HEALTH & SAFETY GUIDE FOR THE RESEARCH LABORATORIES

General laboratory safety - Codes of Practice

1. Additional health and safety guidelines are in place for all laboratories. All laboratories have a specific Code of Practice relating to that area on display at the entrance, containing information about COSHH, waste disposal, microbiological containment, isotope usage, etc. You must read this document before starting work in that laboratory. An emergency telephone number for the person in charge of the laboratory should also be displayed on the door. The School Safety Co-ordinator should be informed of any significant changes to any Laboratory Code of Practice.

Personal Protective Equipment (PPE)

2. During many everyday tasks, including research, teaching or maintenance, staff and students may be exposed to chemical, physical, biological or environmental hazards. The aim is to ensure that where persons are exposed to hazards they are provided with, and trained in the use of, personal protective equipment (PPE) in accordance with the Personal Protective Equipment at Work Regulations 1992.

3. PPE is defined as "all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects him/her against one or more risks to his/her health or safety". This does not include ordinary working clothes such as uniforms, which do not represent PPE. In many cases PPE will be simply standard laboratory coats, gloves and where necessary, safety goggles. All persons are strongly urged to adopt the correct use of laboratory coats. These provide a useful means of confining the dangers of toxic chemicals to certain areas within the building. Laboratory coats should be worn for all work with toxic chemicals and should then be taken off before leaving the laboratory area. The wearing of laboratory coats in lecture theatres, common rooms and offices is strictly forbidden. Various types of gloves are available from the store as follows:

a. Rubber and heavy PVC gloves: for handling toxic chemicals. These should be discarded when punctured or perished.

b. Disposable nylon or nitrile gloves: although adequate for handling most toxic chemicals these are too thin to provide adequate protection in some cases and may be dissolved by some organic solvents. Check with manufacturers recommendations before use,

c. Thick insulating gloves: used for handling hot equipment or containers of liquid nitrogen/ dry ice. These gloves are also useful to avoid cuts, for example when attempting to free stuck glass joints. Further guidance on the correct selection of gloves is given at http://www.st-andrews.ac.uk/staff/policy/Healthandsafety/Publications/

4. NB. It is University policy that the type of gloves required in any operation must be specified in the relevant risk assessment. 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. Gloves should be worn, as required, in laboratories, but in no other parts of the School. It is extremely bad practice to walk around the building, opening and closing doors and so on, while wearing laboratory gloves. This simply spreads far and wide any chemical/biological contamination present on the gloves. Before leaving a laboratory, take off any protective gloves. All respiratory equipment must be ‘face-fitted’ (potential users should contact the EHSS to arrange such fitting). School Safety Co-ordinators should be notified if work activities that require more specialised PPE. Those working in these areas should have the appropriate equipment provided to them and should also receive appropriate training in the use of the equipment. It is the responsibility of the individual user and School Management to ensure that such equipment is correctly employed.

5. The booklet “The Selection, Use and Maintenance of Personal Protective Equipment (PPE)” is 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

Out-of-hours Lone Working

6. **BEFORE** anyone may work alone an appropriate risk assessment must be performed. There are many hazards in a workplace, and written risk assessment should be performed by the supervisor in consultation with the School Safety Co-ordinator and a copy of the risk assessment sent to the Building Health and Safety Co-ordinator. See section 10 for details on overnight working/experiments. A copy of the HSE leaflet entitled ' ***Working Alone in Safety'*** is available for consultation on-line at: www.hse.gov.uk/pubns/indg73.pdf

Safety of Support Staff

7. It should be borne in mind that the service and support staff (e.g. janitors, cleaners, glass washing staff) may have no scientific training. Therefore, it is essential that you pay special attention in ensuring that the laboratory procedures, which you perform do not compromise their safety.

Supervision and Safety of Undergraduate and Postgraduate Students

8. Supervisors of both undergraduate and postgraduate students are responsible for the Health and Safety of these people. Responsible staff must be able to demonstrate that they have exercised an effective supervisory role within the context of School Health and Safety procedures. Risk assessments should in any case have been made for most activities such as use of chemicals and biological agents (COSHH), genetic modification of organisms, manual handling, etc. Supervisors and undergraduate/postgraduate students are reminded that risk assessments must also be performed for other activities that may pose a risk to Health and Safety.

General Laboratory Practice

9. Previous inspections of the School by the Health and Safety Executive have highlighted the very poor standard of "housekeeping" and working practices in some laboratories. In addition, it should be noted that slips, trips and falls are major causes of accidents in the workplace.

