411 |

Note: The Duty Safety Coordinator is shown on the School Intranet page:
<https://universityofstandrews907.sharepoint.com/sites/chemistry/SitePages/Home.aspx>

| | | | |
|--|-------|------|-------|
| School Biological Hazards Officer Prof T. K. Smith | B310 | 3412 | tksl |
| School Laser Safety Officer Dr C. Penedo | B108 | 3106 | jcp10 |
| X-Ray adviser Dr M. S. Alphey | B204 | 7257 | msa31 |
| First Aid Workers | | | |
| *Iona Hutchison | 214 | 3803 | ilh |
| *Iain Patterson | M241 | 1856 | iljp |
| *Steve Francis | 101e | 2273 | smf6 |
| *Neil Keddie | 362 | 7264 | nsk |
| Louise Major | B Lv3 | 3417 | llm6 |
| Chris Simmons-Riach | 2RM01 | 3416 | csr5 |
| Jacqueline Nairn | 1RM10 | 3604 | jn37 |
| John Nicolson | B Lv2 | 3398 | jn |
| Emergency First Aid Workers | | | |
| Sabine Gruschow | B Lv3 | 7195 | sg200 |
| Dominic Stewart | M241 | 1856 | dms20 |
| Magnus Alphey | B204 | 7257 | msa31 |

* also qualified as Oxygen-Cyanide First Aiders

M = Medical building B = BMS Annexe RM = Willie Russell Labs

| | | | |
|--|---------------|------|------|
| University Chemical Hazards Adviser Dr R. A. Aitken | 441 | 3865 | raa |
| University Director of Health and Safety Mr H. Graham | Bute Building | 2751 | hg61 |
| University Deputy Director of Health and Safety Dr P. W. S. Szawlowski | Bute Building | 2753 | pwss |

This School Safety Document replaces all previously issued safety documents and directives

1. Policy Statement

The Health and Safety at Work etc. Act, 1974, the object of which is to secure the health, safety and welfare of persons at work, came into force on 1st April 1975. This Act seeks to unify and strengthen existing legislation relating to safety and may be regarded as an enabling Act, which lends the force of law to safety regulations introduced in the workplace.

It is the policy of the School of Chemistry to comply fully with the Health and Safety at Work etc. Act as required by law and to act positively to prevent injury, ill-health, damage and loss arising from work carried out within its precincts. This policy is a supplement to the University's Health and Safety policy and is applicable to members in the School of Chemistry who work in the Purdie, Biomolecular Sciences and Medical School Buildings.

It considers the promotion of the safety and health of all persons working in the School to be an essential part of the academic staff's duties for which they are accountable at all levels. The School will seek to encourage all members of the School to participate in and contribute to the establishment and observance of safe working practices. The School expects all persons working within its precincts to recognise that equally there is a clear duty on them to exercise self-discipline and accept responsibility to do everything they can to prevent injury to themselves and others and loss to the School.

Current legislation applies in full to all work carried out in the School. The School expects all personnel to co-operate fully in carrying out the procedures required by these Regulations and in obeying the School safety rules arising from them, which are given in this booklet.

The School and University take Health and Safety very seriously. Noncompliance with safety policies is a disciplinary matter which can ultimately result in dismissal for both staff and students.

In accord with the above policy the School of Chemistry will:

- (i) Employ and provide proper resources to ensure competent advice on safety and health matters.
- (ii) Continue to develop and implement procedures and codes of safe working practice.
- (iii) Maintain systems for exchange of information with other chemistry Schools for reporting and controlling safety performance and for monitoring and assessing health at work.
- (iv) Provide training in safe working methods.
- (v) Maintain an appropriate framework for consultation on effective measures for promoting safety and health at work including a School Safety Committee.



**Russell Morris, FRS, Head of School
November 2020**

2. Organisation and Arrangements

To give effect to the above statement of policy the School of Chemistry has made the following arrangements.

2.1 **Head of School**

The Head of School is responsible for ensuring, so far as it is reasonably practicable, that the operations in the School do not constitute a hazard to safety and health; and, in particular, that any rules made by the University and the School are understood and observed by all persons working in the School.

He is responsible for making suitable arrangements for consultation between himself, the staff and representatives of the School for the purpose of reviewing existing safety practices and, in particular, for the introduction of new safety measures.

2.2 **Members of the Academic Staff**

Members of the academic staff are responsible, under the direction of the Head of School, for:-

- (i) Instructing members of their research groups and technicians under their supervision in safe working practices.
- (ii) Ensuring safe working practice, adherence of equipment to safety standards (e.g. Electricity at Work Regulations) and good housekeeping in laboratories and workshops designated as their particular responsibility.
- (iii) Arranging for a colleague to be responsible for their research group if they are to be absent for more than three days, and notifying this arrangement to the Head of School's office.
- (iv) Requiring that School safety rules are obeyed.
- (v) Ensuring that the necessary safety equipment is available and used.
- (vi) Demonstrating their personal concern with health and safety at work.
- (vii) Engaging the interest and commitment of all persons under their supervision to healthy and safe working practices.

Part-time Postgraduate Demonstrators

Part-time demonstrators will have the responsibilities listed in 2.2 (iv)-(vii) above for members of staff whilst they are demonstrating.

2.3 **All Employees of the University, Postgraduate and Undergraduate Students**

All employees of the University and students have a responsibility to themselves and to others to:-

- (i) Carry out their work in a safe manner and with due regard to health.
- (ii) Adhere to the University and School safety rules.
- (iii) Inform themselves of the safety and health hazards of the equipment and materials with which they are concerned, in so far as these hazards may reasonably be foreseen.

- (iv) Bring to the notice of supervisors any potential hazard to safety and health of which they know or learn of whether in routine work or arising from faults in equipment.

2.4 School Safety Coordinator

The Head of School has appointed **Dr Kevin Jones** as the Health and Safety Manager for the School of Chemistry. He is to advise the Head of School and to act on his behalf in any matters affecting the personal safety of individuals and equipment. This is not, however, a delegation of responsibility, which resides with the Head of School. The School Safety Coordinator is advised, as necessary, by the University Environmental Health and Safety Services (EHSS). Note that members of the School should refer all safety matters to the School Safety Coordinator in the first instance who will then consult EHSS as necessary.

A function of the Safety Coordinator is to keep under review the measures taken to ensure health and safety at work, and to promote the effective co-operation of all members of the School at all levels in such measures. The Safety Coordinator will also chair the School Health and Safety Committee which meets four times a year and reports to the School Council.

The School Safety Coordinator is responsible for Safety Audit within the School of Chemistry. He will therefore arrange for the inspection of all laboratories on a regular basis and present a written report to the member of staff responsible for each laboratory and the Head of School indicating any matters which are in contravention of the School's safety rules. The staff member responsible should then ensure that the necessary improvements are made and confirm this fact to the School Safety Coordinator. Finally the School Safety Coordinator will present a brief summary of the results of the inspection to the University Safety Adviser and Head of School.

2.5 Jurisdiction

Members of the School of Chemistry are located in the Purdie Building, the Medical Science Building (MSB) the Biomolecular Sciences Building (BMS) and the Biomolecular Sciences Annexe, and these buildings are also partly occupied by members of other Schools. The provisions in this Handbook apply to all members of the School of Chemistry regardless of which building they normally work in. It should be noted however that in some matters (e.g. emergency evacuation procedure) different provisions may apply according to where personnel are located. It is your responsibility to know the procedure for the building you work in.

Students on placements with external organisations will normally be subject to the Health and Safety policies of those organisations. It is the policy of the University of St Andrews that students only undertake placements in organisations making an appropriate and adequate provision of Health and Safety care.

All other academic activities undertaken outwith the School of Chemistry must be subjected, in advance, to appropriate risk assessment.

2.6 Electronic Mail

It is convenient and efficient to circulate urgent safety information by electronic mail. For this reason all permanent employees, research workers and postgraduate students are

required to obtain a University e-mail account and to inform the General Office of their e-mail code. In this way the School Safety Coordinator can ensure that essential safety information can be rapidly disseminated to all personnel using the e-mail address list 'chem-all'.

2.7 Survey of Hazards

A systematic survey of the hazards present in the School has been performed and this indicates that the major types of hazard are as follows:

Fire – a major risk due to the large amounts of highly flammable materials in use. The relevant regulations are contained in sections **4** and **8**.

Chemical – again major due to the large number of substances in use many of which are toxic, irritant, corrosive, potentially explosive, carcinogenic and so on. The relevant regulations are contained in section **9**.

Radiation – this only involves a few personnel and is strictly controlled. See section **19**.

Biological Hazards – again only a few personnel are involved and the hazards are relatively minor. See section **18**.

Physical and mechanical – this group includes personal injuries such as burns, cuts, sprains etc. which may be caused by falling, equipment failure and incorrect manual handling (see section **20**.) or unsatisfactory use of Display Screen Equipment (see section **21**).

Noise – only a few pieces of equipment generate a noise level which requires ear protection. See section **6.10**.

Flood – a widespread and major hazard due to the large number of experiments and pieces of equipment using water, many on a continuous basis. See sections **7.7** and **12.7**.

Electrical – major due to the large amount of electrical equipment in use, some of it operating at high voltage. See section **13**.

3. *Access to the School and Security*

The School is open from 8.00 am to 6.00 pm Monday to Friday. When the School is closed access may only be gained through certain doors by swipe card/or key. Members of staff, research workers and certain undergraduate students are issued with swipe cards and/or keys by the School Office.

3.1 **All persons entering the buildings outside normal hours must sign the book at the door by which they enter.** This is to enable the Emergency Services to immediately ascertain the number and location of persons in the buildings. In the event of an emergency occurring outside normal hours, lives could depend on these books having been signed. Persons intending to remain in the buildings after 6 pm must also sign the books at that time. All persons should "sign out" when leaving the buildings.

3.2 No person should attempt to travel in the Purdie goods lift outside normal working hours with goods. Goods can be moved by loading the items into the lift, then proceeding via the stairs to the destination Level and calling the lift from there. **Please note you should never enter the lift if dry ice, gas cylinders or large liquid nitrogen dewars are in the lift even if these are empty.**

- 3.3 All key and swipe card holders are responsible for ensuring the security of the buildings outside normal hours. To leave the doors unlocked or pass a key or swipe card to, or otherwise allow admission to, any unauthorised person is a serious breach of the School Safety Regulations. The designated emergency exit doors at the bottom of the stair-wells are for emergency use only and should not be used to exit the buildings under normal circumstances since they cannot be properly closed from the outside and may therefore compromise the security of the buildings.
- 3.4 Undergraduate students are provided with a swipe card which only affords access to the common room and library area of the Purdie Building after 6.00 pm. They are not permitted to enter the research laboratory block outside normal hours and research personnel must ensure that the doors at the north end of the common room and in front of the lift on level 2 remain locked.

4. ***Emergency Procedures***

Emergencies are classed as minor, which can be dealt with locally, and major, requiring evacuation of the buildings and signalled by the sounding of the fire alarm. The buildings must be evacuated whenever the alarm sounds continuously.

There are smoke or thermal detectors in selected rooms but it may be that the system will have to be activated manually from a break-glass button. If a major emergency arises, sound the fire alarm from the nearest break-glass unit if it has not gone off automatically. (See 4.2)

The argon system of the Purdie Building overnight room 438 is permanently armed. Before entering this overnight room, read carefully the instructions outside the door. In particular, if a continuous bell sounds while you are in the overnight room, argon discharge is imminent: leave the room immediately and close the door.

4.1 **Minor Emergencies**

Small Fires

- (i) Raise the alarm locally (e.g. within your own laboratory) by voice.
- (ii) Attempt to extinguish the fire immediately using a CO₂ extinguisher or other suitable method. Do not take any personal risk, and ensure that you have a safe exit route at all times.
- (iii) If the fire cannot be extinguished quickly using a maximum of one 2 kg CO₂ extinguisher, immediately sound the fire alarm using the nearest break-glass point, and follow the evacuation procedure set out in Section 4.2 below.

If at any stage the fire-alarm siren sounds, immediately break off fire-fighting activity and leave the building under the usual evacuation procedure.

- (iv) If the fire can be rapidly extinguished, check at intervals thereafter to ensure that the fire has not re-ignited

- (v) On no account return any fire extinguisher which has been used to its normal position. Contact the Buildings Officer to obtain a full replacement.
- (vi) Make a report on the fire as soon as possible to the Safety Coordinator (see Section 5 below).

Small Fires in a Fume Cupboard

If a fire occurs in a fume cupboard the draught may make the normal fire-extinguishing methods ineffective. If safe to do so, lower the sash then tackle the fire as normal using CO₂, dry powder or sand.

Personal injury

- (i) Keep calm and give immediate First Aid.
- (ii) Summon a qualified First Aid Worker (see p.3) or if the injured person requires hospital treatment, first call for an ambulance (dial 9 999 from any telephone) and then summon a First Aid worker. Arrange for someone to receive the ambulance and repeat the emergency call if help does not arrive within 10 minutes. Personnel should note carefully the location of First Aid workers in the building in which they normally work and when necessary summon the closest one regardless of which School they might belong to. Signs with name, room number and phone of all first aiders are on each floor of the building. It should be noted however that all accident reports should be sent to the School Safety Coordinator

4.2 Major Emergencies

Fires and Evacuation procedure

All buildings are equipped with an automatic fire alarm system activated by smoke detectors. Any incident which threatens the safety of persons in the buildings calls for sounding of the alarm and immediate evacuation. This includes fires, explosion, and major accidental release of poisonous gas or vapour. If a major emergency arises, sound the fire alarm using a break-glass button if it has not already gone off automatically.

When the alarm sounds continuously

Switch off all gas taps and electrical heating sources. If for any reason you have not been able to do this and have, for example, left a distillation in progress, report this immediately to the School Safety Coordinator at the relevant assembly point (see below). Make other equipment safe if this can be done quickly and without risk.

Leave the building by the nearest safe exit. It is emphasised that you must evacuate the building by the shortest safe route and not the route you may normally use to come in and out of the building. The main stair-wells are "fire protected escape routes". In particular, once you enter a stair-well go right down to the bottom and out the exit door. Never leave a stair-well to go back into a corridor on a lower level.

Assembly points

For Purdie staff: Proceed to the car park in front of the level 2 entrance. This is your assembly point

For BMS: Proceed to the grass across the road from the main entrance of the BMS Building. This is your assembly point.

For the BMS Annexe, leave the building and follow the road to the north of the building, cross the road and congregate near the trees. A sign is in place marking the area. This is your assembly point.

For the MSB: Your assembly point is across the road from the main entrance on the grass at the Gateway building.

