Ship Laboratories Code of Practice

The Safe use of Laboratory Facilities

Aboard ships of the British Antarctic Survey

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Lab Code of Practice onboard BAS Ships

The following sections are extracts from the BAS Laboratory Handbook relevant to ships and which are held in their entirety at :

http://basweb.nerc-bas.ac.uk/health_and_safety/FAQ/laboratory.php

These extracts apply generally within BAS and only instructions specific to laboratories in Cambridge and the Antarctic Stations are omitted from this "Ship" document.

Also at the above website are:

ACDP Bio Hazard Advice

General advice on Waste Disposal (Biological and chemical)

Laboratory Biosafety Manual issued by the WHO

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1.1 INTRODUCTION

The aim of this *Code of Practice* is to advise laboratory users at BAS of safe and correct working practices, and of their responsibilities and conduct within the laboratories. The laboratory environment is one that may present special hazards and this *Code of Practice* provides an overview of the measures that should be implemented to ensure laboratory safety.

1.1.1. Your role in Health and Safety

As an employee you have certain responsibilities these are set out in health and safety legislation.

- You must take reasonable care of your own health and safety and that of others who may be affected by your acts or omissions at work.
- You must co-operate with your employer with respect to health and safety requirements.
- You must report to management any shortcomings in health and safety practice.
- You must not intentionally or recklessly misuse or interfere with any equipment provided in the interest of health and safety.
- You must reports all accidents, incidents and "near-misses", and deterioration in health related to work.

The most critical aspect of laboratory safety is that:

All laboratory users are responsible for their own health and safety, and that of others who may be affected by their actions.

For this reason it is mandatory that you make an assessment of the risks that may arise from your work activities in the laboratory **before** you commence the work. This risk assessment is a legal requirement, and no work may be undertaken in any BAS laboratory until a formal risk assessment has been undertaken and approved.

The appropriate laboratory regulations and guidelines must be followed at all times, and you must inform the person responsible for the laboratory of any accident, incident or "near-miss" that occurs in that laboratory.

Employee's can be prosecuted as a result of negligence or carelessness while at work.

1.1.2. The employer's responsibilities and safety organisation at BAS.

The responsibilities of the employer are also set out in legislation; as an employer the Survey

- Must strive to maintain a safe working environment
- Must provide and maintain equipment and systems of work, which are safe, and without risk to health.
- Must provide information, instruction, supervision and training to ensure employee's health and safety.
- Must provide all necessary health and safety equipment.
- Must provide and maintain safe access and egress for the workplace

- Must provide arrangements to ensure safe transport, storage and handling of articles and substances.

Within the British Antarctic Survey, the ultimate responsibility for safe working practices and the health of employees while at work lies with the Director. Each Head of Division is responsible for the running of the laboratories in his/her division.
For each laboratory at BAS there is a named individual who is responsible for the general running of, and safety in that laboratory (the name of the responsible person should be posted on, or next to, the door of that laboratory).

If an accident or incident occurs, you should in the first instance consult the person responsible for that laboratory and also inform your line manager. If you are not satisfied with the action taken, you can proceed further through the union representative and/or other representatives on the BAS Safety Committee. If necessary the Project Leader and the Division Head should be consulted. The Health and Safety Advisors at BAS may also be consulted.

All accidents or work related illnesses and "near-misses" must be recorded within the Accident, Incident, Near Miss and Environmental (AINME) reporting software found upon the BAS webpage's under " Health and Safety" quick links.

All new staff at BAS must have read the ***BAS Health and Safety at Work Policy Statement*** that is issued on commencement of employment. They should also have attended a **BAS Health and Safety Seminar** conducted by the Health and Safety Adviser as part of the induction to BAS.

All new lab users must attend a brief **Laboratory Induction Course** before working in the laboratories.

1.1.3. Health and Safety Legislation.

Health and safety legislation puts a duty of care on employers to safe guard the health and safety of **employees** and anyone else who may be affected by their work activities; the same legislation places duties on employees both for their own safety and that of their colleagues. There is more specific legislation which is particularly relevant for laboratory work and is designed to protect the health of the worker by controlling or preventing exposure to the chemicals and other substances hazardous to health. These *Control of Substances Hazardous to Health (COSHH) Regulations* require the assessment and control of risks **before** any work is undertaken in the laboratory. The *Chemicals [Hazards Information and Packaging for Supply](CHIP) Regulations* deal specifically with the classification and hazard labelling of chemicals.

Health and Safety legislation that is relevant to laboratory work generally deals with the identification of the ***hazard*** and the elimination or reduction of the ***risk.***

1.2 SAFE WORKING IN LABORATORIES

Although each laboratory project is subject to formal risk before it can start, there are a number of general aspects of working in laboratories, which apply to all work undertaken in laboratories. These are basically common sense, and they serve to minimise risks to individuals and those working alongside them.
You should inform the Laboratory Manager/Supervisor before commencing work in a lab so that bench space can be allocated and demand for equipment scheduled appropriately

1.2.1. Safe Laboratory Conduct

Personnel working in, or visiting, any laboratory area **MUST** observe the following rules:

- Laboratory coats and safety spectacles must be worn at **ALL** times within ALL laboratories (safety specs may be removed when doing light microscopy, if it is safe to do so). Prescription safety spectacles are available for those who require them.
- When handling hazardous substances the appropriate additional protective clothing such as disposable gloves, facemasks, aprons must be worn, this will be defined in the risk assessment.
- **NO** food or drink is to be taken into, or consumed, in any laboratory.
- **NO** smoking is allowed in any laboratory.
- **NO** application of cosmetics (including lip balm and hand cream) is allowed in the laboratory.
- Appropriate footwear should be worn at all times (open-toed sandals or flip-flops are not acceptable). If moving heavy objects, safety shoes must be worn.
- **NO** laboratory coats should be worn in communal areas e.g. canteen and corridors.
- Hands should be washed before leaving the laboratory, and laboratory coats removed before entering any office area. This is particularly important for work involving the handling of microorganisms or hazardous chemicals.
- Keep your work area clean and tidy.
- Label **ALL** sample, specimen and reagent containers with details of the contents, your name, date, and any relevant chemical hazard label.
- Store all chemicals and reagents under the correct conditions.
- Return all chemicals and reagents to their storage place after use.
- Dispose of any chemicals and biological waste in the correct manner.
- Discard disposables such as sharps into the appropriate container
- Clean up any spills **immediately taking note of any emergency precautions defined in the risk assessment.** Warning signs should be used until floor is dry.
- Wash up glassware immediately after use. Remove equipment from the drying cabinet as soon as it is dry and return to its storage place.
- Use a Winchester/Eurobottle carrier for transporting bottles.
- On completion of an experiment clean your work area thoroughly and put away small pieces of equipment so that someone else may use the bench space.

1.2.2. Working alone in the laboratory

Working alone should be avoided if at all possible, but sometimes it is necessary to work alone during normal hours or for laboratory work to be undertaken outside normal working hours (9.00 – 17.30).

Lone working exposes an individual to additional risk, because of lack of supervision and the difficulty of obtaining help in the event of an accident. An assessment of the risks involved and control measures to be used **MUST** be made before working alone in the laboratory.

Permission to work alone in the laboratory will only be given if the person is responsible and competent, and the activity carries a low risk. The person intending to work alone must inform both the laboratory manager and his/her line manager whenever they intend to work alone. Lone workers must then pick up a "lone worker" alarm unit from reception and they **MUST** complete the "lone worker logbook" found on reception.

1.2.3. Personal Protective Equipment (PPE) and safety equipment.

Certain protective clothing such as laboratory coats and safety spectacles must be worn routinely in all laboratories.

Other PPE such as safety helmets, foot protection, gloves, face shield and hearing protection should be used when necessary.
Respiratory protection should be used only as an interim measure until some other way of controlling the risk can be found, or for use in emergencies. **Respiratory protection must be face fit tested for the user.**

Remember that PPE only protects the person wearing it, and not others in the work environment. You should also remember that PPE can be awkward to wear and may introduce new risks to certain activities, to reduce these ensure all PPE fits correctly.

Fume cupboards and extraction hoods are present in some of BAS laboratories to protect the user from hazardous substances. The ***NERC Guidance note: Safe use of fume cupboards*** located next to each fume cupboard, should be consulted prior to use.

In some laboratories there will be an emergency shower, eyewash station. In all laboratories there are eyewash bottles and First Aid boxes (if not in laboratory, in the corridor) for use in case of an accident.

All Accidents / Incidents/ Near misses (AINME) must be recorded in the AINME software upon the intranet and also report the AINME to the person whom is responsible for the laboratory. Use of any First Aid equipment should be reported to the duty First Aider.

Fire extinguishers, fire blankets and chemical spill kits are provided in the relevant laboratories.

1.2.4. Risk assessments

Health and Safety legislation requires employers to make *suitable* and *sufficient* assessment of risks to health and safety of their employees whilst at work. To satisfy these requirements all laboratory users **MUST** undertake a risk assessment for **ALL** work that is to be conducted with the laboratory **before** that work commences.