10. Monthly lab inspections must be conducted by PIs.

Personal Hygiene, Tidiness, Cleanliness and Good Practice.

11. Eating and drinking are strictly forbidden in all laboratories. In accordance with University policy, smoking is forbidden anywhere within the buildings. 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. Storage of food and drinks is not allowed in any laboratory. 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 heavy 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 stepladder with handrail and not a stool or chair. All laboratory sinks should be fitted with a filter in the drain that prevents solid objects falling down it. This must be kept in place and on no account be removed and thrown away. Frequently, reports of blocked drains have often resulted from 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 referred to medfaultreport@st-andrews.ac.uk. Experimental work within the MBS Building requires a degree of concentration and alertness, which is incompatible with excessive background noise. For this reason, the playing of

music is permitted subject to the following condition. 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. Also, the use of noise cancelling headphones in the laboratory. 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.

Chemicals

12. All chemicals must be stored in an appropriate safe place. Old bottles of chemicals, which have deteriorated or decomposed should be immediately disposed of. All corrosive or hazardous chemicals must be periodically inspected (monthly) 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 access to a range of many chemicals and biochemical which are held in the Purdie and Medical School stores and these should be used whenever possible rather than ordering up new materials. Always check whether a material you need is already available here before ordering up new stocks. Many chemicals used in the School are naturally highly flammable or explosive. Stringent precautions are required to minimise the risk of accidents when using these substances.

Flammable Solvents

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

a. Stocks of flammable solvents stored in laboratories are to be kept to a minimum. As a rough guide, the stock should never exceed 10L within each bay (specially dried or purified solvents may be counted separately).

b. Flammable solvents must never be disposed of by pouring down drains. This includes water miscible solvents such as methanol and acetone.

c. Stock containers of flammable solvents must be kept in the marked fire-resistant storage cupboards in each laboratory at all times except when being dispensed. Stock containers of flammable solvents must never be left on the floor, on benches or in direct sunlight.

d. Wherever possible flammable solvents should be heated electrically. The use of open flames for heating flammable solvents is forbidden. **NB.** Electrical heating mantles should only be used under reflux conditions, never for flask-to-flask distillation, when an oil-bath or steam 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 heating in electric heating mantles as, again, this can lead to dangerous overheating.

Explosive Hazards

14. 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.

15. The following materials are explosive:

a. All azides, organic and inorganic (except sodium azide).

b. Certain acetylenes including dimethyl- and diethyl acetylenedicarboxylate which explode on distillation, All metal acetylides.

c. All diazo compounds.

d. All diazonium salts - (aryl diazonium fluoroborates are marginally safer).

e. Hydrazine.

f. All perchlorates, organic and inorganic.

g. Ammonium nitrate.

h. All peroxides.

i. Many nitro compounds including polynitroalkanes and polynitroaromatics such as trinitrobenzene, trinitrotoluene, trinitrophenol (picric acid), metal picrates, trinitrochlorobenzene (picryl chloride), all onitrobenzoyl chlorides and metal salts of nitrophenols.

j. Some poly-nitrogen heterocycles such as tetrazoles and tetrazines.

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

a. 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.

b. 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.

c. 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 Officer.

d. 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.

17. 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.

Fume Cupboards.

18. Fume cupboards are essential for experimental work involving toxic or hazardous chemicals. Indeed, when space allows, it is advisable to handle all volatile chemicals in a fume cupboard. However, fume cupboards which are excessively filled with bottles of dangerous and corrosive chemicals are not suitable for experimental work. Fume cupboards used for experimental work must be cleared of all unnecessary items including bottles of dangerous chemicals. In particular the storage of highly 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 nonvolatile 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 or in a closed wooden cupboard. Once full they should be disposed of immediately by arrangement with the Lab Manager or Building Officer. 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 Lab Manager or Building Officer. Experiments involving a foreseeable risk of explosion should be carried out within a fume cupboard and also surrounded by safety shields.
NB. It may 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, or on roof-mounted facilities.

Vacuum Systems/Freeze Drying

19. 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).

20. All glass bulbs on vacuum lines/freeze dryers 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 is left clear.

21. The exhaust from pumps connected to systems containing toxic chemicals should not be discharged into the laboratory. It should be vented into a suitable trap or preferably ducted into an active fume cupboard or out a window.