When the alarm sounds in the building where you are, you should leave by the nearest sign posted exit. Note that this should never involve going through the passages connecting the three buildings, Purdie, BMS and the BMS Annexe. The only exception is if the normal exit route from the BMS and the Annexe is blocked by fire or smoke, it may be easier to cross into the Purdie building and use the fire escape at the end of the NE or NW wing rather than go to the other end of the BMS building.

Note: The corridors between buildings have systems in place to indicate an emergency situation: a buzzer and a flashing beacon. Under no circumstances should you use the corridor when any of these are activated. If you do you are liable for disciplinary action by the Head of School.

DO check that your room is empty of personnel;
close doors behind you;

DO NOT run (except in a life-threatening situation);
stop to collect personal belongings;
use lifts;
enter a smoke-filled stairwell: use an alternative exit;
re-enter the building until it has been declared safe.

The importance of closing all doors on evacuation of the buildings is emphasised. All laboratory doors must be kept closed outside normal working hours. The automatic extinguishing system of the overnight room is completely ineffective if the doors are propped open. The doors to the overnight room must be kept closed at all times.

The School has a carefully planned Major Incidents Procedure which goes into action whenever the fire alarm sounds. Anyone having detailed knowledge of the incident which has caused an alarm should exit the building as normal but then report to the School Safety Coordinator at the main emergency assembly point.

Members of the Academic Staff conducting a class when the fire alarm sounds should ensure the immediate and safe evacuation of all persons in the class.

When the buildings have been evacuated it is strictly forbidden to re-enter them for any reason unless authorised to do so by a senior Fire Officer. Unauthorised re-entry to a building while it is under the control of the Fire Service is a criminal offence and offenders are liable to arrest for obstruction.

Note: When instructed, re-entry by Chemistry personnel to the Buildings is ONLY permitted via the following doors:

Personnel working in the Purdie Building: Level 2 entrance.

Personnel working in the BMS Building: Level 1 BMS entrance.

At all times the alarms are connected to the fire-station and the fire brigade will automatically respond if they are set off.

If the alarm sounds **outside normal hours** any person in the buildings should:

If a small fire in your laboratory has caused the alarm, extinguish it in the normal way, but only if this can be done without any personal risk.

Immediately leave the building and assemble at the main entrance.

Provide as much information as possible to the emergency services upon their arrival (e.g. nature and location of fire, persons still in the building, etc.).

Only re-enter the building when informed by the Fire Service that it is safe to do so.

In order to test various aspects of the fire alarm systems, the alarm will sound for not more than thirty seconds every Wednesday at 2.00 pm in the BMS annexe, 3.25 pm in the Purdie building and 4.00 pm in the BMS building.

Other major incidents and emergencies

In the event of any serious accident or incident which does not involve activation of the fire alarm such as an explosion, major spillage of hazardous chemicals, major flood or serious injury, the Duty Safety Coordinator should immediately be called and will assume control of the situation. He will arrange to secure the area, assess the risks involved and organise appropriate response. In controlling access to area the School Safety Coordinator acts for the Head of School and has absolute authority. No person may enter such a closed off area for any reason.

4.3 First Aid Equipment

- (i) A full set of First Aid equipment is maintained by each qualified First-Aid worker.
- (ii) One set of First-Aid equipment is available outside Room 343 on Level 3 for use out-of-hours.
- (iii) In accordance with School policy, a trained First Aid worker should be called to each incident to assess the situation, administer first aid and if necessary alert the emergency services.

4.4 Fire Fighting Equipment and Fire Safety Measures

- (i) All research workers and all staff should have attended a training session on Fire Safety, provided by EHSS. These sessions will be arranged as required and a record of attendance kept.
- (ii) Fire extinguishers, sand buckets and blankets are provided throughout the buildings. Make yourself familiar with the location of these in rooms in which you work.

- (iii) Improper use or wilful damage of any fire-fighting equipment is a criminal offence. The use of extinguishers or sand buckets to prop open doors or of sand buckets as rubbish bins is strictly forbidden.
- (iv) The connecting doors provided between some rooms are designed to afford an alternative means of escape if the main door is blocked by fire or smoke. These doors, as well as all fire exits, must be kept completely clear and unobstructed at all times.
- (v) The access doors to all stairwells in the building are designated as smoke doors and must never be propped open at any time.
- (vi) The provision of clear glass windows in the doors of certain rooms allows a fire or dangerous situation within the room to be seen without opening the door and makes it easy to ensure that all the occupants have left. The hanging of such items as posters or laboratory coats so as to obscure the view through such windows is forbidden.
- (vii) All laboratory doors should be kept closed when not in use. It is essential that all laboratory doors are closed outside working hours as this will prevent the spread of fire.
- (viii) Strict rules apply to the positioning and use of notice boards and combustible materials in corridors. The notice boards have been carefully positioned to comply with these regulations and no-one is permitted to move them or erect a new notice board without the permission of the School Safety Coordinator. All notices and posters must be firmly attached to a board by all four corners. Attachment of notices or other combustible materials to the corridor walls or doors is prohibited. Any notices posted in violation of these rules are liable to be removed without warning at any time and disposed of. Combustible materials such as papers, which need to be stored in corridors, must be inside a metal cabinet.
- (ix) The Purdie, MSB and BMS buildings have convenient bicycle racks provided outside. **It is forbidden to bring or store bicycles inside the buildings.** In addition, the passage to and from the Purdie Building central courtyard adjacent to the out of hours access door is a fire escape route and must never be blocked by bicycles, motorcycles or other items.
- (x) The area at the foot of the central stair-well is the main fire escape route for the Purdie Building and must remain unobstructed at all times. This has been marked out with yellow tape and it is strictly forbidden to leave trolleys or any other items within the marked off area at any time. Once personnel have left by this exit they are to make their way out through the passage beside the out of hour's access door to the assembly point. This designated fire escape route must not be obstructed at any time. Any items found there including bicycles will be removed and impounded.

4.5 Major Power Failures

In the event of a widespread power failure within the School all members of the School should make safe their work places, in particular by switching off electrical and/or water supplies to experimental equipment, computers, etc. Fume-cupboard sashes should be

closed. As far as possible electrical equipment should be switched off to reduce potential damage caused by surges when the power supply is restored.

If power has not been restored after an hour, individuals who do not have designated responsibility to restart critical equipment such as freezers, etc. may leave.

5. *Reporting of Accidents*

Under current legislation, the Director of Environmental, Health and Safety Services is legally obliged to report certain classes of accidents occurring within the University to the Health and Safety Executive. Since complex rules govern exactly which accidents must be reported, School Safety Coordinators are required to report all accidents to the University Safety Office.

With the exception of minor cuts, abrasions and burns, all accidents within the School must be reported. This includes:

- fires of any kind, no matter how minor;
- explosions;
- cases of poisoning;
- cases of chemicals entering the eye;
- incidents requiring outside medical attention;
- significant spillage of a class 5 material.

The report should be made, if possible by the person concerned, to the School Safety Coordinator (or in his absence to the Head of School's Office), as soon as possible and **in any case not later than the next working day**. In addition you are asked to report any dangerous situation or "near miss" which you experience. Besides fulfilling the legal obligation, the reporting of accidents is essential to allow the review and possible revision of the existing Safety Regulations.

The required accident report form is available at:

<http://www.st-andrews.ac.uk/media/environmental-health-and-safety-services/health-and-safety/accidents/Accident-Rep-Form.doc>

Your report of an accident or near miss could prevent death or serious injury to others.

6. *Personal Protective Equipment*

Personal Protective Equipment (PPE) should be properly used whenever it has been identified as a requirement in a risk assessment. PPE relevant to this School includes such items as eye protection, hand protection, respiratory protection, as well as hearing protection, etc. Workers in any doubt about the appropriate form of PPE should consult their supervisors in the first instance, and if further advice is needed, the School Safety Coordinator. Further detailed guidance is also available at

<http://www.st-andrews.ac.uk/media/environmental-health-and-safety-services/health-and-safety/personal-protective-equipment/PPE-Policy-04-11-2008.pdf>

The School has undertaken an assessment of the risks to eyes and implemented the control measure of mandatory wearing of eye protection by all those who enter the laboratories.

It is the policy of the School to ensure that all persons within its precincts have their eyes adequately protected.

6.1 Eye Protection

Undergraduate Laboratories (MSB)

In all laboratories the wearing of eye protection is mandatory at all times. This includes students not engaged in experimental work and visitors. Laboratory supervisors are instructed to exclude from their laboratory any person who refuses to wear eye protection.

No mobile phones or headphones are allowed in the laboratories

Proper shoes giving full coverage should be worn and lab coats.

Specific safety rules are in place for undergraduate labs, summarised in the front of each laboratory class manual, and all staff and demonstrators involved in teaching should make themselves aware of these, which are valid for all laboratory modules.

Research Laboratories

The wearing of eye protection is mandatory for all persons in any laboratory where any chemicals, vacuum systems or high pressure systems are in use and also in any laboratory marked with an eye protection sign on the door. The protection must conform to EN166-1FT European safety standard. Normal glasses are not sufficient. All workmen and visitors must be provided with suitable eye protection before entering such laboratories. No headphones are allowed in the laboratories.

Contact Lenses

Contact lenses present a serious hazard in the laboratory since any chemical entering the eye may penetrate behind the lens and be impossible to wash out. **The wearing of contact lenses in laboratories is strongly discouraged.** Anyone who wears contact lenses must inform the School Safety Coordinator. A list of wearers is given to each First Aid Worker so that appropriate action can be taken in an emergency.

Workshops

Suitable eye protection must be worn for all operations involving any reasonably foreseeable risk of eye damage. This includes, for example, welding, and cutting or grinding metal or ceramics.

The workshops have their own procedures that all University staff and visitors should be aware of and follow.

Lasers

No laser equipment may be operated in the School without the knowledge of Dr C. Penedo. Laser equipment may only be operated in full accordance with the *University Local Rules for Work with Lasers*. Suitable eye protection must be worn at all times.

Visors

Full-face visors provide protection against splashing of corrosive chemicals on the face and should be worn whenever there is a significant risk of this (as for example during preparation of chromic acid). This should also be observed when working with explosive risks.

6.2 Laboratory Coats

All persons are strongly urged to adopt the correct use of laboratory coats. These provide a useful means of confining the dangers of chemicals to certain areas within the building. **Laboratory coats must be worn for all work that involves handling chemicals** and should then be taken off before leaving the laboratory area.

The wearing of laboratory coats in lecture theatres, common rooms and the library is strictly forbidden.

6.3 Other Protective Equipment

For each of the following items of protective equipment, the precise type chosen for a particular task must be of suitable design. Personnel should note that, in addition to the types available at the main store, a great variety of such equipment is available from different sources and they should ensure that the type used is the most suitable, if necessary taking expert advice on this from their supervisor or the School Safety Coordinator.

Safety Shields

A safety shield must be placed around any experiment involving a reasonably foreseeable risk of explosion. Safety shields, obtainable from the Store, are more effective when weighted at the base.

Gloves

Various types of gloves are available from the store as follows:

- (i) Rubber and heavy PVC gloves: for handling toxic chemicals. These should be discarded when punctured or perished.
- (ii) Disposable Nitrile and Neoprene gloves: although sometimes useful for handling toxic chemicals these are too thin to provide adequate protection in many cases.
- (iii) Thick insulating gloves: used for handling hot equipment and also useful to avoid cuts, for example when freeing stuck glass joints.
- (iv) Kevlar gloves can be purchased cheaply and are recommended for explosive hazards

Further guidance on the correct selection of gloves is given on the school website under safety information:

<http://chemhealthandsafety.wp.st-andrews.ac.uk/glove-comparision-chart/>

NB It is University policy that the type of gloves required in any operation **must** be specified in the relevant risk assessment.

Gloves should be worn, as required, in laboratories, but not in other parts of the School. It is extremely bad practice to walk around the building; opening and closing doors, using banisters and so on, while wearing laboratory gloves, as this simply spreads any chemical contamination present on the gloves (see also Section 7.4). Before leaving a laboratory, take off any protective gloves.

Dust Masks

These should be worn when handling fine powders such as TLC grade silica and alumina which can cause serious lung damage. These are available in the stores. There is now an HSE requirement for fit-testing of all face masks: consult the School Safety Coordinator.

Ear Defenders

As required under the Noise at Work Regulations, the noise level has been evaluated throughout the School. All persons using the ultrasound probe sited in BMS Room 4.11 must wear the ear defenders provided. Anyone who is concerned about a high noise level should inform the School Safety Coordinator so that an assessment can be carried out.

7. General Laboratory Practice

7.1 Tidiness

All work areas must be kept clean and tidy as possible. Benches and fume cupboards must be cleared and cleaned on a regular basis. In the event of an accident, the presence of large quantities of chemicals, solvents and apparatus seriously aggravates the hazard. All items should be returned to safe storage after use. Laboratory floors must be kept as clear as possible.

The storage of items above head height is dangerous and is to be avoided. Where such storage does exist, an appropriate safe means of access must be used, for example a step-ladder with hand rail and not a stool or chair.

All laboratory sinks should be fitted with a filter in the drain which prevents solid objects falling down it. This must be kept in place and on no account be removed and thrown away. Frequently cases of blocked drains have been caused by items being routinely washed down unprotected drains. The filters must be kept in place on all drains.

No alteration to the fabric or fittings of laboratories is permitted without the permission of the Head of School. If any fitting is defective it should immediately be reported to the Buildings Officer Mr Scott Filipovic (e-mail: sf75) so that repair or replacement can be arranged.

7.2 Chemicals

All chemicals must be stored in an appropriate safe place. Old bottles of chemicals that have deteriorated or decomposed should be re-purified or immediately disposed of (see 11). All corrosive or hazardous chemicals must be periodically inspected for signs of

leakage or deterioration. Any labels that have deteriorated or fallen off must be replaced immediately.

The need to keep the quantity of chemicals held in the School, and in particular those stored in laboratories, to the minimum is emphasised. The School has a small stock of chemicals in the Main Store and these should be used whenever possible rather than ordering up new materials.

The School maintains a centralised inventory listing the chemicals present in each research laboratory and this is available to the Emergency Services if required. Research groups should ensure that their contribution to the inventory is kept accurate and up to date.

7.3 **Fume Cupboards**

Fume cupboards are essential for much experimental work involving toxic or hazardous chemicals. It is advisable to handle all volatile chemicals in a fume cupboard. Fume cupboards used for experimental work should be cleared of all unnecessary items including bottles of dangerous chemicals. In particular the storage of toxic or corrosive chemicals along the back of such fume cupboards is forbidden. Where chemicals need to be stored in a fume cupboard they should be placed in one set aside for storage in which experimental work is not allowed. The vented cupboards available in some laboratories are ideal for this purpose. However these must be kept in good order and cleaned out regularly. This valuable space should not be wasted for storage of non-volatile materials and the storage of highly reactive non-volatile chemicals such as sodium or lithium metals or sodium hydride in these facilities is forbidden. Containers used for the collection of highly toxic waste for disposal must on no account be stored in a fume cupboard where experimental work takes place. While being filled they should be kept in a separate fume cupboard set aside for that purpose. Once full they should be disposed of immediately by arrangement with the School Safety Coordinator (see section 11.4).