All risk assessments must be undertaken using the relevant forms and entered on the "Procedures and Risk assessment system" a word copy should be sent to the Health and Safety advisor and a paper copy kept within the laboratory in question.

Risk assessment should identify both hazards and risks. A **hazard** is something, or a situation that can cause harm. A **risk** is the likelihood that an unsafe event may occur and the severity of the outcome if it does.

An outline of the 5 steps in the risk assessment process follows.

Step 1: **Identify** the **hazards**

Step 2: **Decide** who may be **harmed**

Step 3: **Evaluate** the risks and whether existing precautions are adequate or more should be done. Define the **procedure.**

Step 4: **Record** this by completing a ***Risk Assessment*** form.

Step 5: **Review** the **risk assessment** on a yearly basis and revise if necessary.

Only once all the information is available to carry out the risk assessment can a valid judgement of the risks arising from the activity be made, and a decision made on whether the risks are acceptable.

The following table should be used to assign a **risk factor** to each assessment:

Risk Level Matrix					
Hazard Severity Index	Probability Index				
	Remotely Possible	Possible	Likely	Highly Probable	Virtual Certainty
Minor injury/illness	**1**	**2**	**3**	**4**	**5**
Injury/illness requiring Medical assistance	**2**	**4**	**6**	**8**	**10**
Injury/illness requiring 3 days or more off work	**3**	**6**	**9**	**12**	**15**
Major injury or long term illness	**4**	**8**	**12**	**16**	**20**
Fatal injury/illness	**5**	**10**	**15**	**20**	**25**

Once the risk has been determined the following table should be used to inform your decision on **further action**:

Rating	Risk	Action
1-2	Negligible	No further action
3-5	Low	Further action as resources allow
6-9	Medium	Requires action; Set timetable for improvements
10-15	High	Priority action; Control as soon as possible
16-25	Unacceptable	Stop activity until risk reduced

Your **line manager and/or a person with knowledge of the process that your RA covers** should check your risk assessment for compliance and agreed procedures, produced as a result of the risk assessment process. Ensuring that control measures and precautions are suitable and sufficient.

Laboratory work may pose additional health and safety problems for new or expectant mothers, young persons (under 18) or those with disabilities. This must be of prime consideration when undertaking a risk assessment involving workers from these groups. For young persons, a copy of the risk assessment must be copied to, and authorised by their parents/guardian before they may commence work in a laboratory.

To reduce the number of risk assessments carried out assessments should include environmental risk arising from the activity.

Depending on your laboratory procedure, one or more of the following types of risk assessment will be required **before** you can start work, in the laboratory.

Risk assessment and COSHH assessment forms and guidance can be found here:
http://basweb.nerc-bas.ac.uk/forms/health_and_safety/

(i) Laboratory risk assessments.

A laboratory risk assessment is required if the "hazard" is not covered under COSHH, radioactive substances or manual handling risk assessment for example the use of a rotary evaporator or centrifuge, or non-ionising radiation such as ultraviolet light. Generally, this will form part of the overall project risk assessment. The risk assessment must be reviewed at regular intervals; this is to be determined by the line manager.

1.3 POTENTIAL HAZARDS IN LABORATORIES

1.3.1. Chemical hazards

Laboratories may contain many hazardous chemicals; these may be in the form of solid, liquid or gas. Chemicals may present a hazard to health and safety due to their effects on health and/or their physico-chemical properties. The physico-chemical properties of, and associated hazard symbols for chemicals are: **extremely flammable, highly flammable, explosive, oxidising, radioactive.** The possible effects on health and the associated hazard symbols for chemicals are: **very toxic** (includes **carcinogen, mutagen** and **substances toxic to reproduction**), **toxic, harmful, corrosive, irritant.** Certain chemicals may also have a hazard symbol to indicate that it is "dangerous to the environment". All chemicals that are supplied to a laboratory will bear a hazard symbol (Appendix 3.1), risk phrases (R-) (Appendix 3.2) and safety phrases (S-) (Appendix 3.3) to conform with the CHIP Regulations, these will be present on the packaging and also on the Material Safety Data sheet (MSDS) supplied with the chemical.

Chemicals that are hazardous to health may enter the body through various routes: inhalation or respiration, ingestion, absorption through, or direct contact with the skin. The COSHH risk assessment you carry out should identify the possible routes of entry into the body and indicate the necessary containment measures and PPE required to prevent exposure.

If you make up any reagents/ preparations or transfer chemicals from the supplier's container, they **MUST** be labelled with:

- Correct chemical hazard symbol
- Chemical name and concentration/quantity
- Your name and date.

If you need information on the hazardous nature of a chemical consult the supplier's material data sheet (MSDS), which gives information on chemical composition, hazards associated with the chemical, first aid measures, exposure controls and PPE requirements.

A COSHH risk assessment **must** be undertaken **before** the procedure is started for any activity using hazardous chemicals. The COSHH assessment forms and guidance can be found here: **http://basweb.nerc-bas.ac.uk/forms/health_and_safety/**

Chemicals must be stored and transported correctly to avoid any risk to health and safety. Information on storage and transport can be found in the supplier MSDS. Bottles of chemicals must be transported around the laboratory using a bottle carrier.

Some chemicals will have a **Workplace Exposure limit** (WEL), this can be found on the material safety data sheet (and listed in EH40/2005, copy held by Laboratory Manager or Health and Safety advisors). WEL's are the concentration of hazardous substance within the air that can affect health; therefore these limits should not be exceeded without any control measures in place. Any chemical that has a WEL must be handled in such a way as to ensure the operator is not exposed to a concentration above the WEL, usually by the use of a fume cupboard or other local exhaust ventilation system.

1.3.2. Biological hazards.

A biological hazard can be presented by a **biological agent** which is any micro organism, cell culture or human endoparasite, including any which have been genetically modified, which **may** cause infection, allergy, toxicity or otherwise create a hazard to human health. Naked or extracted and solubilised DNA is not a biological agent.

Biological agents may be transmitted to the laboratory worker by one of the following routes: ingestion, inhalation of airborne particles (aerosols), skin contact with contaminated object, needle-stick injury, contact with an infected person or animal.

Biological agents are classified into four hazard groups and the criteria under COSHH and the relevant guidance are as follows:

Group 1 - unlikely to cause disease i.e. cyanobacteria, algae.

Group 2 - can cause human disease and may be a hazard to employees; unlikely to spread to the community and effective prohylaxis or treatment usually available e.g. *Actinomyces spp, Clostridium spp, Escherichia coli* (pathogenic strains).

Group 3 - can cause severe human disease and may be a hazard to employees; may spread to the community but effective prophylaxis or treatment usually available i.e. *Salmonella typhi*, hepatitis viruses.

Group 4 – cause severe human disease and pose a serious hazard to employees, is likely to spread to the community and there is usually no effective prophylaxis or treatment available e.g. Ebola viruses, Lassa fever virus.

The handling of hazard group 3 or 4 organisms is prohibited in all BAS laboratories. (Some group 3 organisms are allowed providing appropriate risk assessment is completed and authorisation from laboratory manager is approved).

Biological agents may be present in, or cultured from, plant tissue, animal tissue or soil/sediment. It may not be possible to identify a specific biological agent in an environmental sample and so to determine the containment level at which you must handle samples a **biological agent risk assessment** must be undertaken. A Biological Material Hazard RA from and relevant information may be obtained from the Biological Safety Officer in the Biological Sciences Division and from the web pages: **http://basweb.nerc-bas.ac.uk/forms/health_and_safety/index.php?dir=risk-assessment**

It is often necessary to use Containment Level 2 when certain microorgansims have been enriched or isolated and their numbers concentrated, and also if your procedure is likely to produce aerosols. If you are working at Containment Level 2 this requires the use of a Class 2 Microbiological Safety Cabinet.

Biological material may also be regulated by the Ministry of Agriculture, Food and Fisheries (MAFF) or Genetically Modified Organisms (GMO) legislation and may require further control procedures and containment above those set out in the COSHH/biological agent risk assessment. For further information consult your line manager or the Biological Safety Officer at BAS Cambridge.

If you are importing any animal, plant or environmental material into the UK from non-UK sites, you should inquire about the requirement for an import license. The Head of Biological Sciences Division should be contacted for further information.

1.3.3. Flammable liquids.

Flammable liquids are classified as **flammable** (flashpoint 21º - 55ºC), **highly flammable** (flashpoint below 21ºC) or **extremely flammable** (flashpoint below 0ºC and boiling of 35ºC or less). The flash point is the lowest temperature at which a liquid gives off vapour in sufficient concentration to form a combustible mixture with air, which may be ignited by an external source of flame.

The main hazards from the use of flammable liquids are fire and explosion, involving either the liquid or the vapour given off from it, especially if the flashpoint is below room temperature.

When working with flammable liquids it is important to be aware of the flashpoint of the liquid you are handling and take that into consideration in your COSHH risk assessment.
A maximum of 50L of flammable liquid may be stored in any laboratory, larger quantities must be stored in the hazardous chemical store.
Flammable liquids and wastes must be stored in fireproof metal storage cabinets marked "highly flammable".
Winchester or Eurobottles of flammable liquids must not be left on laboratory benches or in fume cupboards when not in use they must be returned immediately to the metal storage cabinet.