22. The vapour of corrosive or toxic chemicals must never be allowed to enter an oil-pump. Always use an appropriate in-line trap.

Cryogenic Materials (see Appendices 21 and 22)

23. To avoid burns it is recommended than heat resistant gloves are used at all times when handling liquid nitrogen or dry ice. The sleeves of lab coats should be worn over the top of the gloves to prevent the liquid nitrogen entering the glove. Do not allow liquid nitrogen to fall on clothing as the garment may retain it in contact with the skin. Attempting to pick up dry ice with wet hands or handling dry ice wet with acetone or other liquids can produce severe burns.

24. All Dewar flasks used for carrying liquid nitrogen along corridors must be fitted with a carrying handle.

25. It is strictly forbidden to travel in any lift together with a large (>5 litre) container of liquefied gas. 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.

26. Careful consideration must be given to the siting and use of Dewars of liquid nitrogen, particularly those used outside the Cell Archive Store. In general, these should be sited in a well ventilated space such as a laboratory with functioning fume cupboards. Under no circumstances are Dewars 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 Officer to agree upon a suitable location for it.

High Temperature Ovens/Microwave Ovens

27. Safety glasses, heat resistant gloves and laboratory coat should be worn when removing or inserting samples into a high temperature oven. Where possible all items must be allowed to cool to near room temperature before removal.

28. The area around the oven should be kept clean and dry with no flammable materials within the vicinity.

29. Always ensure that there is a clear, safe and heat resistant surface for any samples removed when still hot from the oven.

30. All samples removed at high temperature should be kept near the oven until they have cooled down. The item or area should be clearly labeled to alert others of the high temperature hazard.

Autoclaves

31. Autoclaves are used in the School to sterilize media used for bacterial, yeast and animal cell cultivation as well as to sterilize and render harmless all biological wastes from these procedures. Volatile chemicals, strong acids and alkalis and wastes resistant to temperatures up to an including 120^{o}C must not be autoclaved and disposed of by other routes. See Appendices 20 and 23 for information and a Code of Practice for autoclave use. Autoclaves are only operated by trained members of staff.

a. It is a legal requirement that all microbiological and transgenic waste be treated to render them sterile and totally non-viable by a suitable, tested method. The approved method in this department is as far as is practicable to autoclave all such waste.

b. For autoclaving to be effective for sterilisation the temperature **in all parts of the load** must reach 121°C.

c. Waste materials must be 'bagged' in the place of origin ie. where they have been created, cultured or grown (culture room or laboratory) and transported to the autoclaves in **double sealed containers** (e.g. autoclave bag inside a sealable container). Containers for transport must be autoclavable, robust (resistant to being dropped) and must prevent leakage under all conditions. Autoclave bags must be filled no more than two thirds full. Immediately prior to autoclaving open the top of the bag wide open and roll back the edges to keep the bag open

d. Only autoclaves which have been tested regularly for maintenance of cycle pressure and temperature can be used for processing waste materials. **Portable lab autoclaves are unsuitable for this purpose.**

e. The effectiveness of autoclaving for waste disposal should be monitored, especially for difficult materials, using an appropriate thermal indicator - *temptubes* or *thermalog* strips. Autoclave tape on its own is inadequate. Any materials failing this test should then be re-autoclaved under appropriate conditions.

Noise/Sonicators

32. Apart from sonicators, there are no items of equipment in the School that produce excessive noise requiring ear protection. Should individual staff wish to purchase equipment that might be excessively noisy during operation and require ear protection, you must first contact the Lab Manager.

33. All users must read the appropriate instruction manuals and/or consult with their supervisor on the correct use of these instruments.

34. Prior to use, the laboratory door must be closed, signed with “Do not enter-Sonication” and ear protection used by the operators with all sonicators.

35. Where possible use the probe sonicator, which is sited in its own sound-proof cabinet.

36. Probe sonicators must be thoroughly cleaned with 70% ethanol after use.

37. **Freezers for General Use.**

a. All items placed in these facilities must be labeled to indicate who is responsible for them. Where a research group or individual requires to put several items in these, it is sufficient for a compartment or shelf to be labeled rather than each item. No-one else should then put items in such a reserved space.

b. All containers placed in freezers must be securely closed. No open vessels are allowed.

c. All unlabelled items found in these facilities are liable to be removed and disposed of without warning at any time.

d. Freezers must be defrosted and cleaned out on a regular basis.

38. **Rubber 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 for 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.