The performance of all fume cupboards is tested on an annual basis and the flow rates achieved recorded on the notice on the front. Please ensure that this notice remains legible and in place and report any problems with fume cupboard performance immediately to the Buildings Officer.

The ventilation systems in all buildings are centralised. If any section of fume cupboards fails (as indicated by the sounding of the alarms) during normal hours, you should IMMEDIATELY contact the Buildings Officer or Estates. Outside normal hours it should be treated as all other emergencies and be reported to the Out of Hours Call Centre.

Experiments involving a foreseeable risk of explosion should be carried out within a fume cupboard and also surrounded by safety shields.

Certain work in fume cupboards that unavoidably produces poisonous gases or fumes must be notified in advance by sending an e-mail message to “chem-roofaccess”. You will then be informed whether, in view of any proposed roof work, this can go ahead at the planned date and time. It may also be necessary from time to time to call a halt, at short notice, to all discharges from fume-cupboard stacks, because of maintenance or similar work being carried out on the roof.

7.4 **Personal Hygiene, Cleanliness and Good Laboratory Practice**

Eating and drinking are strictly forbidden in all laboratories. In accordance with University policy, smoking is forbidden anywhere within the buildings.

No area in the Purdie, MSB or BMS buildings is designed or properly equipped to allow the preparation of food under safe and hygienic conditions. Specifically the installation or use of conventional or microwave ovens for cooking or heating food is not allowed, and items such as toasters and sandwich makers are also forbidden. Only the heating of water for the preparation of hot drinks is permitted. Microwave ovens are however accessible in the kitchen on floor 1 for heating food. No other microwaves or other appliances should be brought into the kitchen.

Good practice requires that, after carrying out any experimental work, you should wash your hands thoroughly and move to a suitable clean area before eating or drinking. Consumption of food and drinks is only permitted in offices, writing up rooms where no chemicals are present, and in the Common Room. Eating and drinking in the corridors or in lecture theatres presents an unacceptable hygiene and litter problem and is not allowed. Storage of food and drinks is not allowed in any laboratory.

Experimental work in chemistry requires a degree of concentration and alertness, which is incompatible with excessive background noise. For this reason the playing of music is only permitted subject to the following conditions:

It must be with the agreement of all persons in the room and the volume must be controlled such that it is not audible outside the room.

The electrical safety of private electrical appliances is the responsibility of the owners and they may be held responsible for any damage or loss to the School arising, for example, from a fire started by a faulty appliance.

All personal electrical equipment must be tested for electrical safety when it is introduced into the School, and it must be regularly tested thereafter.

Care should be exercised in the use of gloves so that clean areas are not inadvertently contaminated. Gloves that have been in contact with toxic chemicals should be decontaminated or discarded as soon as possible. In particular they should not be allowed to come into contact with taps, door handles, telephone receivers, computer keyboards or books.

7.5 **Fridges and Freezers**

- (i) All items placed in these facilities must be labelled to indicate their contents and who is responsible for them.
- (ii) All containers placed in freezers must be securely closed. No open vessels are allowed.
- (iii) Freezers must be defrosted and cleaned out on a regular basis.
- (iv) All freezers and fridges used for chemical storage should be spark free.

7.6 Rubber/Plastic Tubing

To avoid flooding it is essential that rubber tubing carrying water is inspected regularly and replaced at the first sign of deterioration. For permanently running equipment plastic tubing is more durable. The use of wire to secure water tubing connections is not allowed under any circumstances. All water tubing connections must be secured if left unattended at any time. This must be done using metal hose clips, high performance nylon hose clips or, for thin walled tubing only, plastic tension straps. Floods are often caused by the water flow being too hard or a free end of tubing coming out of a sink. Never put the water on any harder than necessary (remember the water pressure increases significantly at night) and secure water outlet tubes firmly in sinks. If rubber tubing has adhered to glassware, it is best removed by being cut away rather than being pulled or otherwise forced, in order to minimise the risk of breakage.

7.7 Regulations for the Use of Needles

Needles used in the School of Chemistry are of two types:

(a) Re-usable needles or those permanently attached to a syringe. These are of strong all metal construction and can be repeatedly washed out, dried and re-used. They are used in the chemistry laboratory for operations such as transfer of air-sensitive reagents, connecting inert gas supply to a reaction flask via a septum etc. Such items as GC and HPLC syringes would also come in this category. While these must be always be used with care, they do not present the same level of safety hazard as a disposable hypodermic needle since they are typically large, not too sharp and present in lower numbers as they are reused.

(b) Disposable hypodermic needles which, as the name implies, are designed for injection under the skin normally in a medical setting. Because of their low cost and ready availability they are used increasingly for transferring small amounts of reagents and solvents. These are mainly plastic with a small and typically sharp metal needle attached. Management of these needles is a major concern since they are designed to penetrate the skin, and they are small so are easily overlooked, and because they are used in some labs in large numbers.

(i) Whenever possible use a sturdy re-usable needle for your application. Not only is this much safer, but when the cost of disposal (of sharps containers) is taken into account it may be cost effective. Reusable needles should be stored in a safe place, for example inside a drawer or box and after use they should be promptly washed, dried and put away again. They should not be left lying out on working surfaces at any time. When they eventually have to be disposed of this must be via a locally located approved sharps container and then to the Main Store (see below).

(ii) **When disposable needles have to be used, then they must be disposed of, without exception, after a single use.** Disposable needles should also be stored in a safe place and only taken out when required for use. When they are removed from the packaging or sheath they must be used once, then immediately placed in an approved sharps container. Disposable needles must under no circumstances be left lying on work surfaces, in fume-cupboards, stuck into cork rings or rubber bungs for future re-use. Disposable needles should not be used to attach an inert

gas supply to a reaction vessel. For this application always use a re-usable needle, preferably with a metal to tubing connector.

- (iii) For all needles of any type, the correct and only allowed route of disposal is via an approved sharps container. These are obtained from the Main Store and returned there when full. The sharps container must be sited close to the work location. For fume cupboard work, the container should be located within the fume-cupboard in which the needles are being used. Containers must have the lid fitted while in use and are required to be changed before becoming full. Never let a sharps container run over or have excess needles or other items protruding from it.
- (iv) If you ever drop a needle, it must be immediately and carefully picked up. Needles must never be on surfaces or on the floor and must never find their way into bins for domestic waste, metal recycling or plastic recycling or down a sink. Workers should regard a disposable hypodermic needle as a dangerous item and should give their full attention to its use which will follow the pattern: remove carefully from protective packaging, use once for required application, immediately place in an adjacent sharps disposal container.

8. *Fire and Explosion Hazards*

Many substances used in the School are highly flammable or explosive. Stringent precautions are required to minimise the risk of accidents.

8.1 **Flammable Solvents**

Many organic solvents are highly flammable and their vapour forms explosive mixtures with air. The following rules are to be strictly observed:

- (i) Stocks of flammable solvents stored in laboratories are to be kept to a minimum. The DSEAR Regulations (2002) impose a limit of 50 litres per fire-resistant cabinet and this must never be exceeded. In addition the total stock of flammable solvents in laboratories should not in general exceed 50 litres. A guideline for commonly used solvents is that the stock should not be more than 2–3 days' supply. For any laboratory wishing to stock more than 50 litres of flammable solvents, a separate risk assessment must be completed using the CHARM system and including the chemical entry "excess solvents" to trigger Safety Coordinator approval.
- (ii) Flammable solvents must never be disposed of by pouring down drains. This includes water miscible solvents such as methanol and acetone. For the correct disposal procedure see 11.2.
- (iii) Large 2.5 or 5 litre bottles of flammable solvents must be kept in the marked fire-resistant storage cupboards in each laboratory at all times except when being dispensed. Such bottles of flammable solvents must never be left on the floor, on benches or in direct sunlight. In addition they must be kept upright at all times and never stored on their side

- (iv) Flammable solvents should be heated electrically. The use of open flames for heating flammable solvents is strongly discouraged and only allowed under special circumstances.

NB Electrical heating mantles should only be used under reflux conditions, **never** for flask to flask distillation, when an oil-bath should be used. Heating baths maintain a constant temperature, whereas heating mantles deliver a constant heat flow, leading to the possibility of dangerous overheating in flask to flask operations. Similarly, insulating materials such as glass wool or aluminium foil must **never** be wrapped around flasks being heated in electric heating mantles as, again, this can lead to dangerous overheating.

Safe use of Metal heating blocks (E.g. Drysyn)

As the use of metal heating block becomes more prevalent, it is important to use these correctly and be familiar with the manufacturer's instructions. (a) Large round-bottom flasks (>1000 mL) can become stuck or broken if they are allowed to cool in a heating block and solvent stills are therefore vulnerable. When heating a large flask with a metal block, the heating assembly should be mounted on a laboratory jack; this allows the heating block/hotplate assembly to be lowered immediately after the operation is complete. (b) The heating block should NOT be heated beyond that stated in the specifications (normally 250 C is the maximum).

- (v) Wherever possible flammable solvents should be used in a fume cupboard. Before using a flammable solvent make sure there is no open flame or other source of ignition in the vicinity.
- (vi) Any experiment, including redistillation, involving the heating of more than 1 litre of a flammable solvent must be carried out in an Overnight Room or a fume cupboard equipped with an automatic fire suppression system ("Firetrace").
- (vii) Distillation of solvents using a dangerous set-up in which flammable vapour can escape through the collection port without passing through the condenser is forbidden.
- (viii) Chromatography supports (silica and alumina) covered with flammable solvents must not under any circumstances be placed directly in a waste bin. For correct disposal procedure see 11.3.

8.2 **Base Baths**

The use of a solution of sodium and/or potassium hydroxide in ethanol and/or isopropanol for cleaning glassware presents a serious fire hazard. Such baths must only be used where there is no reasonable alternative and then subject to the following rules:

- (i) A base bath must only be used within one of the fail-safe metal fire-extinguishing boxes. Its use must be the subject of a separate risk assessment using the CHARM system and including the chemical entry "base bath" to trigger Safety Coordinator approval.
- (ii) The default position of such a unit should be with the lid closed. Only when adding items or removing them should you open the lid so it is held open and proceed. As soon as you

are finished working at the bath close the lid. When the unit is closed and not being used, the power may optionally be left off or on.

- (iii) No item must be added to a base bath unless it has been thoroughly rinsed with water to destroy any water-reactive residues. In doing this, be sure to break up any crust of solid that may conceal reactive material underneath.
- (iv) Any malfunction of the magnetic mechanism of a metal base bath unit should be immediately reported to the School Safety Coordinator.
- (v) When a base bath is exhausted the contents should be carefully poured out into 5 litre plastic bottles for disposal as non-halogenated solvent waste.

8.3 Other Fire Hazards

Certain substances may ignite spontaneously on contact with air or water. These must be handled and disposed of with great care.

- (i) **Hydrogenation catalysts** including palladium/charcoal and Raney nickel may ignite spontaneously in air. Under no circumstances are these to be placed in a waste bin. They should be kept damp with water, stored in a separate container and retained for special disposal.
- (ii) **Reactive metals** - Finely divided magnesium, aluminium and zinc may ignite spontaneously. These must not be placed in a waste bin but should be fully dissolved in dilute acid and the residues then washed down the sink with excess water (Mg or Al) or sent for special disposal (Zn).
- (iii) **Organometallic reagents** Many commonly used solutions of organolithium compounds, Grignard reagents and other organometallics in organic solvents may ignite spontaneously in moist air. These should be handled under nitrogen and disposed of as detailed in the following Section.

8.4 Disposal of Pyrophoric Reagents

The following detailed procedure for the safe disposal of used bottles of pyrophoric organometallic reagents must be strictly followed. This regulation applies to commercial bottles of methyllithium, butyllithium (all isomers), phenyllithium, Grignard reagents and also to stocks of such reagents prepared in house.

- a. The quantities of such reagents for disposal must be minimised by keeping bottles in good order, properly sealed and not allowing moisture or oxygen to enter. If the concentration of such a solution has dropped, carry out a titration to find the current concentration and wherever possible use the remaining reagent, do not simply order up a new bottle. Once the contents of a bottle are of no further use, they must be disposed of immediately using the procedure below and on no account stored for prolonged periods.
- b. The disposal of pyrophoric materials must only be carried out in the fume-cupboard of an Overnight Room or a fume cupboard equipped with an automatic fire

suppression system ("Firetrace").. This is a potentially dangerous operation:— expect a fire and plan in advance exactly what action will be taken in that event. On no account carry out this operation outside normal working hours or over lunchtime (1–2 pm).

- c. No other materials and in particular no flammable materials must be present while the fume cupboard is being used for such an operation. A dry powder fire-extinguisher should be placed in readiness beside the disposal site.
- d. Carefully remove the top from the bottle and place it inside a large fire-clay trough behind a safety shield at the back of the fume cupboard. With great care, add all at once 100 ml of isopropanol or ethyl acetate. Particularly in the case of methyl lithium, ethyl acetate is recommended for this operation. While it has a lower flash point than isopropanol (–3 °C vs. 22 °C) the reaction is less exothermic, and of particular importance in the case of methyl lithium, no flammable gas is evolved since an addition rather than hydrolysis reaction is involved.
- e. After waiting for 30 min., any visible crust of solid must be carefully broken up using a glass or metal rod before pouring out the contents of the bottle, behind the safety shield, into a large fire-clay trough half full of water. After pouring out the contents, the bottle should be rinsed out with ethyl acetate or isopropanol first into the trough and only then with water. After allowing to stand for a further 30 min the contents of the trough should be washed down the sink with plenty water.
- f. If a fire breaks out, proceed immediately as above under *Small Fires in a Fume Cupboard*. If the fire is not immediately extinguished, leave the room, close the door and wait for the extinguisher system to take effect.

8.5 Explosive Hazards

All experiments involving potentially explosive substances must be carried out in a fume cupboard, **behind a safety shield**. Except under special circumstances explosive substances should not be heated and must never be subjected to grinding or mechanical shock.

The following materials are explosive (this is not an exhaustive list):

- (i) All azides, organic and inorganic (except sodium azide).
- (ii) Certain acetylenes including dimethyl- and diethyl acetylenedicarboxylate which explode on distillation, All metal acetylides.
- (iii) All diazo compounds.
- (iv) All diazonium salts - (aryl diazonium fluoroborates are marginally safer).
- (v) Hydrazine.
- (vi) All perchlorates, organic and inorganic - (see 8.4 (ii)).
- (vii) Ammonium nitrate.