Bottles of flammable liquids must be transported around the laboratory using a bottle carrier.

Flammable liquids must not be stored with corrosives, explosives, organic peroxides, radioactive substances, halogens, poisons or spontaneously combusting materials.

1.3.4. Compressed gas

In the laboratory, compressed gases are usually supplied in pressurized gas cylinders. Compressed gas cylinders may present a significant fire/explosion hazard and manual handling hazards if the cylinders are large. In addition the chemical content of the cylinder may present a hazard independent of the pressure vessel.

Ideally gas cylinders should not be used or stored in the laboratory. If it is necessary to use a gas cylinder within the laboratory, then it must be secured properly using a cylinder clamp. Cylinders of flammable or toxic gas must not be used or stored in the laboratory without specific permission.

A cylinder trolley must be used when moving compressed gas cylinder, and steel-toe capped shoes, heavy-duty gloves and safety spectacles must be worn during this operation. Gas cylinders must not be moved with a pressure regulator attached.

Cylinder valves must not be "cracked" open ('snifting') to blow out dirt or debris. This practice releases a high-pressure stream of compressed gas, which could damage the eyes or penetrate the skin causing a gas embolism.

Never use soapy water, oil, greases, solvent or PTFE thread tape on compressed gas cylinders as some gases may react violently with these.

Compressed gas cylinders should be leak tested every time a connection is disturbed (i.e. when changing a regulator or connecting new pipe work), with an approved leak detector spray solution (e.g. BOC Diamond).

Cylinders valves should be closed when not in use.

Never use gas regulators or control valves with gases other than for those for which they are intended and always use the correct pressure regulator for all cylinders. Check that the regulator inlet pressure matches that of the cylinder. Inspect the gas cylinder regulator for damage before use, and do not use if it is more than 5 years old or faulty. Always wear eye protection and heavy-duty gloves when attaching a regulator to a gas cylinder. Ensure you have read and understood the correct operating procedure before using a gas regulator.

A COSHH risk assessment must be undertaken before the use of any compressed gas. Compressed gases may be hazardous because they are **flammable** (e.g. hydrogen), **toxic** (e.g.carbon monoxide), **oxidizing** (e.g. oxygen), **corrosive** (e.g. chlorine) or **inert** (e.g.helium). Inert gases, although not chemically hazardous, present a hazard in the laboratory in that they are asphyxiants and do not support life.

All staff changing gas cylinder valves must have attended an appropriate training course.

1.3.5. Pressure and vacuum systems

Pressure systems are rigid vessels with associated valves and pipe work that may contain steam, gas or fluid. Examples of pressure vessels used in laboratories are autoclaves, sealed-tube chemical reaction vessels and compressed gas containers (see section 3.4)

The principal hazard from a pressure vessel is the sudden, unexpected release of stored energy. This hazard is largely a function of the pressure and volume of the system. The release of hazardous substances or material at elevated or reduced temperatures are additional hazards.
The pressure vessel must be inspected for damage before use.

Ensure you have undertaken a risk assessment, and read and understood the correct operating procedures before you use any pressure system

The autoclave is a steam pressure vessel used for the sterilization of laboratory equipment, reagents and also for the destruction of biological agents. The main hazards from the use of an autoclave are scalding from steam or hot liquids and risk of infection from inadequate sterilization material. Before using an autoclave the relevant risk assessment and correct operating procedure should be read and understood. Eye protection and steam/heat poof gloves must be worn. When using the autoclave for destruction of infectious agents it is important to ensure that the load reaches the recommended temperature to kill the microorganisms present (usually 130^{o}C).
If using an autoclave for the first time ensure it has been tested in accordance with requirements.

Vacuum systems are those in which air has been removed by the use of vacuum pump. The pressure within these systems is less than atmosphere and because of the pressure differential between the inside and outside there is a risk of the containment equipment, which is often constructed of glass, imploding and as a result the possibility of projectile glass or metal fragments. All vacuum systems should have guards to protect the operator from projectiles, which may be generated by implosion. A vacuum system with chemical or

microbiological contents may present a hazard if the system fails and implodes releasing the contents into the surrounding atmosphere.

Before using a vacuum system ensure you have undertaken an assessment of the risks, read and understood the correct operating procedures.

Any glassware that is to be used as part of the vacuum system must be carefully inspected for defects or damage before use. Ensure electrical equipment has been tested for safety before use.

1.3.6. Ultrasonic equipment

Ultrasonic equipment provides high frequency airborne acoustic energy, usually in the range 20 kHz- 100kHz. The ultrasonic sonicator is an example of ultrasonic equipment used in the laboratory, for example for disrupting cells in microbial cultures or tissues. Ultrasonic baths may be used for cleaning purposes in the laboratory.

The main hazards associated with ultrasonic equipment are exposure of human tissues (e.g. the hand) through direct contact with a vibrating solid or vibrating liquid coupling medium: this may cause damage to the tissues. Exposure of human ear tissue through airborne ultrasound can cause noise-induced hearing loss if the ultrasound is above recommended limits.

If the emissions from ultrasonic equipment are likely to have a frequency above the advised health and safety threshold, the equipment must be enclosed in an acoustically insulated cabinet. Check the manual and operating instructions of your ultrasonic equipment for the relevant information before use.

Hands should never be immersed in ultrasonic baths.

Ensure that the acoustically insulated cabinet enclosing the ultrasonic sonicator is properly closed and secured before switching the equipment on if possible link the equipment switch so that it will not operate if the enclosure is open.

Ensure all ultrasonic equipment has been PAT tested before use.

Before using the ultrasonic equipment you must undertake a risk assessment and the correct operating procedure should be read and understood.

1.3.7. Electrical equipment

Electrical equipment is ubiquitous in the laboratory and may be in form of high-voltage equipment, fixed installations, portable or fixed freestanding equipment, bench-top or hand held equipment and sources such as batteries and capacitors.

Electrical equipment may create additional hazards in the laboratory where highly flammable substance and combustible gases are used. Sparks, arcing or overheating from electrical equipment may increase risk of fire or explosion. There is an increase in the risk of electric shock from electrical equipment if it is used in a laboratory that has a wet or corrosive environment.

The failure of electrical power and equipment may affect the proper functioning of essential laboratory safety facilities such as fume cupboards and microbiological safety cabinets, which would be hazardous for the operator.

It is important that you ensure that an electrical appliance including its flexible cord, cable and plug has been tested (PAT) and that the test is in date before you use it. All electrical equipment must be PAT tested before it is packed up to send South for use on Antarctic bases and ships.

Ensure that the laboratory refrigerator/ freezer and other equipment are spark-proof before you store any flammables within them. If possible do not use electrical equipment in a damp or wet atmosphere: if it is necessary to do so ensure that the equipment is waterproof and plugged into a waterproof socket.

The use of multiple plug adapters or long, trailing cables should be avoided.

Electrical equipment that is left running unattended should be clearly marked with details of your name, a contact telephone number and emergency action if required.

The user is responsible for checking for faults before using electrical equipment. If faulty the appliance must be taken out of use. The laboratory manager should be informed that the equipment is faulty.

Before using a piece of electrical equipment ensure that you have read and understood the risk assessment and operating procedures.

1.3.8. Cryogenic substances

The term cryogenic substance is applied to substances that generally speaking have a boiling point of less than -150^{o}C at atmospheric pressure. Certain gasses such as nitrogen, argon and methane are liquefied by compression and stored as liquids at low temperatures by efficient insulation or in pressurized containers. Carbon dioxide is converted to a solid known as dry ice or 'Cardice' which, although isn't at such low temperatures (-76^{o}C), is considered a cryogenic substance for the purpose of safe handling, storage and use.

There are four main hazards associated with cryogenic substances:

a) Extreme cold that can cause severe burns.

b) Cryogenic gas that has been released into the atmosphere can displace the oxygen in the air and cause the asphyxiation of those exposed, particularly in enclosed spaces.

c) There is a considerable volume change between liquid and gaseous phases, which if occurring rapidly could be catastrophic.

d) There can be an increased risk of fire/explosion from storing and using flammable cryogenic gases.

When using cryogenic substances do not store or transport in an unvented container as a pressure build up could cause the container to explode. Only vessels that are designed for use with cryogenic substances should be used. Domestic vacuum flasks must not be used for holding cryogenic substances as a pressure build-up between the inner and outer casing can lead to an explosion.

Cryogenic substances should only be stored, handled and used in a well-ventilated area. If a cryogenic substance is being used in a laboratory/indoor area an oxygen monitor/alarm should be positioned in the vicinity of the work to detect any displacement of oxygen in the air. Care should be taken when placing samples or equipment into cryogenic liquids as boiling will occur which may cause the liquid to overflow. A safety visor and thermo protective gloves must be worn when decanting or pouring cryogenic liquids.

A risk assessment must be undertaken before using cryogenic substances.

1.3.9. Furnaces and ovens

Laboratory furnaces are distinct from other heating equipment because they are designed to operate at much higher temperatures (>1000^{o}C) and are constructed from heat-resistant materials. Laboratory ovens typically operate up to temperatures of 300^{o}C.

Hazards that may arise from the use of a furnace are:

a) Burns from hot surfaces and materials.

b) Injury from violent rupture of sample or reaction vessel.

c) Toxic effects from exposure to fumes released from the furnace.

d) Fire and explosion by the release of and ignition of flammable or explosive substances or overheating of the furnace/oven.

Ensure you have read and understood the correct operating procedures and undertaken a risk assessment before you use a laboratory furnace or oven.

Heat resistant gloves, a full face visor and laboratory coat must be worn when using the furnace and handling hot samples. Tongs must be used when manipulating or removing anything from the oven. Ensure a heat-resistant surface is available for placing hot material removed from the furnace.

If there is a possibility that a toxic fume may evolve from your samples, the furnace must be used with local exhaust ventilation in lace to prevent fumes being released into the laboratory.

1.3.10. Centrifuges

Centrifuges are common items in the laboratory, generally used to separate solids/liquids using centrifugal force. The most hazardous aspect of the centrifuge is the rotor assembly. Most centrifuges accidents occur as a result of failure to balance the load or incorrect use of the buckets. If excessively out of balance, the centrifuge will vibrate causing metal fatigue and eventually failure of the rotor, which could be catastrophic if the centrifuge, is running at high speeds.

There are mechanical hazards associated with the use of a centrifuge because of the moving parts, the high kinetic energy used, and the heaviness of the head/buckets rotating at high speed. Mechanical failure can result in the ejection of pieces of metal, or production of heat and/or sparks caused by friction of the moving parts.
Check

- Rotating assemblies of the centrifuge for damage or wear before use.
- That the buckets are paired up by weight.
- The weight of your samples to ensure they will be in balance before running the centrifuge.
- That there is no damage to your sample tubes before centrifugation.

Never attempt to open the lid of the centrifuge whilst it is running.

If sample tubes break during centrifugation, hazardous chemicals or microorganisms may be present in aerosol or vapour form on opening the equipment. Broken glass within the centrifuge may be contaminated with hazardous chemicals or biological agents.

If you have a spill or breakage within the centrifuge ensure that you clean and decontaminate it so that it is safe for the next user, and also inform the laboratory manager.

Care should be taken when using flammable substances as concentrations of vapor can accumulate rapidly within the centrifuge. There is increased risk of fire or explosion through ignition from a discharge of static electricity or spark from mechanical friction. Flammable liquids must be only be centrifuged in closed vessels (Stoppard tubes). Flammable liquids should not be centrifuged at or above or near their flash point. The centrifuge should be opened as little as possible and used in a well-ventilated area while centrifuging flammable liquids. Flammable liquids should be centrifuged only in equipment designed for that purpose.

Ensure you have undertaken a risk assessment, read and understood the correct operating procedures before you use a centrifuge.

1.3.11. Ultraviolet radiation

Ultraviolet (UV) radiation is a form of 'non-ionizing' radiation and encompasses the following wavelength regions of the electromagnetic spectrum: 400-315 nm (UV-A), 315-280nm (UV-B), 280-100nm (UV-C). The following may be sources of UV radiation in the laboratory: fluorescent lamps, fluorescence analysis equipment, lasers, xenon lamps, mercury vapour lamps, welding equipment.

UV radiation is a hazard (in particular with a wavelength of 300 – 250nm) when there is a risk of exposure to unprotected eyes or skin, the most serious effects being the formation of cataracts or skin cancer. Other hazards associated with U.V. source are explosive failure of the lamp, and the photochemical decomposition of oxygen in the air by UV-C with ozone formation.

Ensure you have undertaken a risk assessment, read and understood the correct operating procedures before you using equipment containing a U.V emitting source.

Direct observation of UV radiation source must be avoided. The UV source should be enclosed within suitable shielding or a screen off area. All UV sources should be adequately shielded. If due to unforeseen circumstances the UV source is exposed, anyone in the vicinity must wear suitable eye (visors/ lenses opaque to < 400nm) and skin protection. Access doors and entry points into those places that house UV radiation sources, should have a safety interlocking device which will cut power to the source if entry is gained. Protective gloves and eye/face protection must be worn when handling high-pressure UV lamps to prevent injury if the lamp explodes.

Signs warning of the presence of UV radiation must be fixed to lamps, equipment containing the UV emitting source and the door of the room in which the source is housed.

1.3.12. Lasers

Lasers are present in many items of laboratory and office equipment these are usually sealed and inaccessible to the user, under no circumstances should you break in to access the laser unless it is part of a documented maintenance procedure.
Laser light has the potential to cause burns and if contacting the eye may result in the loss of all or part of vision in the eye. Laser eye injuries are extremely painful and need to be treated by a hospital with specialist knowledge.
If you are designing equipment or an experiment that uses a laser that is not completely shielded a specific laser risk assessment must be completed.

1.3.13. Ionising radiation

The term 'ionising radiation' covers both radioactive substances and radiation generators such as X-ray machines. Radioactive substances can emit ionising radiation as atomic particles (Alpha or beta particles, or neutrons) and/or electromagnetic radiation (gamma rays and X-rays).
The effect of ionising radiation on the human body may be "stochastic", for example cancer or genetic changes, or "deterministic", such as radiation sickness, cataract formation.

Radiation sources can be either open or closed. Open or unsealed sources such as carbon-14 and tritium may be used in solution form for laboratory work such as radiotracer experiments. Closed or sealed sources are usually in solid form and may be used as an internal standard in laboratory equipment such as scintillation counters.

There are two types of hazard involved in working with radioactive materials: the external radiation hazard and the contamination hazard. Work with closed sources involves only a radiation hazard unless the source is damaged and has leaked. In most laboratories work deals with open sources and in principle this can involve both radiation and contamination hazard. Work involving the use of ionising radiation must only take place in designated laboratories.

If you wish to undertake work using ionising radiation, you must consult the Radiation Protection Supervisor (RPS).

A Radioactive Substances risk assessment (see 2.4.3) must be undertaken before working with ionising radiation. This must be authorized by the RPS before work can proceed.

1.3.14. Manual handling hazards

Within the laboratory environment there are potentially many manual-handling hazards, for example transport of compressed gas cylinders and moving of large pieces of scientific equipment that have been returned from labs in the Antarctic. Statistics show that manual handling is one of the most common causes of absence through injury at work. These injuries may have long-term effects.

"Manual Handling" means the transporting or supporting of a load by hand or bodily force i.e. human as opposed to mechanical, where effort is required to move or hold the load. It includes lifting, putting down, pushing, pulling, carrying, or moving a load.

Whenever possible, the risk must be avoided by eliminating the need for manual handling operations for example by using alternative means of handling such as mechanization of the task. If it is not possible to avoid a hazardous manual handling operation you must make a suitable and sufficient assessment of the risks and wear appropriate PPE including safety shoes. A generic manual handling risk assessment covering all bases can be found on the BAS operating procedures database: **http://basweb.nerc-bas.ac.uk/procedures**

1.4 WASTE DISPOSAL OF POTENTIALLY HAZARDOUS SUBSTANCES

This section deals only with disposal of potentially hazardous waste generated at Cambridge.
For information on waste disposal in the Antarctic refer to the **BAS Waste *Management Handbook.***
http://basweb.nerc-bas.ac.uk/information/manuals/docs/waste_management_handbook.pdf

As far as is possible the amount of waste that you produce from an experimental procedure should be minimised. Producing large quantities of hazardous waste is expensive and damaging to the environment.

Waste disposal is an integral part of your experiment and the waste produced must be disposed of correctly and safely. The procedures for dealing with your waste should be detailed within your COSHH or other relevant risk assessment.

1.4.1. Chemical waste

It is general policy of BAS that hazardous substances are not to be disposed of into domestic waste water system, and hazardous chemicals are therefore not to be poured down the sink (permission may be granted to dispose of dilute or non-hazardous waste to drain).

It is important that all waste chemicals are correctly labelled. Incorrectly labelled waste will require classification by a chemist.
The cost of disposal of incorrectly labelled chemicals will fall to the Division generating the waste.
Radioactive waste must be disposed of via the Radiation Protection Supervisor.

As far as is possible waste chemicals must not be mixed because of chemical incompatibilities and potential reactivity e.g. formaldehyde and hydrochloric acid must never be mixed or stored together due to the formation of bis-chlormethyl ether gas which is extremely toxic. Halogenated and non-halogenated solvent **must** be disposed of separately since they can form explosive mixtures and need to be treated separately. If it is unavoidable that two chemicals need to be mixed, the hazard data sheet that is supplied with the chemical should be consulted which will give information on chemical incompatibilities. If in doubt consult the Laboratory Manager.

Details of hazardous chemical waste disposal must be indicated in your COSHH risk assessment.

Storage of waste chemicals

- Keep reactive chemicals separate.
- Store waste in appropriate containers.
- Waste chemicals must be stored in correctly labelled containers. The label should indicate the chemical content of the waste and the correct hazard symbols should be used where possible.
- Where multiple small containers of waste would make individual labelling difficult a large correctly labelled secondary container should be used.
- Waste must be stored under the correct conditions for the chemical. For example waste flammable solvents must be stored in a flammables cabinet and away from oxidising agents. (Remember the waste solvents contribute to the maximum limit of 50L of flammable liquid that may be stored in a laboratory).