- (viii) All peroxides - (see 8.5).
- (ix) Many nitro compounds including polynitroalkanes and polynitro-aromatics such as trinitrobenzene, trinitrotoluene, trinitrophenol (picric acid), metal picrates, trinitrochlorobenzene (picryl chloride), all o-nitrobenzoyl chlorides and metal salts of nitrophenols.
- (x) Some poly-nitrogen heterocycles such as tetrazoles and tetrazines.

8.6 Oxidising Agents

Certain strong oxidising agents are themselves stable, but react with any organic material to cause fire or explosion. These include:

- (i) Fuming nitric acid and concentrated nitric acid - Operations involving these should be performed on as small a scale as possible. Special care is required when using conc. nitric acid for cleaning purposes: Nitric acid should only be used as a last resort for removal of metal residues **not** for organic dirt. The apparatus must be thoroughly washed with water before and after use of nitric acid. The mixing of nitric acid with organic solvents such as ethanol or acetone for cleaning purposes is extremely dangerous and is prohibited.
- (ii) Perchloric acid - Steps should be taken to avoid accidental contact of perchloric acid with any other material. Several very serious accidents have occurred after a spillage of perchloric acid reacted with organic material (e.g. a wooden floor). There was often no immediate effect but friction or spillage of another chemical many years later resulted in explosions and fires. Any spillage of perchloric acid must be reported immediately to the School Safety Coordinator. Never mix perchloric acid with dehydrating agents such as acetic anhydride or sulfuric acid.
- (iii) Hydrogen Peroxide - While normal concentrations of hydrogen peroxide up to 30% ("100 volume") do not present a serious hazard, stronger solutions may cause spontaneous ignition of any organic material. Solutions stronger than 50% and particularly 90% "anhydrous" H_2O_2 require special precautions and may not be used without the permission of the School Safety Coordinator.
- (iv) Liquid Oxygen - Because nitrogen has a lower boiling point than oxygen, cooling any vessel in liquid nitrogen while it is open to the air results in the condensation of a liquid rich in liquid oxygen. This may cause a violent explosion in contact with any organic material. This situation most often arises through forgetting to remove the liquid nitrogen flask from a trap in a vacuum system after it is opened to the air. If this does occur allow the liquid oxygen to evaporate behind a safety shield in a fume cupboard.
Another case where this may occur is in the cooling of a glass tube of reagents for sealing. Sealed tubes must be flushed out with nitrogen before sealing. Do not apply a positive pressure of nitrogen since this will condense liquid nitrogen inside the tube and it will explode on warming.

8.7 Ether Peroxides

Many commonly used ether solvents form explosive peroxides on storage. These include: diethyl ether, tetrahydrofuran, 1,4-dioxane, all ethers of ethylene glycol and higher ether diols (including glyme, diglyme, etc.), all aliphatic ethers such as di-n-butyl ether and diisopropyl ether which peroxidises particularly easily.

- (i) Most of these solvents are now supplied containing an inhibitor to prevent peroxide formation. This will be removed by distillation. Do not redistill these solvents unnecessarily and if distillation is necessary the distilled solvent should be used immediately. Never store quantities of ethers which have had the inhibitor removed by distillation.
- (ii) Note that the inhibitors used only prevent peroxide formation. Once peroxides have formed the inhibitor will not destroy them.
- (iii) All ether peroxides are less volatile than the corresponding ethers and evaporation will concentrate them leading to a violent explosion. Never evaporate an ether solution that may contain peroxides.
- (iv) All redistilled ethers and older bottles of ethers must be tested for peroxides before use and peroxides if present must be removed (test and removal procedure – Page 404 Vogel's Text book of practical organic chemistry; 5th edition B S Furniss, A J Hannaford, P W G Smith and A R Tatchell; Longmans, 1989.).
- (v) For disposal of ethers found to be badly peroxidised or containing crystalline deposits of peroxide consult the School Safety Coordinator.

8.8 Sodium and Potassium Metal

Because of their extreme reactivity sodium and potassium present a serious fire and explosion hazard.

- (i) The sodium press (room 438) used to produce sodium wire for drying solvents should be kept clean and tidy. Excess sodium on the press and die should be destroyed with ethanol or methylated spirit immediately after use (see also 11.6).
- (ii) On no account try to dry any chlorinated solvent with sodium - a violent explosion will result.
- (iii) The oxide coating on old potassium may catch fire or explode on touching (e.g. on cutting up). Potassium should always be cut up under oil. Oxidised potassium should be disposed of with great care.
- (iv) *Disposal Procedures* - Disposal of alkali metals, which involves addition to a flammable solvent and liberation of large quantities of hydrogen, is a serious fire hazard. Always carry this out in a fume cupboard away from sources of ignition and anticipate a fire. Alkali metals are disposed of by careful addition of small pieces to an excess of an alcohol: for sodium and lithium use ethanol or methylated spirit; for potassium use isopropanol. When the reaction is complete wash the solution down the sink with plenty of water. On no account are sodium or potassium, even in small quantities, to be disposed of by addition to water.
- (v) Fires involving sodium or potassium should never be tackled using water or CO₂ extinguishers. Use only dry sand or a dry powder extinguisher. Small fires during

disposal of these metals may be quickly extinguished by covering the vessel with a glass plate.

8.9 Carbon Disulfide

Besides being highly toxic (LTEL* 10 ppm), carbon disulfide presents a very serious fire and explosion hazard due to its extreme volatility, low flash point (–30 °C) and low auto ignition temperature (102 °C). The latter means that its vapour can ignite spontaneously even in contact with steam-heated equipment.

(* for definition of LTEL see section 9.2).

9. Chemical Hazards

The chemical, physical and toxicological properties of the majority of substances purchased by the School, and all the subsequent research chemicals derived therefrom, have not been fully investigated. Their handling and usage may be hazardous. Working practices should be adopted which minimise the exposure of yourself and others to contact with all chemicals.

9.1 Hazard and Risk Assessment Procedures

Current legislation requires among other things that:

- (i) All substances and biological organisms in use in the School must have been assessed for their potential hazard to health and a record of such assessment kept, subject to inspection by the Health and Safety Executive.
- (ii) Based on the hazard assessments each operation involving a hazardous material must be assessed with regard to the degree of risk involved and (a) the risk assessment recorded on a Risk Assessment Form again subject to external inspection (b) the appropriate control measures and precautions instituted to safeguard the health of those involved.
- (iii) Control equipment such as fume cupboards and biological safety cabinets must be tested for efficiency at least every 14 months and a written record kept of the results.

Hazard Assessment involves an informed judgement of the degree of hazard posed by a substance in the light of available safety information including where appropriate its Occupational Exposure Limit (see Section 9.2) contained in the most recent edition of Guidance Note EH/40 and its classification under current legislation.

The result of the Hazard Assessment will be expressed as a hazard rating according to the following five point scale:

- 5 = highly hazardous
- 4 = hazardous
- 3 = moderate hazard
- 2 = low hazard
- 1 = no significant hazard

The nature of the hazard(s) involved will be indicated by adding letters as follows:

| | |
|---------------------------|---------------------|
| A = corrosive or irritant | C = carcinogenic |
| F = flammable | O = oxidising agent |
| T = toxic | X = explosive |
| M = mutagenic | R = radioactive |

When ordering chemicals, all research workers must look up and mark the Hazard Assessment Code of all materials ordered on the order form. This can be found by consulting the University's Chemical Hazard and Risk Management (CHARM2) System available on the school of chemistry webpage under safety information <http://www.st-andrews.ac.uk/chemistry/resources/safety/> and at EHSS link <https://www.st-andrews.ac.uk/ehss/charm/>. If a material does not appear on this system, use the "Suggest" facility within the programme to request a new entry. The request is automatically forwarded to the University Chemicals Hazards Adviser, Dr R. A. Aitken, who will assign a code and inform you of it as soon as possible. Purchase orders without a code will not be sent out.

It should also be noted that chemicals and biological organisms obtained other than by conventional ordering (e.g. as a gift from a company or collaborator outside St Andrews) must also be assigned a hazard code. Only commercially available chemicals are assigned a hazard code. "Home-made" substances are not assigned a hazard code but the potential hazards of such materials must however be fully considered in the course of the risk assessment and can be stated in the detailed procedure section.

No operation involving any chemicals or biological organisms may be started unless a Risk Assessment Form has been completed and signed by the School Safety Coordinator (for any operation involving a Class 5 chemical) or by your supervisor (in all other cases).

A detailed record is kept of the number of Risk Assessment Forms current for all personnel. All workers must ensure that they have properly completed and signed forms in place for all aspects of their work. You are reminded that persistent refusal to abide by legally required Health and Safety procedures would constitute valid grounds for termination of studies for research students and dismissal for post-doctoral workers and other employees.

Active risk assessments should be displayed outside each laboratory, in the document holder provided, for all chemical operations in progress within that laboratory. Risk assessments which are not in use i.e. the reaction is not being carried out in the laboratory, should be stored elsewhere and not in the tray. It is the responsibility of all research workers to ensure that the displayed risk assessments are current and complete, with no redundant or obsolete assessments.

A. Carrying out a Risk Assessment

To consider the possible dangers of a given operation and to plan in advance what action would be needed in the event of any mishap is clearly the duty of any responsible and professional research worker. Although most people have probably been doing this informally for some time, it is now required that this be carried out in a more formal and systematic way with written records being kept.

For every operation you intend to undertake you must carefully consider and assess all possible risks, decide how to minimise these and how you would deal with any foreseeable consequence of anything going wrong. If you have any doubts about what some of the risks may be, you must ask your supervisor for advice. You should acquire copies of the Material Safety Data Sheet for any substance you intend to use if required. A Material Safety Data Sheet must be provided by all chemical suppliers in accordance with UK law and is generally to be found on the company website. It is up to you, in consultation with your supervisor, to obtain all the necessary information to conduct a thorough risk assessment. Having assessed the risks associated with the operation, complete a Risk Assessment Form as described below.

When a risk assessment has been completed, it is essential that all safety measures identified in the assessment must be in place throughout the operations covered by the assessment, without exception.

B. Filling in a Risk Assessment Form

This must be done using the CHARM system referred to above. All users of this system are recommended to consult both the user help and training system provided before using the system.

The system is designed to be largely self-explanatory and you should follow the instructions given at each stage. If you have problems consult the CHARM Guidance notes System User Notes, the School Safety Coordinator, or in the last resort contact Dr P. W. S. Szawlowski, tel 2753 pwss@st-Andrews, giving as much detail as possible about the nature of the problem.

Note in particular the following points:

- a. The normal expectation is that each worker will prepare their own risk assessment forms. Where there are multi-worker forms, all workers included in a risk assessment must sign the form. The creator of the form must add themselves as a worker by using the button provided. A request to your supervisor to approve the risk assessment will not be sent until the creator and any additional workers have signed the form.
- b. The forms apply to individual work activities, such as a preparative experiment, a particular type of measurement etc. and also such operations as washing-up using a flammable solvent. Forms are not required for storage of chemicals or equipment, or for purely physical activities involving no chemicals, such as drying of equipment. Wherever possible you should try to combine closely related operations on a single form. For example if you are carrying out a particular reaction on a series of similar starting materials, only one form is required but not where there are several synthetic steps involved or great differences in toxicity of the compounds. In filling in the forms, be sure to include all stages of the operation from beginning to end. For a preparative experiment, for example, you must include preparation of reagents and extraction, purification and processing of the product as well as the actual reaction. Make sure the procedure section is comprehensive and not just a copy of a published experimental section from a journal paper. The operation of **dry solvent stills**, by which is meant not only setting up and maintaining them but obtaining solvents from them, requires a separate risk assessment form. The type of glove used must be stated in the form

- c. On the first page, the system has a separate search function under Chemicals and micro-organisms where you can search for chemicals in the data base and check if the compound has a hazard rating before you start to fill in a risk assessment or place an order for a chemical. If the chemical you need is not listed, use the suggest button and fill in the questions and press submit. This information goes to the University Chemicals Hazards Adviser, Dr R. A. Aitken who will assign a hazard rating and other relevant data. You will then receive an email informing you that this has been done. To search for the chemical or biological organism to be used relegate all numbers, letters and brackets which describe isomers to the end and be careful as to what should be a separate word. If you are unsure exactly how to spell a name, simply entering the first few letters followed by 'return' will give all names containing this fragment from which you can select the right one. In accordance with the 1990 decision of IUPAC, sulfur, aluminium and caesium and all derived names should be spelled as such. Examples:

ethyl acetate but ethylbenzene
dipropylphenol 2,4- -iso-
cytosine glucopyranoside 1-alpha-D-
ethyl chlorophenylacetate (\pm)- alpha-
bis(diphenylphosphino)butane 1,4-

If after trying all possible alternative names and spellings the system does not find a chemical, contact the University Chemicals Hazards Adviser, Dr R. A. Aitken, before proceeding.

When you find a substance of interest simply click on the substance and it is thereby collected to appear on the form. For class 5 materials, exposure limits are automatically filled in on the form. Once you have located and included all the chemicals and/or microorganisms, proceed with the system which will allow completion of the risk assessment.

- d. In filling in the 'Details of the Procedure' section describe briefly what is involved within the space provided, **but carefully drawing attention to any potential hazards and what precautions are required.** Similarly in the Procedures for Disposal section, draw particular attention to the hazards involved and the resulting precautions needed.
- e. After you have indicated the major risks involved by clicking the appropriate boxes, choose the emergency action needed from the pull-down menus. Fill in the section on disposal. Only choose a disposal method for types of waste actually produced in the procedure.
- f. If it is relevant, you must fill in the section on how you will notify other people of the work you are doing and who these people may be.

C. Processing of Forms

When you are satisfied with the form and have submitted it, an email is automatically sent to any other named workers requesting their electronic signature. Only when all have signed will the system notify your supervisor & request his/her approval. Where class 5 materials are involved, the system will then notify the School Safety Coordinator for his approval but only when the supervisor has approved the request. Please do not contact the

School Safety Coordinator unless you are sure your supervisor has approved the request. Forms not approved by the School Safety Coordinator will be returned via the system with an explanation of the reasons for rejection.

Notes

- a. If your supervisor or the School Safety Coordinator is away for any period, you should submit forms for signing to the nominated deputy.
- b. **Any person who carried out an operation without having completed the required form and having had it properly signed would deprive themselves and their supervisor of a means of defence in the event of a criminal prosecution.**
- c. All members of staff and students are reminded of their clear legal responsibility for ensuring not only that risk assessments are in place for each operation carried out by those under their control, but also that these are thorough and complete (to use the legal term 'suitable and sufficient') and that the procedures contained within them are followed.