Disposal of the waste chemicals

- The waste must be labelled using a waste chemical label (available from Lab Managers or the Safety Adviser).
- The label must show
  - the chemicals in the waste.
  - approximate volume.
  - concentration of chemicals where relevant.
  - name of the scientist generating the waste.
  - the date.
- All chemical waste should be transferred to the external hazardous waste store as soon as possible to minimize the amount of chemicals kept unnecessarily within the laboratories.
- The Health and Safety Advisor should be notified via email as to the contents of the waste that is being deposited into the external hazardous waste store for inclusion onto the Waste Management Register.

1.4.2. Biological waste

Biological waste includes all human, animal and microbiological samples.
Needles, syringes, pipettes and other equipment used to collect, culture or handle samples must be disposed as special waste.

Our Biological waste is collected and incinerated by a licensed operator, part of their requirement for the collection of the waste is that it must be correctly labelled and packaged.

- As **a minimum** all biological waste must be **double** bagged in bio-waste bags. Both bags must be tightly secured with cable ties so no leakage can occur.
- Sloppy or aggressive waste must be bagged and then enclosed in a Griff bin which is then labelled.
- The weight of waste in any one bag **must not** exceed 8kg.
- The outer bag must be labelled with a "Vetspeed bar code label" (for the waste handlers use) with the following corresponding code marked onto the label along with your name, date, nature of waste:
  - 18 01 01 for Clinical waste
  - 18 02 03 for Microbiological and animal waste
- Notify Jarvis of the type of waste, volume and contents.
- The bagged waste must be placed in the yellow Biowaste bin located in the hazardous chemicals compound. If possible deposit waste by Monday morning.

Sharps (needles, syringes, pipettes, etc…) must be disposed of in a sharps bin (see sharps section)

The smelly waste or waste going to be smelly should be kept frozen and placed in the bin at the last moment. Ask Jarvis to advice if necessary.

Plant and animal tissues that have been preserved in fixatives such as formaldehyde or ethanol are to be disposed of as hazardous chemical waste (see Chemical waste section).

The Risk Assessment, DEFRA licence, Genetically Modified Organisms (GMO) legislation or Home Office licence will determine if biological waste must be inactivated by destructive autoclaving before it is disposed of.

If it is suspected that animal or plant tissue contains infectious agents, this must also undergo destructive autoclaving before it is disposed of in the biohazard bin.
For further information contact your line manager or the Biological Safety Officer in the Biological Science Division.

Waste disposal protocols for biological waste must be detailed in your biological material hazard risk assessment.
Incorrectly disposed of waste will be referred to the line manager for attention.

1.4.3. Broken glass

Broken glassware should be placed in the yellow griff bins labelled broken glass that are present in the laboratory. These bins are only to be used for the disposal of "non-contaminated" glass. When full the lids will be secured and the bins transferred to the external hazardous waste store where they will be stored until the waste management company collects. If you fill a bin with glass inform the laboratory Manager.

Contaminated glass must be decontaminated in a suitable manner before it can be disposed of.

1.4.4. Sharps

Laboratory "sharps" include hypodermic needles, scalpel blades, small pieces of broken glass and other hazardous sharp materials that may be contaminated with hazardous chemicals or biological agents. These items should be disposed of in the yellow contaminated "sharps" containers present in the laboratory. These containers should not be filled more than three quarters full. The "sharps" container should have the lid secured and be labelled with the appropriate "Vetspeed bar code label" and placed into the biohazard bin in the external hazardous waste bay when full. Inform Jarvis that you have put "sharps" container in the biowaste bin and they will arrange for the waste management company to come and collect for incineration.

1.4.5. Radioactive waste

BAS have a certificate of authorization for the disposal of certain radioactive substances. If you want to use or dispose of radioactive substances contact the Radiation Protection Supervisor before commencing work.

Details of radioactive waste disposal should be contained in your Radioactive Substances risk assessment.

APPENDIX 3.1 - CHEMICAL HAZARD SYMBOLS

Symbol	Abbreviation	Hazard	Description of hazard
		Physicochemical	
	E	explosive	Chemicals that explode.
	O	oxidising	Chemicals that react exothermically with other chemicals.
	F+	extremely flammable	Chemicals that have an extremely low flash point and boiling point, and gases that catch fire in contact with air.
	F	highly flammable	Chemicals that may catch fire in contact with air, only need brief contact with an ignition source, have a very low flash point or evolve highly flammable gases in contact with water.
		Health	
	T+	very toxic	Chemicals that at very low levels cause damage to health.
	T	toxic	Chemicals that at low levels cause damage to health.
	Carc Cat 1	category 1 carcinogens	Chemicals that may cause cancer or increase its incidence.
	Carc Cat 2	category 2 carcinogens	
	Carc Cat 3	category 3 carcinogens	
	Muta Cat 1	category 1 mutagens	Chemicals that induce heritable genetic defects or increase their incidence.
	Muta Cat 2	category 2 mutagens	
	Muta Cat 3	category 3 mutagens	
	Repr Cat 1	category 1 reproductive toxins	Chemicals that produce or increase the incidence of non-heritable effects in progeny and/or an impairment in reproductive functions or capacity.
	Repr Cat 2	category 2 reproductive toxins	
	Repr Cat 3	category 3 reproductive toxins	
	Xn	harmful	Chemicals that may cause damage to health.
	C	corrosive	Chemicals that may destroy living tissue on contact.

	Xi	irritant	Chemicals that may cause inflammation to the skin or other mucous membranes.
		Environmental	
	N	dangerous for the environment	Chemicals that may present an immediate or delayed danger to one or more components of the environment

APPENDIX 3.2 - HAZARDOUS CHEMICAL RISK PHRASES

Hazard Data Sheets available in the UK now may contain codes for certain “risk phrases”, shown as R23, R45 etc. These risk phrase codes have the following meaning:

RISK PHRASES (R)

R 1	Explosive when dry
R 2	Risk of explosion by shock, friction, fire or other sources of ignition.
R 3	Extreme risk of explosion by shock, friction, fire or other sources of ignition.
R 4	Forms very sensitive explosive metallic compounds.
R 5	Heating may cause an explosion.
R 6	Explosive with or without contact with air.
R 7	May cause fire.
R 8	Contact with combustible material may cause fire.
R 9	Explosive when mixed with combustible material.
R 10	Flammable.
R 11	Highly flammable.
R 12	Extremely flammable.
R 14	Reacts violently with water.
R 15	Contact with water liberates extremely flammable gases.
R 16	Explosive when mixed with oxidizing substances.
R 17	Spontaneously flammable in air.
R 18	In use, may form flammable/ explosive vapour-air mixture.
R 19	May form explosive peroxides.
R 20	Harmful by inhalation.
R 21	Harmful in contact with skin.
R 22	Harmful if swallowed.
R 23	Toxic by inhalation.
R 24	Toxic in contact with skin.
R 25	Toxic if swallowed.
R 26	Very toxic by inhalation.
R 27	Very toxic in contact with skin.
R 28	Very toxic if swallowed.
R 29	Contact with water liberates toxic gas.
R 30	Can become highly flammable in use.
R 31	Contact with acids liberates toxic gas.
R 32	Contact with acids liberates very toxic gas.
R 33	Danger of cumulative effects.
R 34	Causes burns.
R 35	Causes severe burns.
R 36	Irritating to eyes.
R 37	Irritating to respiratory system.
R 38	Irritating to skin.
R 39	Danger of very serious irreversible effects.
R 40	Limited evidence of a carcinogenic effect.
R 41	Risk of serious damage to eyes.
R 42	May cause sensitization by inhalation.
R 43	May cause sensitization by skin contact.
R 44	Risk of explosion if heated under confinement.
R 45	May cause cancer.

R 46	May cause heritable genetic damage.
R 48	Danger of serious damage to health by prolonged exposure.
R 49	May cause cancer by inhalation.
R 50	Very toxic to aquatic organisms.
R 51	Toxic to aquatic organisms.
R 52	Harmful to aquatic organisms.
R 53	May cause long-term adverse effects in the aquatic environment.
R 54	Toxic to flora.
R 55	Toxic to fauna.
R 56	Toxic to soil organisms.
R 57	Toxic to bees.
R 58	May cause long-term adverse effects in the environment.
R 59	Dangerous for the ozone layer.
R 60	May impair fertility.
R 61	May cause harm to the unborn child.
R 62	Possible risk of impaired fertility.
R 63	Possible risk of harm to the unborn child.
R 64	May cause harm to breastfed babies.
R 65	Harmful: May cause lung damage if swallowed.
R 66	Repeated exposure may cause skin dryness or cracking.
R 67	Vapours may cause drowsiness and dizziness.
R 68	Possible risks of irreversible effects.

COMBINATION OF RISK PHRASES (R)

R 14/15	Reacts violently with water, liberating extremely flammable gases
R 15/29	Contact with water liberates toxic, extremely flammable gas
R 20/21	Harmful by inhalation and in contact with skin
R 20/21/22	Harmful by inhalation, in contact with skin and if swallowed
R 20/22	Harmful by inhalation and if swallowed
R 21/22	Harmful in contact with skin and if swallowed
R 23/24	Toxic by inhalation and in contact with skin
R 23/24/25	Toxic by inhalation, in contact with skin and if swallowed
R 23/25	Toxic by inhalation and if swallowed
R 24/25	Toxic in contact with skin and if swallowed
R 26/27	Very toxic by inhalation and in contact with skin
R 26/27/28	Very toxic by inhalation, in contact with skin and if swallowed
R 26/28	Very toxic by inhalation and if swallowed
R 27/28	Very toxic in contact with skin and if swallowed
R 36/37	Irritating to eyes and respiratory system
R 36/37/38	Irritating to eyes, respiratory system and skin
R 36/38	Irritating to eyes and skin
R 37/38	Irritating to respiratory system and skin
R 39/23	Toxic: danger of very serious irreversible effects through inhalation
R 39/23/24	Toxic: danger of very serious irreversible effects through inhalation and in contact with skin
R 39/23/24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
R 39/23/25	Toxic: danger of very serious irreversible effects through inhalation and if swallowed
R 39/24	Toxic: danger of very serious irreversible effects in contact with skin
R 39/24/25	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed
R 39/25	Toxic: danger of very serious irreversible effects if swallowed
R 39/26	Very toxic: danger of very serious irreversible effects through inhalation

R 39/26/27	Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin
R 39/26/27/28	Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
R 39/26/28	Very toxic: danger of very serious irreversible effects through inhalation and if swallowed
R 39/27	Very toxic: danger of very serious irreversible effects in contact with skin
R 39/27/28	Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed
R 39/28	Very toxic: danger of very serious irreversible effects if swallowed
R 42/43	May cause sensitisation by inhalation and skin contact
R 48/20	Harmful: danger of serious damage to health by prolonged exposure through inhalation
R 48/20/21	Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin
R 48/20/21/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed
R 48/20/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
R 48/21	Harmful: danger of serious damage to health by prolonged exposure in contact with skin
R 48/21/22	Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
R 48/22	Harmful: danger of serious damage to health by prolonged exposure if swallowed
R 48/23	Toxic: danger of serious damage to health by prolonged exposure through inhalation
R 48/23/24	Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin
R 48/23/24/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed
R 48/23/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
R 48/24	Toxic: danger of serious damage to health by prolonged exposure in contact with skin
R 48/24/25	Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
R 48/25	Toxic: danger of serious damage to health by prolonged exposure if swallowed
R 50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment
R 51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment
R 52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment
R 68/20	Harmful: possible risk of irreversible effects through inhalation
R 68/20/21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin
R 68/20/21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed
R 68/20/22	Harmful: possible risk of irreversible effects through inhalation and if swallowed
R 68/21	Harmful: possible risk of irreversible effects in contact with skin

R 68/21/22	Harmful: possible risk of irreversible effects in contact with skin and if swallowed
R 68/22	Harmful: possible risk of irreversible effects if swallowed

APPENDIX 3.3 - HAZARDOUS CHEMICAL RISK PHRASES

Under EC legislation, Hazard Data Sheets available in the UK now contain codes for certain "safety phrases", shown as S1, S17 etc. These phrase codes have the following meaning:

SAFETY PHRASES

S1: Keep locked up
S2: Keep out of the reach of children
S3: Keep in a cool place
S4: Keep away from living quarters
S5: Keep contents under ... (appropriate liquid to be specified by the manufacturer)
S6: Keep under ... (inert gas to be specified by the manufacturer)
S7: Keep container tightly closed
S8: Keep container dry
S9: Keep container in a well-ventilated place
S12: Do not keep the container sealed
S13: Keep away from food, drink and animal feedingstuffs
S14: Keep away from ... (incompatible materials to be indicated by the manufacturer)
S15: Keep away from heat
S16: Keep away from sources of ignition - No smoking
S17: Keep away from combustible material
S18: Handle and open container with care
S20: When using do not eat or drink
S21: When using do not smoke
S22: Do not breathe dust
S23: Do not breathe gas/fumes/vapour/spray (appropriate wording to be specified by the manufacturer)
S24: Avoid contact with skin
S25: Avoid contact with eyes
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
S27: Take off immediately all contaminated clothing
S28: After contact with skin, wash immediately with plenty of ... (to be specified by the manufacturer)
S29: Do not empty into drains
S30: Never add water to this product
S33: Take precautionary measures against static discharges
S35: This material and its container must be disposed of in a safe way
S36: Wear suitable protective clothing
S37: Wear suitable gloves
S38: In case of insufficient ventilation wear suitable respiratory equipment
S39: Wear eye/face protection
S40: To clean the floor and all objects contaminated by this material use ... (to be specified by the manufacturer)
S41: In case of fire and/or explosion do not breathe fumes
S42: During fumigation/spraying wear suitable respiratory equipment (appropriate wording to be specified by the manufacturer)
S43: In case of fire use ... (indicate in the space the precise type of fire-fighting equipment. If water increases the risk add - Never use water)

S45: In case of accident or if you feel unwell seek medical advice immediately (show the label where possible)
S46: If swallowed, seek medical advice immediately and show this container or label
S47: Keep at temperature not exceeding ... ℃ (to be specified by the manufacturer)
S48: Keep wet with ... (appropriate material to be specified by the manufacturer)
S49: Keep only in the original container
S50: Do not mix with ... (to be specified by the manufacturer)
S51: Use only in well-ventilated areas
S52: Not recommended for interior use on large surface areas
S53: Avoid exposure - obtain special instructions before use
S56: Dispose of this material and its container at hazardous or special waste collection point
S57: Use appropriate containment to avoid environmental contamination
S59: Refer to manufacturer/supplier for information on recovery/recycling
S60: This material and its container must be disposed of as hazardous waste
S61: Avoid release to the environment. Refer to special instructions/safety data sheet
S62: If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label
S63: In case of accident by inhalation: remove casualty to fresh air and keep at rest
S64: If swallowed, rinse mouth with water (only if the person is conscious)

COMBINATION OF SAFETY PHRASES

S1/2: Keep locked up and out of the reach of children
S3/7: Keep container tightly closed in a cool place
S3/7/9: Keep container tightly closed in a cool, well-ventilated place
S3/9/14: Keep in a cool, well-ventilated place away from ... (incompatible materials to be indicated by the manufacturer)
S3/9/14/49: Keep only in the original container in a cool, well-ventilated place away from ... (incompatible materials to be indicated by the manufacturer)
S3/9/49: Keep only in the original container in a cool, well-ventilated place
S3/14 Keep in a cool place away from ... (incompatible materials to be indicated by the manufacturer)
S7/8: Keep container tightly closed and dry
S7/9: Keep container tightly closed and in a well-ventilated place
S7/47: Keep container tightly closed and at temperature not exceeding ... ℃ (to be specified by the manufacturer)
S20/21: When using do not eat, drink or smoke
S24/25: Avoid contact with skin and eyes
S27/28: After contact with skin, take off immediately all contaminated clothing, and wash immediately with plenty of ... (to be specified by the manufacturer)
S29/35: Do not empty into drains; dispose of this material and its container in a safe way
S29/56: Do not empty into drains, dispose of this material and its container at hazardous or special waste collection point
S36/37: Wear suitable protective clothing and gloves
S36/37/39: Wear suitable protective clothing, gloves and eye/face protection
S36/39: Wear suitable protective clothing and eye/face protection
S37/39: Wear suitable gloves and eye/face protection
S47/49: Keep only in the original container at temperature not exceeding ... ℃ (to be specified by the manufacturer)

APPENDIX 3.4 - LABORATORY CONTAINMENT LEVEL 1

Laboratory Containment Level 1 is suitable for work with agents in Group 1.
Although defined as unlikely to cause disease by infection, some agents in this group are nevertheless hazardous in other ways (i.e. are allergenic or may be toxigenic) and the due precautions must be taken. Guidance on respiratory sensitisation is available. Laboratory personnel must be received suitable and sufficient information, instruction and training in the procedures to be conducted in the laboratory.

1. The laboratory should be easy to clean. Bench surfaces should be impervious to water and resistant to acids, alkalis, solvents and disinfectants.

2. Effective disinfectants should be available for immediate use in the event of spillage.

3. If the laboratory is mechanically ventilated, it is preferable to maintain an inward airflow while work is in progress by extracting room air to atmosphere.

4. All procedures should e performed so as to minimise the production of aerosols.

5. The laboratory door should be closed when work is in progress.

6. Laboratory coats or gowns should be worn in the laboratory and removed when leaving the laboratory suite.

7. Personal protective equipment, including protective clothing must be:
   (a) stored in a well-defined place;
   (b) checked and cleaned at suitable intervals;
   (c) when discovered to be defective, repaired or replaced before further use.

8. Personal protective equipment which may be contaminated by biological agents must be:
   (a) removed on leaving the working area;
   (b) keep apart from uncontaminated clothing;
   (c) decontaminated and cleaned or, if necessary, destroyed.