9.2 Poisons

Whilst all chemicals should be regarded as potentially toxic, certain substances used within the School are known to be very severe poisons. In handling these, all possible precautions must be taken to completely avoid contact with the body or release to the environment. An attempt has been made to quantify the toxic hazard of many chemicals by the introduction of certain limits.

Many materials have been assigned a Workplace Exposure Limit (WEL). For each material one or both of two limits may exist: the Long Term Exposure Limit (LTEL) is the concentration to which it is believed nearly all persons can be repeatedly exposed without adverse effect and it has an 8-hour reference period; the Short Term Exposure Limit (STEL) is a higher concentration which should not be exceeded even for a short time, and it has a 15-minute reference period. In the absence of further information it is reasonable to assume the STEL is about three times the LTEL. A full list of current exposure limits is obtainable from:

<http://www.hse.gov.uk/pubns/priced/eh40.pdf>

Schedule 1 Poisons - Substances listed in Schedule 1 of the Poisons Rules, 1968, are subject to strict legal control. The common Schedule 1 poisons are listed below. **These substances must be stored in a LOCKED CUPBOARD which is not marked as containing poisons. These materials all have classification 5T and can only be purchased on production of the appropriate Risk Assessment Form.**

- (i) Aldicarb
- (ii) Aluminium phosphide
- (iii) Arsenic and all compounds of arsenic
- (iv) Barium compounds except barium sulfate
- (v) Bromomethane (methyl bromide)
- (vi) Chloropicrin

- (vii) Sodium and potassium cyanides (LTEL 1 mg/m³), all other metal cyanides and hydrogen cyanide (LTEL 0.9 ppm) (but not ferrocyanides or ferricyanides). See section 9.8.
- (viii) Cycloheximide
- (ix) Dinitrocresols
- (x) Fluoroacetic acid and its salts, fluoroacetamide, fluoroacetanilide and fluorocitric acid.
- (xi) Lead tetra-acetate and organolead compounds.
- (xii) Mercuric chloride, mercuric iodide, Mercury nitrates, potassio-mercuric iodides and all organomercury compounds
- (xiii) Nicotine and its salts
- (xiv) Paraquat salts
- (xv) Parathion
- (xvi) Strychnine
- (xvii) Thallium compounds
- (xviii) Zinc phosphide

Other highly poisonous substances of comparable or even greater toxicity which do not appear in Schedule 1 only because they are not in common industrial use. The following substances have classification 5T or 4T.

- (i) Volatile and unsaturated aldehydes and ketones including acetaldehyde (LTEL 20 ppm), acrolein (LTEL 0.02 ppm), crotonaldehyde, glutaraldehyde (LTEL 0.05 ppm) and methyl vinyl ketone.
- (ii) Amyl nitrite - a powerful heart stimulant.
- (iii) Simple aliphatic amines including methylamine (LTEL 2 ppm), ethylamine (LTEL 2 ppm), dimethylamine (LTEL 2 ppm), diethylamine (LTEL 5 ppm), trimethylamine, triethylamine (LTEL 2 ppm), diisopropylamine (LTEL 5 ppm), 1,2-diaminoethane.
- (iv) Alkaloids and dangerous drugs including brucine, morphine, codeine, atropine and many others.
- (v) Aromatic amines including aniline (LTEL 1 ppm) and all substituted anilines such as anisidines, 2-aminopyridine, *N*-methylaniline (LTEL 0.5 ppm), *o*-toluidine, *p*-phenylenediamine. (Highly toxic by skin absorption).
- (vi) Volatile organic azides and sodium azide (LTEL 0.1 mg/m³).
- (vii) Benzene (LTEL 1 ppm) - see 9.4.
- (viii) All bis(2-chloroethyl)amines ("nitrogen mustards")
- (ix) Compounds of cadmium (LTEL 0.025 mg/m³)
- (x) Volatile metal carbonyls including nickel carbonyl (STEL 0.1 ppm) and iron pentacarbonyl (LTEL 0.01 ppm).

- (xi) Dimethyl and diethyl sulfate (LTEL 0.05 ppm) - rapidly absorbed through the skin (antidote - conc. ammonia), also carcinogenic.
- (xii) Halogenated solvents and other halogenated compounds including carbon tetrachloride (LTEL 1 ppm) and chloroform (LTEL 2 ppm) (see 9.6), and bromoform, carbon tetrabromide, 1,2-dichloroethane (ethylene dichloride, LTEL 5 ppm), benzyl chloride (LTEL 0.5 ppm), 1,2,4-trichlorobenzene (LTEL 1 ppm), hexachlorocyclopentadiene, iodoform (LTEL 0.6 ppm), methyl iodide (LTEL 2 ppm), 1,1,2,2-tetrachloroethane.
- (xiii) All compounds of many transition metals and heavy metals including chromium (LTEL 0.5 mg/m³ for Cr^{II} and Cr^{III} and 0.01 mg/m³ for Cr^{VI}), cobalt (LTEL 0.1 mg/m³), manganese (LTEL 0.2 mg/m³), nickel (LTEL 0.1 mg/m³), platinum (LTEL for soluble salts 0.002 mg/m³), rhodium (LTEL for soluble salts 0.001 mg/m³), ruthenium, silver (LTEL for soluble salts 0.01 mg/m³, for metal 0.1 mg/m³), tin (LTEL for inorganic compounds 2 mg/m³), molybdenum, tantalum and zirconium (all LTEL 5 mg/m³), vanadium pentoxide (LTEL 0.05 mg/m³).
- (xiv) All organic isocyanates (LTEL 0.02 mg/m³).
- (xv) Nitrobenzene (LTEL 1 ppm) and all substituted nitrobenzenes.
- (xvi) All nitro- and dinitro-phenols, -naphthols and -thymols, p-nitrobenzyl cyanide.
- (xvii) Osmium tetroxide (LTEL 0.0002 ppm).
- (xviii) Oxalic acid (LTEL 1 mg/m³) and its salts.
- (xix) Phenol (LTEL 5 ppm) and all substituted phenols including cresols (LTEL 5 ppm) and picric acid (LTEL 0.1 mg/m³). (Highly toxic by skin absorption).
- (xx) Pyridine (LTEL 5 ppm) and substituted pyridines.
- (xxi) Compounds of selenium (LTEL 0.1 mg/m³).
- (xxii) Compounds of tellurium (LTEL 0.1 mg/m³).
- (xxiii) Compounds of thallium (LTEL 0.1 mg/m³).
- (xxiv) Thiophenol and all substituted thiophenols.
- (xxv) Organo-tin compounds (LTEL 0.1 mg/m³) (readily absorbed through the skin).

9.3 Carcinogens

These substances present a very serious hazard since slight exposure, even on a single occasion, may result in serious irreversible effects producing cancer. In handling these compounds all possible steps must be taken to completely avoid contact with the body or release to the environment. The following list of carcinogens, many of which are subject to statutory control under the COSHH 2002 Regulations must not be taken as comprehensive. Most of these materials have classification 5T, C.

- (i) Certain aromatic nitrogen compounds including:
 - α - and β -Naphthylamine, nitronaphthalenes.
 - All amino and nitrobiphenyls, including benzidines, tolidines, dianisidines, aminobiphenyls, nitrobiphenyls.
 - All amino and nitro stilbenes.

- o*-Toluidine (LTEL 0.1 ppm).
 3-Amino-1,2,4-triazole and related compounds.
 Nitroquinoline N-oxides and similar compounds.
- (ii) Certain polycyclic aromatic hydrocarbons, notably "bay region" compounds such as benzo[*a*]pyrene, and heterocyclic analogues such as benzacridine.
- (iii) All N-nitroso compounds including
 Nitrosamines such as dimethylnitrosamine.
 Nitrosamides, including the diazomethane precursors N-methyl-N-nitrosourea, N-methyl-N-nitrosoguanidine and N-methyl-N-nitroso-*p*-toluenesulfonamide ("Diazald").
- (iv) All diazo-compounds including ethyl diazoacetate and diazomethane (see 10.4).
- (v) Alkylating agents including:
 All epoxides (especially ethylene oxide and propylene oxide, both LTEL 1 ppm) and aziridines.
 Dimethyl and diethyl sulfate (LTEL 0.05 ppm).
 Trimethyl- and triethyloxonium fluoroborate ("Meerwein reagents").
 All alkyl halides, particularly more volatile and reactive ones such as methyl iodide (LTEL 2 ppm) and ethyl bromide.
 Methyl fluorosulfonate ("Magic methyl") - see 9.11.
 Acylating agents such as β -propiolactone, β -butyrolactone and 1,3-propanesultone.
- (vi) All hydrazines and simple derivatives thereof, e.g. 1,1- or 1,2-dimethylhydrazine, methylhydrazine, hydrazine (LTEL 0.01 ppm).
- (vii) Vinyl halides including vinyl chloride monomer (LTEL 1 ppm), vinyl bromide (LTEL 1 ppm) and acrylonitrile (LTEL 2 ppm).
- (vii) Haloalkane solvents including carbon tetrachloride (LTEL 1 ppm), chloroform (LTEL 2 ppm), 1,2-dibromoethane (ethylene dibromide) (LTEL 0.5 ppm), hexachlorobutadiene and trichloroethylene.
- (viii) Benzene (LTEL 1 ppm) - see 9.4.
- (ix) Hexamethylphosphoramide - see 9.9.
- (x) Chloromethyl methyl ether and bis(chloromethyl) ether (LTEL 0.001 ppm) - see 9.7.
- (xi) Certain compounds of arsenic, beryllium, cadmium, cobalt, nickel and chromium(VI) including nickel sulfide, lead and zinc chromates, chromic acid (see 9.14).
- (xii) All radiochemicals.
- (xiii) All forms of asbestos.

- (xiv) Miscellaneous compounds including ethyl carbamate (urethane), thioacetamide, and thiourea.

Use of Asbestos Items

The use of items containing asbestos must be avoided wherever possible. In particular such items as asbestos gloves, tape, string and wire gauzes are not allowed and these should be replaced by safer substitutes. The smooth compressed asbestos/cement boards may be used but not older style rough boards. Any items containing asbestos, or which are suspected of containing asbestos should all be passed to the Building Officer for approved disposal.

9.4 Benzene

Although commonly used for many years, benzene is now known to be so dangerous that it must not be used except when there is no possible alternative. Benzene is rapidly absorbed both by inhalation and skin contact to produce very serious irreversible effects leading to leukaemia. The LTEL is 1 ppm, and the level at which it can be detected by smell is already well above this. Benzene must only be handled in an efficient fume cupboard and wearing heavy gloves. For most purposes toluene is a safer substitute (LTEL 50 ppm).

9.5 Beryllium

Beryllium (LTEL 0.002 mg/m³) and all its compounds are extremely toxic and also carcinogenic. No compound of beryllium may be used without the permission of the School Safety Coordinator. Used X-ray generator elements with beryllium windows require special disposal

9.6 Carbon tetrachloride and Chloroform

Carbon tetrachloride (LTEL 1 ppm) and chloroform (LTEL 2 ppm) are both highly toxic, accumulating in the liver and kidneys to produce very serious irreversible effects including cancer.

In addition, international legislation on ozone-depleting substances (the Montreal Protocol) requires stringent control measures to prevent any escape of carbon tetrachloride into the environment: the use of this substance as a solvent is forbidden except in circumstances where it can be demonstrated that no practical alternative exists.

Similarly, chloroform must not be used except where there is no alternative (an exception is the use of deuteriochloroform as an NMR solvent, which should nevertheless be handled with adequate precautions). Work with these solvents must only be carried out in an efficient fume cupboard and wearing heavy gloves. Dichloromethane (LTEL 100 ppm) is a much safer substitute in most applications.

9.7 Chloromethyl methyl ether and bis(chloromethyl) ether

Commercial samples of chloromethyl methyl ether contain a significant impurity of bis(chloromethyl) ether (LTEL 0.001 ppm) which is an extremely powerful carcinogen.

Cancer has been caused in experimental animals at concentrations as low as 0.1 ppm. Neither of these substances may be used without the permission of the School Safety Coordinator. Bis(chloromethyl) ether is also formed at room temperature when formaldehyde and HCl vapours mix and in Friedel-Crafts reactions involving formaldehyde. All personnel should consider very carefully whether this compound might be formed fortuitously in the course of any operations (for example washing up) and take adequate precautions.

9.8 Cyanides

Because of the extremely rapid and potentially fatal consequences of cyanide poisoning the following rules must be strictly observed for all experiments involving inorganic cyanides or hydrogen cyanide.

- (i) All experiments involving significant quantities of cyanides must be carried out in the fume cupboard of room 367 in the Purdie Building. The fume cupboard and door entrance should be posted with warning notices clearly indicating that cyanide is in use.
- (ii) Experiments using cyanides are only permitted in normal working hours. While a reaction may for example be left overnight, any steps involving manipulations (for example, setting up the experiment, taking it off and extracting the product) must be done during normal working hours. In the event of poisoning the required treatment is rapid administration of oxygen and transport to hospital. To allow this a specific First Aid Worker who has had the necessary training must be identified before the work begins and they must be on call. Any person using cyanides must be accompanied by another at all times who can quickly summon the First Aid Worker if required.
- (iii) Before any work with cyanide commences, a special form (available on the CHARM system and complete during doing the COSHH form) must be completed to indicate the precise date(s) and times of the planned manipulations, who will be the other person accompanying the worker at all times, and which first aid worker will be on call. This must be signed by the School Safety Coordinator together with the Risk Assessment Form before the work begins. Note that a special form must be completed and signed each time a cyanide experiment is planned.
- (iv) *Disposal Procedure.* The disposal of solutions containing cyanides directly down the drain or of solids contaminated with cyanides directly into a solid waste container is strictly forbidden. All cyanide wastes, solid or liquid, must first be made safe by addition to a strong solution of sodium hypochlorite. After at least 24 hours or when a Prussian blue test shows cyanide to be absent, solids should be removed, washed with water, and placed in a controlled waste bin and the solution poured down the sink in a fume cupboard. Gloves and apparatus may be decontaminated in a similar way. Solids which have been made safe should not be sent for special disposal.
- (v) The solution of sodium or potassium cyanide in dimethyl sulfoxide, sometimes required in organic synthesis, is immediately fatal on contact with the skin and may not be used without the permission of the School Safety Coordinator.

- (vi) As Schedule 1 poisons, cyanides must be stored in a locked cupboard at all times. Potassium and sodium cyanide have LTEL values of 1 mg/m^3 and STEL values of 5 mg/m^3 . Hydrogen cyanide has a LTEL of 0.9 ppm and STEL 4.5 ppm.

9.9 Hexamethylphosphoric triamide (HMPA, HMPT)

Hexamethylphosphoramide has long been known to be highly toxic but it has been reported that it is also very strongly carcinogenic, producing cancer in experimental animals at concentrations as low as 0.4 ppm. The most stringent precautions must be taken in its handling and disposal.