9. Eating, chewing, drinking, taking medication, smoking, storing food and applying cosmetics should be forbidden.

10. Mouth pipetting should be forbidden.

11. The laboratory should contain a basin or sink that can be used for hand washing.

12. Hands should be decontaminated immediately when contamination is suspected and before leaving the laboratory.

13. Bench tops should be cleaned after use.

14. Use glassware and other materials awaiting disinfection should be stored in a safe manner. Pipettes, for examples, if placed in disinfectant, should be totally immersed.

15. Contaminated materials, whether for recycling or disposal, should be stored and transported in robust and leakproof containers without spillage.

16. All waste material, if not to be incinerated, should be disposed of safely by other appropriate means.

17. Accidents and incidents should be immediately reported to and recorded by the person responsible for the work or other delegated person.

APPENDIX 3.5 - LABORATORY CONTAINMENT LEVEL 2

Laboratory Containment Level 2 must be used for work with biological agents in Hazard Group 2.
Laboratory personnel must receive suitable and sufficient information, instruction and training before working with agents in Group 2.
A high standard of supervision of the work must be maintained.

1. Access to the laboratory is to be restricted to authorised persons.

2. There must be specified disinfection procedures.

3. If the laboratory is mechanically ventilated, it must be maintained at an air pressure negative to atmosphere while work is in progress (see paragraph 17 below).

4. Bench surfaces must be impervious to water, easy to clean and resistant to acids, alkalis, solvents and disinfectants.

5. There must be safe storage of biological agents.

6. Laboratory procedures that give rise t infectious aerosols must be conducted in a microbiological safety cabinet, isolator or be otherwise suitably contained.

7. There must be access to an incinerator for the disposal of infected animal carcasses (see paragraph 24).

8. Personal protective equipment, including protective clothing, must be:
   (a) stored in a well-defined place;
   (b) checked and cleaned at suitable intervals;
   (c) when discovered to be defective, repaired or replaced before further use.

9. Personal protective equipment which may be contaminated by biological agents must be:
   (a) removed on leaving the working area;
   (b) keep apart from uncontaminated clothing;
   (c) decontaminated and cleaned or, if necessary, destroyed.

10. There should be adequate space (24m) in the laboratory for each worker.

11. The laboratory door should be closed when work is in progress.

12. Laboratory coats or gowns, which should be side or back fastening, should be worn and removed when leaving the laboratory suites. Separate storage (for example, pegs) apart from that provided for personal clothing should be provided in the laboratory suite.

13. Eating, chewing gum, drinking, smoking, taking medication, storing food and application of cosmetics in the laboratory is forbidden.

14. Mouth pipetting is be forbidden.

15. Bench surfaces should be regularly decontaminated according to the pattern of the work.

16. When undertaking procedures that are likely to give rise to infectious aerosols, a Class 1 microbiological safety cabinet (BS 5726): 1992 or unit with equivalent protection factor or performance) should be used (see Appendix 8). Safety cabinets should exhaust to the outside air or to the laboratory air extract system (see paragraph 20 at Containment Level 3 except that double HEPA filtration is not essential at Containment Level 2 and there is no need to consult with HSE before adopting the recirculation mode for air discharged from a safety cabinet). Some other types of equipment may provide adequate containment in their own right but this should be verified.

17. In most laboratories operating at Containment Level 2 where there is mechanical ventilation simply to provide a comfortable working environment, it may not be practical to maintain an effective inward flow of air. The often constant traffic in and out of Containment Level 2 rooms may interfere significantly with attempts to establish satisfactory airflow patterns. However, where a laboratory is ventilated specifically to contain airborne pathogens in the event of an accident, then engineering controls and working arrangements must be devised so as to counter the risk of airborne transmission to other areas. Maintaining an inward flow of air is necessary only when work is in progress. 'Atmosphere' in this context (see paragraph 3) may be taken to mean either to external air and/or other parts of the laboratory suite or building.

18. The laboratory should contain a wash basin located near the laboratory exit. Taps should be of a type that can be operated without being touched by hand.

19. Hands should be decontaminated immediately when contamination is suspected, after handling infective materials and before leaving the laboratory. When gloves are worn, these should be washed or preferably changed before handling items likely to be touched by others not wearing gloves, for example telephones, paperwork. Computer keyboards and, where practicable, equipment controls should be protected by a removable flexible cover that fan be disinfected.

20. An autoclave for the sterilisation of waste materials should be readily accessible in the same building as the laboratory, preferably in the laboratory suite.

21. Materials for autoclaving should be transported to the autoclave in robust containers without spillage.
22. There should be a means for the safe collection, storage and disposal of contaminated waste .

23. Contaminated waste should be suitably labelled before removal for incineration .

24. 'Access to an incinerator' – see paragraph 7 above, may be taken to mean an incinerator at another site but whether local or distant, carcasses for incineration must be transported in secure containers.

25. Used laboratory glassware and other materials awaiting sterilisation before recycling should be stored in a safe manner. Pipettes, if placed in disinfectant, should be totally immersed.

26. All accidents and incidents should be immediately reported to and recorded by the person responsible for the work or other delegated person.

APPENDIX 3.6 - SAFE USE OF LIQUID NITROGEN

CODE OF PRACTICE FOR THE SAFE USE OF LIQUID NITROGEN

A risk assessment must be completed before starting work with liquid nitrogen.

The hazards from the use of low temperature liquefied nitrogen are:-

(a) Asphyxiation hazard through the displacement of oxygen in the atmosphere (1L of liquid nitrogen evaporates to form 682L of nitrogen gas).

(b) Prolonged exposure to cold nitrogen vapour can cause frostbite.

(c) Contact with cold surfaces will cause injury.

NOTE: Liquid nitrogen is odourless, colourless and boils at – 195.8ºC. One volume of liquid nitrogen gives 682 volumes of gas. (The safety data sheet must be read before starting work).

A copy of the BOC booklet 'Care with Cryogenics' is in the laboratory and must be read before starting work. The following must also be observed.

1 A safety visor or safety spectacles must be used, visor when decanting/pouring filling dewars.

2. Protective clothing should be worn e.g. a laboratory coat. Gloves should also be worn if handling large volumes of liquid or storage dewars.

3. Decanting liquid nitrogen should preferably be done outdoors but if done indoors must be done in a well ventilated area.

4. Work should be carried out in a ventilated area.

5. All bench areas should be kept clear.

6. Only appropriate containers (not glass) should be used. Use Dewar flasks designed for liquid nitrogen. DO NOT USE DOMESTIC VACUUM FLASKS.

7. As small a volume of liquid nitrogen as possible should be used.

8. Tools should be handled carefully as they may be very cold. If practicable gloves should be worn.

9. Care should be taken when placing specimens or equipment in liquid nitrogen with boiling of liquid and possible overflow likely to occur.

10 Do not store or transport liquid nitrogen in sealed unventilated vessels.

If in doubt of any aspect of the operation please contact the Safety Adviser.

Further information on the safe use of cryogenic liquids please contact the Health and Safety Adviser, ext 1454.

Remember, IF IN DOUBT ASK!

APPENDIX 3.7 - THE SAFE HANDLING OF DRY ICE – SOLID CARBON DIOXIDE

Dry Ice or solid carbon dioxide sublimes at –78.5 deg.C directly back to carbon dioxide gas. It should not be used or stored in confirmed spaces and small unventilated rooms. It must only be used on a temporary basis in walk in freezers and cold rooms. Under these circumstances, its presence must be clearly indicated on the outer, cold-lock door and the handling precautions listed. A second person should always be in attendance when filling or emptying the walk-in freezer and cold room when the dry ice is present.

Airtight containers should be used for the storage of Dry Ice (because it slowly sublimes even where heavy insulation is provided). The carbon dioxide gas will generate a pressure unless released.

When using Dry Ice the following procedures should be followed:-

1 Carbon dioxide gas is an asphyxiant. Relatively low levels of increased concentration eg. 5% can lead to loss of consciousness within a few minutes. If increased level of carbon dioxide are suspected, DO NOT ENTER the area. Seek assistance and thoroughly ventilate the area. Note that all forms of absorptive respirators (e.g. face masks) are totally unsuitable for an atmosphere containing increased levels of carbon dioxide and MUST NEVER be used for this purpose.

2. It should only be used with proper low level ventilation, because carbon dioxide is heavier than air. It should not be used in cellars, small unventilated rooms, etc.

3. When being transported in a vehicle, it should be stored in complete isolation from the driver. Storage in the boot or the rear of an estate care is not sufficient. It should not be carried in a vehicle without adequate ventilation and isolation.

4. When handling Dry Ice, protective gloves or mittens must be worn. It must not be handled with bare hands, it can cause frostbite.

IF IN DOUBT, SEEK ADVICE

APPENDIX 3.8
CODE OF PRACTICE FOR SAFETY IN LABORATORIES
SHIPS

1.1 INTRODUCTION

The ship is a confined environment which presents special hazards for laboratory work.

1.1.1. Your Role In Health And Safety

The appropriate laboratory regulations and guidelines must be followed at all times, and you must inform the Principal Scientist and the Ship's Safety Officer of any accident, unsafe incident, "near-miss" or environmental incident (AINME) that occurs in the laboratory.

1.1.2. The Employer's Responsibilities and Safety Organisation at BAS

Laboratory safety is covered by the ship's overall safety policy. This is set out in more detail on the intranet **http://basweb/ships/sms/**, and is also available in full in the safety documentation displayed in various public areas around the ship. This safety policy applies to you whether you are a BAS employee or not.

The ship's Master has overall responsibility for safety on board. He is supported from the UK by a Safety Adviser (Marine Operations) who is ultimately responsible to the Director of BAS. On ship, the Safety Officer (usually the Chief Engineer) is responsible for day-to-day safety matters, including arranging meetings of the ship's Safety Committee.

Obviously, some aspects of laboratory safety fall outside the areas of competence of ship's staff. For this reason, the Principal Scientist is responsible for health and safety aspects of all scientific work and personnel, within the overall framework of shipboard safety management.

If an unsafe incident occurs, you should in the first instance consult the Principal Scientist and the Ship's Safety Officer. If you are not satisfied with the action taken, you can proceed further through the Ship's Safety Committee. If necessary the Health and Safety Adviser at BAS Cambridge or your UK line management may also be consulted.

BAS operates a "no-blame" AINME (Accident, Incident, Near-Miss and Environmental) reporting system. This is designed to ensure that lessons are learnt from hazardous occurrences. All staff working on ship should use this scheme to report such events.

1.1.3. Health and Safety Legislation

All aspects of safety on board BAS ships come under UK (Falkland Island)

Most of the legislation governing laboratory work in the United Kingdom has no formal application outside the UK. However, BAS management accepts the principle that UK legislation should be followed as closely as is practicable, taking into account the overall working environment on ship or station.

1.2 SAFE WORKING IN LABORATORIES

The Principal Scientist has overall responsibility to ensure that laboratory work is undertaken safely on ship. Laboratory users must provide the Principal Scientist with the information necessary for him/her to allocate laboratory space and to ensure that all necessary safety precautions and equipment are in place for a cruise. The Principal Scientist also has to present all risk assessments for the cruise at the pre-cruise planning process.

1.2.1. Safe Laboratory Conduct

In addition to these common-sense rules which apply to all laboratory work, special conditions apply on ship. Conditions on board during a research cruise are not comparable to conventional land-based laboratories, such as those at the BAS headquarters in Cambridge. Even where the identical process is undertaken in both locations, the working environment is significantly different, the type and level of hazard is unlikely to be the same in both places, and the ways of dealing with the same hazard may differ. In particular:

The ship is not a completely stable platform

Laboratory space is restricted and must fulfil several functions
Several procedures which would normally be carried out in separate spaces may be placed in the same area. More importantly, it is often the case that people who would not normally encounter laboratory work come and go through the working area.

Some working practice which is normal during research cruises would not be tolerated at home
Research cruises typically involve working round the clock, seven days a week. Individuals may be working long hours, and may also be working alone or unsupervised. The work areas are also close to living and recreational accommodation.

In event of emergency, there is significantly less back-up than would be available at home
The ship is a closed environment, which cannot call immediately on emergency services to cope with situations outside its control. Harmful incidents which would be inconvenient or perhaps even just embarrassing in your home laboratory have potential for greater damage, even risk to life, at sea.

Thus, additional points need to be borne in mind when carrying out laboratory work on ship. These include:

- Ensure that all hazardous substances and apparatus are stored in a manner which will withstand ship's motion under all conditions. This includes all chemical stocks and any hazardous wastes

- Only store "ready-use" quantities of hazardous chemicals in laboratories - the remainder should be kept in the original packing in the hold or in the chemical lockers

- Ensure that there are adequate means for safe transport of chemicals around the vessel, especially carrying large volumes of liquid in glass containers between storage facilities and the laboratory. Take special care when passing through self-closing fire-retardant doors, over deep coamings and up and down stairways

- When installing apparatus or instrumentation which contains harmful liquids, take adequate precautions to contain any spillage, using trays and absorbent material as necessary

- Be aware of the effects of fatigue and sea-sickness, and sea-sickness medication if taken, on alertness and concentration

- Avoid carrying contamination from work areas to adjacent living areas, by being scrupulous about removing protective clothing when leaving the laboratory

- Ensure that normal ship's safety precautions are followed. Fire exits must not be obstructed and fire-retardant doors must not be fixed open

- Those persons inexperienced in laboratory work at sea should consult experienced colleagues if conditions become sufficiently rough to consider cessation of work. The ship may prohibit work on deck in bad weather - this should also be the cue to evaluate laboratory work.

- If leaving a laboratory area in bad weather, pay particular attention to the security of apparatus and chemicals. Switch off apparatus which might present a hazard to those remaining in the laboratory, or entering it subsequently, in rough weather.

1.2.2. Working alone and at unusual hours in the laboratory

Working alone is normally discouraged in UK laboratories. Lone working exposes an individual to additional risk, because of lack of supervision and the difficulty of obtaining help in the event of an accident. An assessment of the risks involved and control measures to be used MUST be made before working alone in the laboratory.

However, during research it is common that work is undertaken at odd times of the day and night, and that individuals may be undertaking operations involving potential hazards in spaces where they are remote from others. These users should inform the Principal Scientist, who will arrange suitable monitoring either by a designated Watch Leader or by a member of the ship's staff.

Particular attention should be paid to use of, or undertaking the following activities, which are considered incompatible with lone working:

- hazardous chemicals i.e. concentrated acids, cyanides
- radioactive isotopes and lasers
- cryogenic liquids and dry ice
- oxidising agents or other chemicals involving explosion risks
- pressure vessels and associated equipment
- manual handling of heavy or awkward loads

1.2.3. Personal Protective Equipment (PPE) and Safety Equipment

Work with hazardous materials in other areas of the ship, such as out on deck, may dictate the use of other PPE, such as boiler-suits. Wearing of safety footwear is mandatory on deck. Hard hats must also be worn on deck in areas with heavy equipment or overhead loads.

Eye-wash bottles are provided in all laboratories, and there is a First Aid kit in the Main Lab and in the Scientific workshop. There is an emergency shower and eye wash station in the alleyway

between the Prep Lab and the Chemistry Lab, on the forward starboard side of the laboratory suite. Chemical spillage kits, and appropriate fire extinguishers and fire blankets are provided in the laboratory spaces.

1.2.4. Risk assessments

A generic risk assessment is required before each marine science cruise (link). It is completed by individual risk assessment in order to cover any additional specific activities.

1.3 POTENTIAL HAZARDS IN LABORATORIES

Those potential hazard listed are specific to the Ships.

1.3.1. Compressed Gases

Ship staff are responsible for ensuring the safe stowage of cylinders. Installation of cylinders is undertaken when the ship is alongside, and cylinders are not normally moved whilst the ship is at sea.

1.3.2. Pressure and vacuum systems

There is no fixed autoclave system on the ship.

1.3.3. Electrical equipment

Some laboratory spaces, such as the Wet Laboratory and Water-bottle Annex, are supplied with splash-proof or fully waterproof electrical outlets.

The ship's Electrical Officer cannot undertake extensive PAT testing for research cruises, and equipment which is not covered by an in-date test is prohibited.

1.3.4. Centrifuges

Normally, only smaller, bench-mounted centrifuges would be used on ship. Special arrangements would need to be made for the installation and operation of larger units. Special attention should be paid to sea-state when operating even small centrifuges at sea.

1.3.5. Ionising Radiation

Notification of procedures involving ionising radiation forms part of the pre-cruise planning. Workers should provide full documentation, including a risk assessment and estimation of the volume and type of waste, to the Principal Scientist. The BAS Radiation Protection Supervisor (RPS) must be consulted when planning such work, and his/her authorisation must be obtained before such work can proceed.

1.3.6. Manual Handling Hazards

These operations are made additionally hazardous on ship when at sea, when the ship's motion provides additional momentum to heavy loads.

1.4 WASTE DISPOSAL OF POTENTIALLY HAZARDOUS SUBSTANCES

The disposal of waste from shipboard laboratories is covered by the BAS Waste Management Handbook (**http://basweb.nerc-bas.ac.uk/information/manuals/docs/waste_management_handbook.pdf**) several copies of which are available in public areas on ship. The ship operates a comprehensive waste disposal policy, which means that waste is segregated and some items which would normally be included with general garbage in your home laboratory are given separate treatment. Examples are spent aerosols and batteries, and dead fluorescent strip lights. The protocol for disposal of waste on ship is detailed in notices placed around the ship, including in the laboratories, and in the safety data folder in each cabin.

Some items for waste disposal, such as waste liquid drums, are provided by BAS for general use on ship. BAS will also undertake to arrange for the disposal of such waste, provided that it conforms with the instructions and limits set out in the BAS Waste Management Handbook. Pre-cruise planning should include a realistic estimate of the volume of different types of waste which will be generated in the course of a cruise, so that adequate supplies of containers, labels etc. can be placed on the vessel before leaving UK. More specialist waste disposal items, such as sharps bins, must be provided by the users, and they are also responsible for eventual disposal.

With very few exceptions, no material should ever be disposed of overboard. This includes flushing liquids down laboratory sinks, which all discharge directly into the sea.