9.10 Hydrofluoric acid

In contact with the skin hydrofluoric acid produces very severe burns, which may take some time to become apparent. Several cases of serious HF burns have been followed by death from systemic fluoride poisoning. Anyone intending to use hydrofluoric acid must first obtain the treatment for burns, calcium gluconate jelly. Anyone suffering skin contact with HF should apply this treatment and then get immediate medical attention.

9.11 Methyl Fluorosulfonate ("Magic methyl")

Following several deaths caused by exposure to it, commercial production of this compound has now been stopped and in view of its high volatility and extreme potency as an alkylating agent, its preparation or use in the School is strictly forbidden.

9.12 Mercury

Mercury vapour is extremely toxic and stringent precautions must be taken to avoid its inhalation. Although the vapour pressure of mercury at room temperature is low, evaporation may be rapid if it is finely divided or on heating. In the absence of ventilation the concentration may ultimately reach 20 mg/m^3 in a confined space. The LTEL for mercury vapour is 0.025 mg/m^3 and even brief exposure to 1 mg/m^3 will result in serious poisoning.

- (i) An exposed surface of mercury must never be left open to the air in any laboratory. All mercury stored in bottles or in manometers open to the air should be covered with a layer of water. Mercury should always be handled in a fume cupboard.
- (ii) The exhaust from all vacuum systems containing mercury must be vented to a fume cupboard or out a window. All possible precautions must be taken to prevent mercury being sucked into oil pumps: the hot oil will cause a dangerous release of mercury vapour.
- (iii) The release of mercury vapour resulting from fracture of a hot mercury diffusion pump is likely to cause serious poisoning or death to all persons in the vicinity. These pumps should not be used unless absolutely essential and must be inspected periodically for cracks.
- (iv) Any spillage of mercury should be treated as follows:

pick up all large drops by suction using a pipette connected *via* a trap to the water pump. Cover the affected area with a paste of sulfur and lime in water (this is more effective than sulfur alone). When the mercury has been absorbed (several hours) sweep up the mixture, place it in a bottle and give it to the School Safety Coordinator for special disposal.

- (v) Items contaminated with finely divided mercury should be submitted for special disposal.

9.13 Chromic Acid

The mixture of sulfuric acid and chromic acid formerly in common use for cleaning glassware is highly dangerous. Apart from the obvious corrosive nature of the acid, solutions of Cr^{VI} are highly toxic (LTEL 0.01 mg/m³) and there is strong evidence that it is also carcinogenic. A particular danger exists in the preparation of chromic acid which involves a highly exothermic reaction and in some cases has resulted in an explosion with disastrous consequences. For these reasons chromic acid must not be used unless there is no possible alternative. In many cases modern detergents (Decon 90", "Micro", etc.) are an efficient and safe alternative for cleaning. Where chromic acid must be used the following precautions must be strictly observed:

- (i) The preparation of chromic acid must only be carried out by experienced personnel. Thick rubber gloves and face mask must be worn.
- (ii) Baths of chromic acid must be covered by a glass plate at all times.
- (iii) Tongs and/or thick rubber gloves should be used to put items in and out of chromic acid. Skin contact must be avoided.
- (iv) Many nitrogen compounds react in chromic acid to release highly toxic nitrogen dioxide fumes. Where this is likely to occur the bath must be sited in a fume cupboard.
- (v) Chromic acid should be made up in the minimum quantity required and disposed of as soon as it is depleted or no longer required. In no circumstances is chromic acid to be stored in closed bottles.

10. Gases

In the event of a fire or serious accident the presence of large numbers of compressed gas cylinders in the building presents a serious additional hazard. The need to keep the quantity of compressed gas cylinders in all laboratories to the absolute minimum is emphasised. All gas cylinders should be returned to the appropriate Cylinder Store immediately after use and when empty.

Access to the cylinder stores is by key obtainable from the Main Store. In all cases, personnel must first request the gases required at the store and have them charged to the appropriate account. They must also ensure that the cylinder stores are kept locked, that cylinders are chained up at all times and that the cylinder trolleys are returned to the stores immediately after use.

10.1 General Precautions

- (i) Supplies of natural gas are provided in most laboratories. Gas taps should be firmly closed after use and any leaks reported immediately to the Building Officer.
- (ii) Because of their weight, large gas cylinders may cause very serious injury if they fall over. It is also possible that the force of falling may be enough to shear off the regulator with disastrous results. All gas cylinders must be firmly anchored to prevent falling over. Large cylinders must be fixed to a wall or bench using an approved clamp or placed in a topple-proof support stand. A cylinder trolley does not provide sufficient support.
- (iii) Always ensure that the regulator or control valve is closed before opening the main cylinder valve. Always close the main cylinder valve after use.
- (iv) Under no circumstances are oil or grease to be applied to any regulator or cylinder head.
- (v) All systems connected to a gas cylinder must incorporate a trap to prevent suck back of chemicals into the cylinder.
- (vi) All acetylene cylinders must be fitted with a flash back arrester.

10.2 Toxic Gases

- (i) All toxic gas should be used with great care. No operation involving such gases must be carried out by anyone working in a laboratory on their own or outside normal working hours. The following are some of the most commonly used:

LTEL (or STEL*) (ppm)

| | | |
|-------------------|------------|--|
| Phosgene | 0.02 | (danger to life after 1/2-1 hr at 50 ppm) |
| Diazomethane | (see 10.3) | |
| Bromine | 0.1 | (danger to life after 1/2-1 hr at 10 ppm) |
| Ozone | 0.2* | (danger to life after 1/2-1 hr at 50 ppm) |
| Chlorine | 0.5* | (danger to life after 1/2-1 hr at 14 ppm) |
| Nitrogen dioxide | 0.5 | (danger to life after 1/2-1 hr at 25 ppm) |
| Sulfur dioxide | 0.5 | (danger to life after 1/2-1 hr at 150 ppm) |
| Hydrogen cyanide | 0.9 | |
| Fluorine | 1* | |
| Hydrogen chloride | 1 | |
| Hydrogen fluoride | 1.8 | |
| Nitric oxide | 2 | |
| Hydrogen bromide | 3* | |
| Hydrogen sulfide | 5 | (immediate danger to life at 700 ppm) |
| Carbon monoxide | 20 | (colourless and odourless) |
| Ammonia | 25 | |

- (ii) All toxic gas cylinders must be used with a secondary control valve. The dispensing of any toxic gas from a cylinder by means of the main cylinder valve alone is strictly forbidden.
- (iii) Before using any toxic gas cylinder all persons should plan exactly what action will be taken if an uncontrolled escape of gas occurs, e.g. by the cylinder valve sticking open. In all such cases, immediately signal evacuation of the building by activating the nearest fire alarm button. Any malfunction of the valve of a toxic gas cylinder should be reported to the School Safety Coordinator immediately.
- (iv) The direct venting of significant quantities of toxic gases to the atmosphere is not allowed. Wherever possible excess gas should be absorbed in a suitable solution.
- (v) The stock of toxic gas cylinders in the School should be kept to a minimum. Before ordering any new gases please ensure that any existing stocks are used up.

10.3 Diazomethane

As well as being extremely toxic and a suspected carcinogen, diazomethane is dangerously explosive in contact with rough surfaces. It should only be prepared and handled in dilute ether or methanol solution behind a safety shield in an efficient fume cupboard. Apparatus with ground glass joints or other rough surfaces must on no account be used. Diazomethane is safely destroyed by addition of acetic acid.

11. Disposal Procedures

It is the clear responsibility of all research workers to ensure the safe and correct disposal of all wastes produced in the course of their work. Improper and irresponsible disposal of chemical wastes down drains, to the Local Authority refuse collection or into the atmosphere is forbidden by law. Due to increasingly strict environmental controls and the escalating costs of disposal, it is essential that the appropriate disposal procedures given below are strictly adhered to. All waste should be disposed of in the proper way as detailed in 11.1–11.9 below. No waste materials may be left in the corridors.

11.1 Wash down drains with excess water

For full guidance on disposal to drain please consult Scottish environment protection agency (SEPA) under WM3 Guidance from SEPA. In case of any doubt, consult the School Safety Coordinator who can conduct the required assessment to determine whether or not a given material is allowed to be washed down the drain.

- concentrated and dilute acids and alkalis;
- harmless soluble inorganic salts (including all drying agents such as CaCl_2 , MgSO_4 , Na_2SO_4 , P_2O_5);
- alcohols containing salts (e.g. from destroying sodium);
- hypochlorite solutions from destroying cyanides, phosphines, etc;
- small amounts of fine (tlc grade) silica and alumina.

It should be noted in particular that no material should ever be washed down a drain that is on the list below

- compounds of the following elements – antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, tellurium, thallium, tin, titanium, uranium, vanadium and zinc.
- organohalogen, organophosphorus or organonitrogen pesticides, triazine herbicides, any other biocides.
- cyanides.
- mineral oils and hydrocarbons.
- poisonous organosilicon compounds, metal phosphides and phosphorus element.
- fluorides and nitrites.

11.2 **Incineration** (Solvent Waste disposal)

- all organic solvents including water miscible ones;
- soluble organic waste including most organic solids and liquids;
- paraffin and mineral oil (from oil baths and pumps).

Disposal of solvent waste

1. Each laboratory should collect waste solvents in plastic drums or bottles, separating halogenated and non-halogenated ones.
2. As soon as a plastic container is full, screw the cap on firmly and take it to the external Solvent Store. If you find that a container is full when the Solvent Store is closed (e.g. outside normal working hours) retain it in the laboratory until the Store is next open.

Further Notes

The plastic containers must be labelled to indicate halogenated or non-halogenated and the laboratory or area they have come from (labels from Store). The cost of disposal for partly halogenated solvent waste is much higher than that for non-halogenated waste and the quantity of halogenated waste must be kept to the minimum.

It is forbidden to hoard up waste solvents in a laboratory – there should be the minimum possible number of bottles and they must be taken to the Store as soon as they are full. Do not place waste solvents in glass bottles as the disposal company cannot accept these. In addition, please note that disposal is charged per bottle assuming they are 5 litres. Use of 2.5 litre bottles for solvent waste entails a doubling of cost and should be avoided.

11.3 **Laboratory waste bins and controlled waste**

All waste suitable for the Local Authority refuse collection, except recyclable paper and glass is termed 'controlled waste'. Items in this category, which includes dirty paper, plastic, rubber and wood and non-recyclable packing materials, should generally be placed in the waste bins available in each laboratory and it will be collected by the cleaners. **In no circumstances must any item of glass, sharp metal including syringe**

needles, or fine powder ever be put in a normal laboratory waste bin: for glass, sharps and fine powders see below, sections 11.5 - 11.7. The cleaners are under strict instructions not to touch any such item and to report the circumstances immediately to the School Safety Coordinator.

Personnel in the BMS building handling biologically hazardous waste must dispose of this in strict accordance with the procedures in force in that building. Further details may be obtained from Professor T. K Smith.

11.4 **Waste for special disposal**

The quantity of special waste must be kept to an absolute minimum. Only send materials for special disposal if they cannot be disposed of via any of the other waste disposal streams.

Special waste must be collected in a separate labelled bottle or jar for disposal. On no account must different types of waste be mixed. Advice should be sought from the School Safety Coordinator before beginning any work which will produce waste requiring special disposal in order to ensure (a) that the waste can be disposed of, (b) that it is collected in the most suitable form so as to minimize the cost involved, and (c) that it will be stored under suitable conditions. Whenever waste containers are full, workers should complete the form at:

<http://chemhealthandsafety.wp.st-andrews.ac.uk/hs-forms-2/>
and send this to the School Safety Coordinator.

Please do this regularly, bearing in mind that there is a waste collection every month. The hoarding up of hazardous waste in laboratories is strictly forbidden. All workers must also ensure that waste produced in the course of their work is safely disposed of before they leave the School.

11.5 **Glass, metal and plastic recycling**

For environmental reasons recycling is encouraged, but only certain items of waste produced within the School are acceptable for recycling.

Winchesters and other brown glass bottles which cannot be returned to the suppliers must be disposed of as follows: the plastic cap must be removed and discarded in the normal waste bin, the original contents must be completely removed, and then the bottle must be thoroughly washed with excess water to remove all traces of chemicals. The clean bottle must then be placed in the large container marked "Brown glass bottles and jars" situated in the waste disposal enclosure in the Level 1 car park. NO other material may be placed in this container, which must be kept free of all chemical contamination.

For the disposal of all other glassware, each laboratory should keep at least one of the special glass bins obtainable from the Purdie main store. All glassware for disposal, other than Winchesters, should be made free of significant chemical contamination and then placed in the designated glass bin: these bins must not be allowed to overflow, but when nearly full should be closed, taped up and then placed in one of the skips, labelled "Commercial Waste" in the waste disposal enclosure. **Note that no syringes or needles, or loose powders, must be placed in these skips.**

In most laboratories there are now combined containers for collection of recyclable metal and plastic. Please be considerate in the use of these and only place in them clean items that are suitable for recycling. This includes metal cans in which chemical bottles are received, empty smaller size plastic chemical bottles, plastic syringes (**but NOT needles**) and tops off glass solvent bottles. Note that the containers are not designed to hold large 2.5 or 5 litre empty solvent bottles. When these are empty, plastic ones may be used for waste solvent collection or otherwise researchers are expected to take both metal and plastic solvent bottles to the appropriate skip at the waste compound just as for glass ones.

11.6 **Fine powders**

Finely divided waste materials, which are not contaminated by hazardous chemicals, such as charcoal, silica and alumina must NOT be disposed of in loose form. Such materials, free from significant chemical contamination, must be placed in plastic tubs or bottles with the lids then replaced, and marked as "non-hazardous waste" before being placed in one of the "Commercial Waste" skips.

NB Fife Council has a Duty of Care to their employees, including the crews of the vehicles which remove our waste and the staff of the landfill site where it is deposited. Chemical contamination of the waste material in any of the skips, including the presence of loose powders, has in the past led to suspensions of waste collection by Fife Council, and any further occurrence will again lead to a suspension of collection.

11.7 **Biohazard / Sharps Disposal and Syringes and Needles**

"Sharps", whether or not contaminated with biologically hazardous materials, must be collected in special containers to be sent for safe disposal. These should be obtained from and returned to the Purdie Main Store. It is required that **all needles of any type** should be disposed of by this route. Research groups who do not have their own container for this should take the items to the main store where a container will be available.

No needles must ever be put in a laboratory waste bin, recycling container or controlled waste container.

Used plastic syringes should wherever possible be washed out and placed in the plastic recycling container. Unwanted or broken glass syringes should be placed in a broken glass container. **The previous requirement to place used syringes in a sharps container no longer applies and indeed such a practice is now forbidden.**

11.8 **Waste paper recycling**

All clean waste paper should be placed in one of the specially designated containers. No plastic materials, acetates, used toner cartridges etc. must be put in the paper recycling containers: these should instead be put in the nearest controlled waste container, or in the case of toner cartridges, taken to the Store for recycling.

11.9 **Large-scale waste**

Any person having large items or large quantities of waste to be disposed of should immediately consult the School Safety Coordinator.

From time to time a large builders' skip may be placed outside the building. This is under the control of Estates and is required in association with building work in progress in the School. No person from the School of Chemistry is allowed to deposit any kind of waste in these skips without proper authorisation.

11.10 Waste Electrical and Electronic Equipment

Under the WEEE Regulations 2013, it is illegal to put such waste to landfill. Instead it has to go for special recycling. As a "business" the University has developed a system for this that must be strictly adhered to, involving completion of an online form and arranging a pick-up for each item. There is a special system in operation for Chemistry as follows. For each such item, first go to the web site:

<http://www.st-andrews.ac.uk/environment/recycling/howtorecycle/electrical-equipment/>

and follow the instruction No. 1 there. Then 2. send a copy of the completed form to the School Safety Coordinator, and 3. print out a copy of the form and place it together with the item(s) neatly on the shelves to the left inside the Waste Enclosure entrance. Do not place anything else in this collection area and particularly note that batteries and light bulbs of all types should be disposed of in the containers available in the waste enclosure. If you are in any doubt about how to dispose of an item ask advice from the School Safety Coordinator.

Note that the University cannot waste staff time and resources dealing with such waste equipment that people have brought in from their house. This should be disposed of (without paperwork!) at the Recycling Centre, Argyll Business Park, Largo Road (above Morrison's supermarket).

11.11 Waste disposal compound

The University has a waste disposal compound in the store car park for the disposal of controlled waste and recycling of paper, cardboard, metals, plastic and glass. You must dispose of your waste in the correct skip or shelf and never leave any items on the floor. Used printer toner cartridges should be taken to the Main Store for recycling and not left at the waste disposal compound. If you are in any doubt as to which container to use, or observe any cases of improper disposal please inform the School Safety Coordinator.

12. *Work Outside Normal Hours and Overnight Experiments*

Policy on Lone Working and Work outside Normal Hours

The School accepts that due to the large size of the buildings, the continuous nature of some experimental procedures and the need to maximise use of resources such as spectrometers, personnel may often find themselves working alone in a particular room. When this is outside normal hours without the benefit of First Aid cover and personnel nearby to assist in the event of any incident the risks involved are a particular concern. All personnel should plan to carry out the bulk of experimental work within normal working hours. As noted in 12.1 below, potentially hazardous operations must never be carried out outside normal hours. Even when it may be necessary to carry out a less hazardous experiment outside normal hours, personnel should make contact with someone else in a nearby room that will check regularly on their safety. Any accompanying persons who are present for safety purposes must be either members of staff or matriculated postgraduate students. Examples of activities which may and may not be carried out outside normal hours are as follows:

Allowed

reading, writing and library work;

use of computers, spectrometers and other instruments;
simple physical operations such as sample preparation, recrystallisation, filtration and chromatography.

Not Allowed

use of pyrophoric, highly toxic or potentially explosive substances;
use of poisonous gases.

- 12.1 Never carry out any work involving a significant risk of fire, explosion or any other hazard outside normal hours.
- 12.2 Anyone carrying out laboratory work outside normal hours should, where possible, inform a colleague working nearby of their whereabouts and the expected duration of the work, so that the colleague can periodically check up on their wellbeing and in the event of any mishap raise the alarm.
- 12.3 No experiment may be left running overnight without the explicit permission of the research supervisor or his staff deputy. All overnight experiments must be accompanied by a signed overnight permit obtainable when completing the COSHH form in CHARM.
- 12.4 Overnight permits which certify that the experiment has been checked and found to be safe, may only be signed by a member of the Academic Staff. Where no member of the Academic Staff is available, postdoctoral workers are also authorized to sign overnight permits, but are reminded that in doing so they assume full responsibility for the safety of experiments. Research workers intending to put on an overnight experiment must plan ahead and ensure that the experiment has been set up and stabilized, seen by their supervisor, and the overnight form attached to the relevant COSHH form. Overnight is from 6pm to 9am each day. For longer experiments the date on the overnight form may be extended but all overnight forms must be removed when the experiment is finished.
- 12.5 The overnight permit must be clearly displayed beside the experiment, in a position such that it will not be destroyed in the event of an accident. Thus one copy should be displayed outside the laboratory attached to the relevant risk assessment form, and a second copy should be attached to the sash of the fume-cupboard housing the experiment.
- 12.6 Any overnight experiments discovered without the required permit are liable to be switched off.
- 12.7 All overnight experiments involving the heating or mechanical stirring of any organic material or any other potential hazard may only be carried out in an Overnight Room or in a fume cupboard equipped with automatic fire suppression system ("Firetrace"). The Overnight Rooms must be kept clean and tidy. All materials must be removed immediately after use. Any equipment which appears to be abandoned in an Overnight Room may be confiscated by the School Safety Coordinator at any time without warning. The use of gas burners for overnight experiments is forbidden.
- 12.8 Particular care must be taken to avoid floods outside normal hours. All water tubing on overnight experiments must be in good condition and firmly fixed on with an approved clip or tension strap at each connection. The outlet end of tubing should be firmly clamped to keep it in the drain and the water flow should not be too hard. Water pumps must not be left running overnight.

13. *Electricity*

Current legislation requires that all electrical items should be tested regularly for safety and a record kept of the results. Personnel should ensure that all equipment they use has been tested as required (as indicated by a sticker), New items bearing the “CE” mark do not need to be tested until the first 2-yearly testing round after they are brought into use. However, any new items not bearing this mark and any items from outside the EU should be tested before being brought into use (by arrangement with Mr B Walker, Room 104j/205a, ext: 3797).

In addition to the dangers of electrocution, faulty or unsafe electrical installations may result in fires and explosions.

- 13.1 All electrical equipment must be properly earthed. Under no circumstances must an earth connection ever be made to a gas pipe.
- 13.2 All electrical cables and connections must be properly insulated. Insulation must be replaced at the first sign of deterioration.
- 13.3 Contact of water or any chemicals with electrical connections must be avoided.
- 13.4 The use of round-pin mains plugs, open coil variable transformers, radiant bar electric fires, open element heaters, two and three way mains plug adapters and "varistat" bimetallic strip controls for water baths is prohibited. Personnel should consult Mr Brian Walker, Electronic Workshop for advice on construction or purchase of suitable safe replacements.
- 13.5 Personal electrical equipment may only be used in the School if it has been electrically safety tested.

14. *Vacuum Systems*

- 14.1 All vacuum desiccators taken below atmospheric pressure must be enclosed in a wire guard. In this context there is little practical difference between water-pump vacuum and high vacuum (a pressure difference of 740 mmHg versus 760 mmHg).
- 14.2 All bulbs on vacuum lines must be protected to confine fragments in the event of an implosion. This should be done by covering with a network of adhesive tape such that no area larger than one square inch (2.5 x 2.5 cm) is left clear.
- 14.3 The exhaust from pumps connected to systems containing toxic chemicals (including mercury – see 9.12) should not be discharged into the laboratory. It should be vented into a suitable trap or preferably ducted into a fume-cupboard or out a window.
- 14.4 The vapour of corrosive or toxic chemicals must never be allowed to enter an oil-pump. Always use a suitable cold-trap.

15. *Sealed tubes and High Pressure Equipment*

- 15.1 The heating of steel "bombs" is permitted but they must be of approved construction and have been pressure tested. If they are 250 Bar or above please notify Estates for testing
- 15.2 Sealed tubes must be enclosed in a steel tube before heating and should not be removed until completely cold.
- 15.3 Tubes should be cooled before sealing or opening. Care must be taken to avoid condensing liquid oxygen (see 8.6(iv)) and cracking a tube by cooling too quickly.

16. *Use of High Temperature Furnaces and Ovens*

- 16.1 Safety glasses and laboratory coat should be worn when removing or inserting samples into a furnace. If the furnace temperature is above 1100 °C then UV glasses must be worn. Long tongs should normally be used and heat resistant gloves may be used if appropriate. Particular care should be taken to ensure the tongs do not touch the elements of the furnace in case the door safety cut off is ineffective.
- 16.2 All samples entering the furnace should be entered in the log book giving details of date, user, sample and heating profile.
- 16.3 The area around the furnace should be kept clean and dry with no flammable materials within the vicinity. Always ensure there is a clear, safe and heat resistant surface for your sample when removing it from the furnace.
- 16.4 Samples should normally be placed in alumina, platinum or gold crucibles depending on the sample and the conditions being used.
- 16.5 Consider the chemical hazards of the samples that are being placed into the furnace and ensure that they are safe to heat to the required temperature in air or the atmosphere applied if in a controlled atmosphere.
- 16.6 Never attempt or inspect for repairs when the power is still on. For most repairs you should contact the appropriate person within the department.
- 16.7 All samples removed from the surface at high temperature should be kept near the furnace until they have cooled down, preferably clearly labelled to alert others to the high temperature hazard.
- 16.8 For rapid heating furnace types, in particular where the exterior can be fairly hot, it is essential to ensure that sources of explosion such as compressed gas cylinders are kept at least 1.5 metres away. Considerable care should be taken that gas cylinders are not kept in small rooms containing furnaces.
- 16.9 When removing dust or similar particles from the furnace a dust mask should be worn and the furnace should be isolated from the mains by removing the plug or, in the case of fixed installations, turning off. Similar caution should be taken when using tube furnaces and vacuum furnaces although furnaces will be cooled down before removing the samples to avoid sudden shock damaging the tube. Particular care should be taken when removing

dust or other contaminants from the tube, again wearing a mask and taking care of others in the immediate environment.

- 16.10 Ovens are lower temperature furnaces generally not exceeding 300 °C. Care must be taken to avoid burns from picking up hot objects that are cooling down outside an oven.
- 16.11 Hydrothermal reactions are normally performed in sealed vessels that contain high pressure fluid at high temperature. Therefore care should be taken to work within the safe operational limits for seal and vessel. For hydrothermal systems (i.e. water based) the pressure is determined by the working temperature, however, for solvothermal or solvent based systems all the solvent may well evaporate and the expected pressure of all the solvent being volatilized needs to be calculated also in considering operational limits. Normally a PTFE lined vessel should not be operated above 210 °C.

17. *Cryogenic Materials*

- 17.1 Although liquid nitrogen and dry ice have the potential to cause serious burns, the layer of gas normally prevents heat transfer from the skin. To avoid burns, wear loose fitting gloves for rapid removal when handling liquid nitrogen and do not allow it to fall on clothing. Attempting to pick up dry ice with wet hands or handling dry ice wet with acetone or other liquids can produce severe burns.
- 17.2 All Dewar flasks used for carrying liquid nitrogen along corridors must be fitted with a carrying handle.
- 17.3 It is strictly forbidden to travel in any lift together with a large (>2 l) container of liquefied gas or dry ice. Those responsible for moving such containers between floors must place them in the lift, walk to the destination floor and then summon the lift. If you open the lift and find a large liquid gas container inside, close the door and allow it to continue to its original destination.
- 17.4 Careful consideration must be given to the siting of large Dewars of liquid nitrogen, particularly those ("pressurized Dewars") which are capable of delivering liquid simply by opening a valve. In general these should be sited in a well-ventilated space such as a laboratory with functioning fume cupboards. Under no circumstances are they to be sited in an unprotected fire escape route (such as a main corridor). Those contemplating purchase of a new large Dewar must first consult the School Safety Coordinator to agree upon a suitable location for it.

18. *Biological Hazards*

No work involving biological hazards may be carried out without the permission of Professor T. K Smith, School Biological Hazards Officer. The guidelines set out in the University Handbooks "Safety in Biological Laboratories" and "Guidance on Chemical and Biological Safety, Part 2 – Biological and Genetic Modification Safety" are available from Professor T. K Smith and should be followed in all such work.

Any work involving genetic modification or the use of genetically modified organisms must be registered with the University Chemical and Biological Hazards Sub-committee

in order to comply with government legislation. The School Biological Hazards Officer must therefore be informed of all such work **before it commences**. An up to date list of all biological agents held within the School is also maintained and so all new biological materials brought into the School (e.g. new strains of bacteria) must be registered with the School Biological Hazards Officer. Microorganisms are also covered by the COSHH Regulations and a hazard code must be obtained via the CHARM database before any new microorganism is ordered in or used

19. *Radioactive Materials and Ionising Radiation*

- 19.1 All work involving radioactive materials or ionising radiation must be carried out in accordance with the rules set out in the School's "Local Rules for working with Ionising Radiations" available from Dr M. S. Alphey (e-mail: msa31)
- 19.2 Responsibility for this area is held by Dr M. S. Alphey who deals with all matters concerning X-rays, UV and microwave radiation and magnetic fields.
- 19.3 The SEPA licenses for possession, use and disposal of radioactive materials are on a building rather than School basis. Regardless of which School personnel belong to, the responsibility for keeping a record of stocks and for disposal lies with Dr M. S. Alphey. The appropriate person must be informed before any radioactive materials are ordered or any new project involving radioactive materials is commenced. When the radioactive materials arrive they must then be properly registered and stored. Workers must adhere strictly to the Local Rules in force for the relevant building and in case of any doubt consult the relevant responsible person.
- 19.4 Before the initiation of any project involving the use of radioactive materials research workers **must** consult both the School Safety Coordinator and the School Buildings Officer.
- 19.5 Workers intending to use radiochemicals should take the University Radiation Hazards Course which is run annually. For details contact Dr M. S. Alphey.

20. *Manual Handling*

Legislation applies to all operations in the School involving the lifting or moving of heavy objects. The guidelines contained in the appropriate University Guidance Note, available at: <http://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Publications/Manualhandlingoperations/> should be followed. Anyone who requires to carry out operations which may come under the scope of these regulations should consult the School Safety Coordinator for advice before proceeding.

All personnel whose work falls within the scope of these regulations must complete the web-based training course and present a completed test certificate to the School Safety Coordinator as soon as possible.

1. Go to the site - <http://www.learninglink.ac.uk/moveit/moveit.htm>

2. Follow the instructions carefully on the following pages, going through each of the sections in turn.
3. Once you have completed all sections, go on to the "Quiz" and work through it.
4. When you have got a mark of 60% or more print out the certificate and pass it to the School Safety Coordinator.

21. *Display Screen Equipment*

Legislation applies to all workers in the School who, in the course of their normal work are required to use a word processor, computer terminal or other instrument equipped with a VDU for continuous periods of one hour or more on a regular basis. A detailed written risk-assessment should be carried out by each such worker in respect of their own work-stations. See

<https://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Publications/Displayscreen/Trainingprogram/>

All personnel whose work falls within the scope of these regulations must complete the web-based training course and present a completed test certificate to the School Safety Coordinator as soon as possible. At the same time they should notify him of any aspects of their "work station" which they feel require remedial action.

1. Go to the site - <https://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Publications/Displayscreen/>
2. Follow the instructions carefully on the following pages, going through each of the sections in turn.
3. Once you have completed all sections, go on to the "Quiz" and work through it.
4. When you have got a mark of 60% or more print out the certificate and pass it to the School Safety Coordinator. In case of any problems, contact the School Safety Coordinator.

22. *Safety in Workshops*

Although the hazards present in Workshops are often quite different from those elsewhere in the School they must be taken just as seriously. In particular the work areas must be kept as clean and tidy as possible and waste glass, fragments, metal, plastic and wood debris must be regularly swept up and disposed of. Appropriate protective clothing and equipment should be used for all operations which require it and guards and other safety mechanisms on machine tools should never be removed or disabled. The mains electricity supply to all machine tools should be switched off at the end of each working day. Any member of Workshop staff who has any concern about safety should inform the School Safety Coordinator who will obtain the necessary specialised advice.

All personnel taking items to be worked on at the Mechanical or Electronic workshops must ensure that these are completely clean and safe to work on and not contaminated with any hazardous chemical, biohazard or radioactive material. Workshop staff are under

instructions not to work on any item which they suspect to be contaminated and to report the circumstances to the School Safety Coordinator.

23. *New and Expectant Mothers*

Under current legislation relating to new and expectant mothers, a special assessment has to be carried out in respect of the work activities of any new or expectant mother. Anyone who becomes pregnant or has had a baby in the last 6 months should inform the School Safety Coordinator in confidence as soon as possible so that the required assessment can be carried out. See also:

<http://chemhealthandsafety.wp.st-andrews.ac.uk/hs-forms-2/>

24. *Occupational Stress*

Stress in the workplace can have a serious detrimental effect on the health of staff. Work-related stress is defined by the HSE as: ‘The University has produced a policy on stress, see: <http://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Occupationalhealth/> to reduce the risk of workplace stress; managers/supervisors in the School should be aware of six factors, which are often involved in causing stress. Where any of these factors may be the cause of excessive pressure, which may lead to stress, then the manager should undertake an appropriate risk assessment of the work activity. These six factors are:

- **Demands** - Includes issues like workload, work patterns, and the work environment.
- **Control** - How much say the person has in the way they do their work.
- **Lack of Support** - Includes the encouragement, sponsorship and resources provided by the School and colleagues.
- **Poor Relationships** - Includes promoting positive working relationships to avoid unacceptable behaviour.
- **Uncertain Role** - Do people understand their role in the workplace and whether the School ensures that the person does not have conflicting roles.
- **Change** - How change is managed and communicated in the School.

Further guidance on how managers may deal with stress at work can be found in the University publication entitled: ‘**Manager’s Guide to Monitoring Stress**’

<http://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Occupationalhealth/>

If employees believe they are suffering work related stress they should in the first instance raise the matter with their supervisor or, if they get no satisfaction with this, to raise the issue with the Head of School. Staff may also contact Human Resources with regard to stress issues at work.

NOTE: If an employee does not wish to raise the matter through management, they may directly self-refer to the Occupational Health Adviser (Tel: 2752).

Further guidance on stress recognition and reduction can be found in the University document entitled: ‘**A Guide to Stress Recognition and Reduction**’

<http://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Occupationalhealth/>

Further guidance on stress can be obtained from the Health and Safety Executive at the following website:

<http://www.hse.gov.uk/stress/index.htm>

Further advice can be obtained from the Environmental Health and Safety Services (tel: 2750) or from the Occupational Health Advisor (tel: 2752) or from Human Resources.

25. *Chemical Weapons*

Under the Chemical Weapons Act (1996) possession or production of certain chemicals is prohibited and possession or production of others must be notified to the relevant regulatory body. The materials involved are mainly sulfur and nitrogen mustards and organophosphorus nerve agents and their direct precursors, but many other categories of material are also included. Any supervisor planning new work in these areas of chemistry should check with the University Chemical Hazards Adviser to ensure that it is permitted.

26. *Guidance on sending chemical samples*

Strict and complex rules govern what chemical samples can and can't be sent by air, sea and land. If something can be sent, it may have to be packed and labelled in a particular way. Several people within the University have detailed training on how to interpret and apply the rules and are qualified to authorise shipments. In Chemistry, the qualified person is Dr K Jones. In the section that follows this is referred to as Dangerous Goods Safety Adviser ("DGSA").

The main modes of transportation are road, rail, sea and air. It is often difficult to know what modes a given carrier will use, so it is best to prepare for the most demanding (air transport). To assess the requirements for your shipment, please work through the flow chart on the following page. If this clearly indicates that your goods can be sent with no special restrictions, it is sufficient to state this at the Office and it is also advisable to clearly mark the package "Not Dangerous Goods". Radioactive materials need special assessment only available through EHSS. When referral to the DGSA is suggested or if you are in any doubt, contact Dr K Jones by e-mail (kj34) in the first instance. Once the status of your shipment has been clarified, you should send a message to the generic e-mail address "chem-packages" who will provide further information and arrange the shipment.

27. *Information on Safety*

All persons should make full use of the following sources of safety information:

University Web Site

<http://www.st-andrews.ac.uk/ehss/>

This site, maintained by the University Safety Office has a great deal of valuable information including copies of all documents concerning safety within the University.

Chemistry H&S website

<http://chemhealthandsafety.wp.st-andrews.ac.uk/>

Other documents which are of value include:

In the Chemistry Library

Dangerous Properties of Industrial Materials. N. I. Sax, 5th edn., 1979.

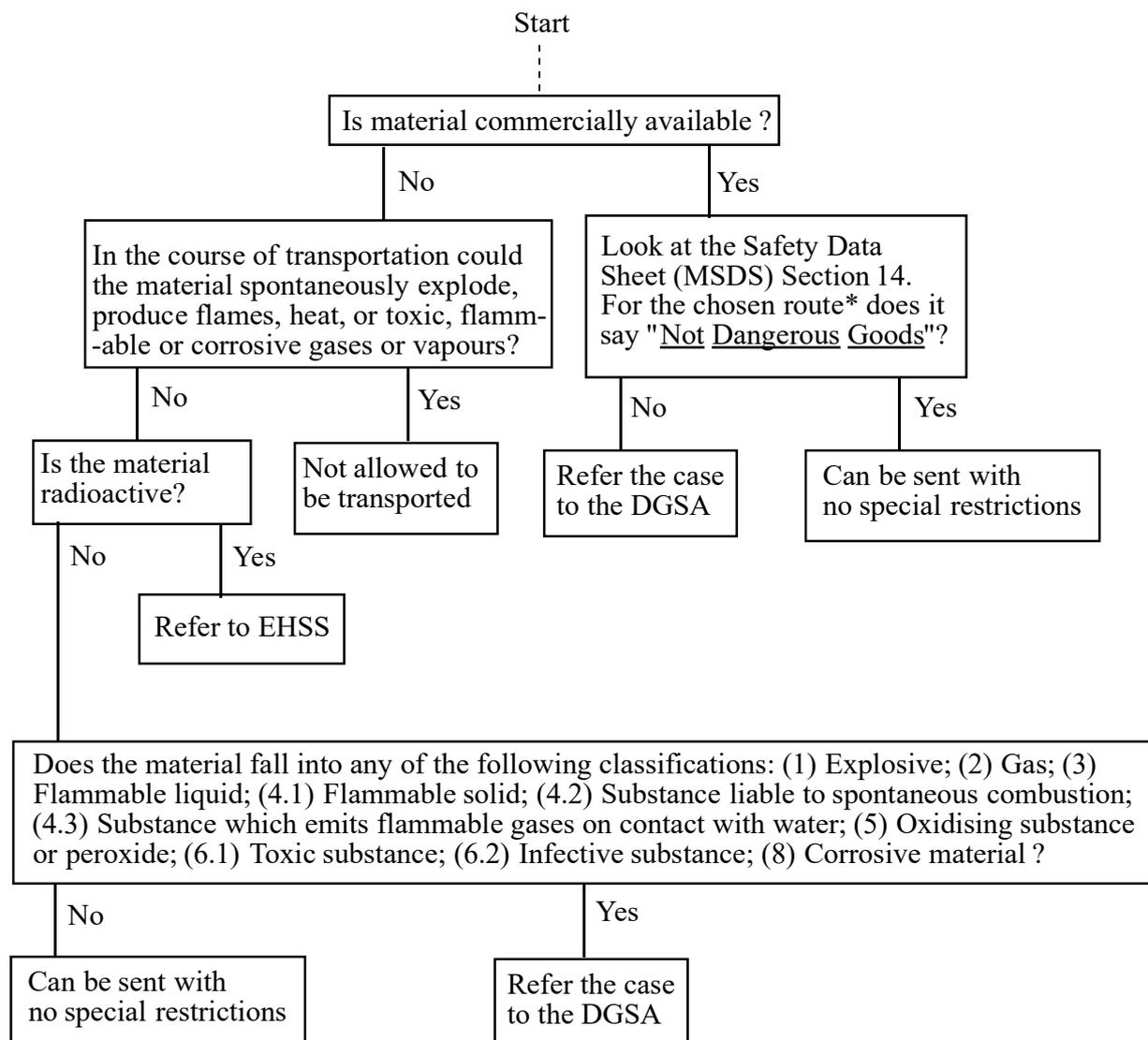
Hazards in the Chemical Laboratory. G. D. Muir, ed., Royal Institute of Chemistry, 1971.

Handbook of Reactive Chemical Hazards. L. Bretherick, 1975.

Effects of Exposure to Toxic Gases - First Aid and Medical Treatment, W. Braker and A. L. Mossman, Matheson Gas Products, 1970.

CRC Handbook of Laboratory Safety, 2nd Edn., 1985.

Solvents: A Guide to Safe Handling, Solvents Industry Association, 1988.



- * ADR/RID = road/rail transport (Agreement on international carriage of Dangerous goods by Road/Regulations on International rail transport of Dangerous goods)
 IMDG = sea transport (International Maritime Dangerous Goods)
 IATA = air transport (International Air Transport Association)

27. *Information on Safety (continued)*

From the University Chemicals Hazards Adviser, Dr R. A. Aitken

Health and Safety in the Chemical Laboratory. RSC Special Publication No 51, 1984.

Poisons and Toxic Substances Act, Guide and Lists of Restricted Poisons, 1968 and 1974.

Lists of Carcinogens and OEL values adopted for toxic chemicals (Guidance Note EH/40)

Control of Substances Hazardous to Health Regulations 1994 and 1999 and Schedules

Chemical Weapons Act 1996, Act and Lists of Scheduled chemicals.

Destruction of Hazardous Chemicals in the Laboratory. G. Lunn and E. B. Sansone, Wiley, 1990.

Chemical Carcinogens. M. Castegnaro and E. B. Sansone, Springer Verlag, 1986.

28. *University Bomb Threat Procedures*

Bomb Threat

- All Bomb threats are to be treated seriously
- Listen to the caller and gain as much information as you can.
- Do NOT hang up even when the call is ended – keep your end of the line open
- Note any incoming number displayed on your phone, plus date, time and duration of call
- If you have a ‘record’ facility on your phone / smartphone, use it during the call
- Can you tell the origin of the call (Mobile, Internal, Landline, Long-distance)?

Ask the following questions;

- | | |
|----------------------------------|--------------------------------------|
| ➤ Who are you? | ➤ Did you place the device yourself? |
| ➤ Is there a code word? | ➤ Why are you doing this? |
| ➤ Where is the bomb? | ➤ How do we contact you? |
| ➤ What type of bomb is it? | ➤ What is your phone number? |
| ➤ What does it look like? | ➤ How do you know so much? |
| ➤ When will it explode? | ➤ Who do you represent? |
| ➤ What will cause it to explode? | ➤ Do you have an address? |

Look for certain characteristics;

Voice

(Male, Female, Young, Old, High-pitched, Deep, Hoarse, Familiar _____?)

Speech

(Fast, Slow, Loud, Soft, Clear, Slurred, Stutter, Nasal, Lisp, Disguised)

Language

(Well-spoken, Rough, Complex, Basic, Fluent, Not fluent, Recorded)

Accent

(Scottish, Other UK, Europe, N America, Australasia, Africa, Middle East, Far East)

Manner

(Calm, Deliberate, Angry, Coherent, Irrational, Crying, Righteous, Excited, Laughing)

Background

(Factory, Office, Children, Animals, Music, Television, Tannoy, Traffic, Trains, Shouting, Loud, Quiet)

ACTION 1: Contact Security and Response on Ext 8999

ACTION 2: If you cannot Security and Response, contact the Police on 9-999

ACTION 3: Security and Response will inform Quaestor and Director of Estates

ACTION 4: Security and Response or Police will assess the situation and advise you what to do next

POSSIBLE POSTAL BOMBS AND OTHER SUSPECT DEVICES

Postal bombs take many forms. They may come in any shape or size: parcels, envelopes or padded 'jiffy bags'. They may explode or ignite when opened and sometimes before they are opened. They are usually designed to kill or maim the person who is opening them. Instead of being posted, such devices may be delivered by hand or arrive by courier.

All staff who might be required to open mail in the course of their work should know the tell-tale signs which are as follows:

- grease marks on the envelope or wrapping;
- an unusual odour such as marzipan or machine oil;
- visible wiring or tinfoil especially if the envelope or package is damaged;
- the envelope or package may feel very heavy for its size;
- the weight distribution may be uneven: the contents may be rigid in a flexible envelope;
- the item may have been delivered by hand from an unknown source or posted from an unusual place;
- if a package, it may have excessive wrapping;
- there may be poor handwriting, spelling or typing;
- the item may be wrongly addressed or come from an unexpected source;
- there may be too many stamps for the weight of the package.

If a member of staff receives any suspicious package, they should

- if handling it, put it down gently;
- walk away from it;
- on no account let anyone move it, touch it, place it in anything (including water) or place anything on top of it;
- on no account let anyone close doors giving access to the suspect item, switch off lights or transmit on a personal radio or mobile phone within 20 metres of the suspect device;
- telephone 9-999 and inform the police immediately;
- evacuate the immediate area by sounding the fire alarm (unless the police immediately advise otherwise) so that occupants of the building gather at the normal fire assembly point(s) of the building;
- take no further action until the police arrive other than doing all that can reasonably be done to ensure that no-one re-enters the building or gets too close to it;
- ensure that a full report reaches the Deputy Principal within twelve hours of the incident.