NAYANG TECHNOLOGICAL UNIVERSITY

SCHOOL OF BIOLOGICAL SCIENCES

Laboratory Safety & Operations Manual

Version (7)
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Message From The Chair

The laboratories of the School of Biological Sciences Building (North & South Wing) are endorsed by the Ministry of Health in June 2004 as Bio-safety Level 2 (BSL2). This means that the school has the approval to carry out biological works on all risk-group 2 (RG2) biological agents and some risk-group 3 (RG 3) biological agents. With this approval, it also means that we will be using chemicals that are hazardous and some may emit radiation. Thus it is our aim in the School of Biological Sciences to provide a safe and healthy work condition for all staff and students.

Complete safety requires all staff and students to observe correct procedures and practices, and to accept their part of the responsibility to protect themselves, their fellow workers and University property.

All staff and students must observe the procedures and rules outlined in this Safety & Operations Manual.

If any person has any doubts or concerns about the information in this Handbook, they should seek advice from either their supervisors or the School Safety Officer.

The School of Biological Sciences Safety Policy is:

- to provide safe working conditions and a healthy working environment
- to provide materials and equipment needed to work safely
- to provide training in safety issues and emergency equipment
- to encourage a culture of safe working practices
- to make everyone aware that safety requires all staff and students to observe the safety rules and procedures as outlined in the School Safety Guidelines.

This policy is mandatory for all Management, Staff and Students of the School of Biological Sciences. This policy pertains to non-laboratory areas, research and teaching laboratories, animal holding facility and BSL-3 facility. Any staff or students found unreasonably violating safety rules may face expulsion from the School Management.

In addition to this manual, the school may from time to time inform staff, via email, on extra safety rules and regulations implemented by the government. This is to ensure that staff of SBS gets the latest information and best practices for creating safety workplace.

I wish every staff a safe and pleasant work experience in SBS.

1.0 Introduction

1.1 Laboratory Safety and Operations Manual

The school of biological sciences commits to take all reasonably practicable means to provide a safe and healthy environment to all staff, partners, students and visitors.

Laboratory Safety and Operations Manual is developed by the School Safety Committee (SSC) to give full and precise details of operational and safety procedures for compliance. No personnel shall work at any workplace in the school premise without having read this manual.

1.2 School Safety Committee

The School Safety Committee (SSC) is comprised of members so selected that they collectively have experience and expertise in: chemical, radiation and biological agents and technology; the capability to assess the safety of the research experiments; and, the capability to assess any potential risk to public health or the environment. The SSC conducts facility inspections in order to assist the school management in maintaining and using safe conditions and procedures in their laboratories, offices and other workstations.

The SSC consists of several members with expertise for specific aspects of safety. The roles of the committee members are not mutually exclusive, e.g. in the event of an accident any available committee member may be approached to attend and provide assistance, therefore it is essential that all members are familiar with possible risks and safety measures related to especially laboratory environment. Following are the names and contact numbers of the School Safety Committee:

Name	**Position**	**Contact**
Liu Chuan Fa	SSC Chairman	6316 2862
Peter Droge	Member	6316 2809
Tobias Carl Cornvik	Member	6586 9714
Ang Wei Kian Andy	Member	6513 7652
Tay Mei Xia	Member	6592 1795
Tin Tun	OHS Representative	6316 2810

The roles and actions of the School Safety Committee are endorsed by the Chair of the School of Biological Sciences.

The SSC is scheduled to **meet quarterly or when necessary**. The SCC will meet on a regular basis. At such meetings:

1. The Chair, or a nominated deputy, will chair the meeting
2. The committee will formulate policies, programmes and codes of practice as necessary for safety issues.
3. The committee will develop and monitor a system designed to ensure adherence to safety rules and regulations including training of staff.
4. Safety Officer implements safety programmes and procedures formulated by the committee.
5. Safety Officer reports the committee any laboratory or individual that is violating safety rules and regulations.
6. Committee will discuss appropriate actions. Repeated offender may receive warnings and then be banned from workplace.
7. Committee has authority to shut down entire laboratory until evidence of adherence to safety rules and regulations is provided.

1.3 Workplace Emergency

For workplace emergency within the school premise, we have Emergency Response Team (ERT) and Emergency Coordination Team (ECT) to assist staff or students. Team members are trained in Occupational First Aider, First Aider, Fire Responder, Chemical Safety and Biological Safety. First Aid box is available in the laboratory or department. Before seeking their assistance, injured staff or students should look at the seriousness of the injuries and perform self–treatment if possible.

On 24/7 basis, help can be obtained from the University Fault Reporting Centre (x4777) or Campus Security (x5200). Try to dial 999 or 995 only when the situation is beyond self- control.

Emergency Services	Phone Number	Purpose of Contact
Fire Brigade	995	When a fire unable to extinguish using school safety facility
Ambulance	995	When someone is seriously injured and need immediate medical aid (for life threatening cases)
Police	999	To handle suspicious or threatening person or article
Campus Security	67905200	When suspicious person or article is observed or when there is an alarm raised
Fault Reporting Centre	67904777	For assistance in remedy building faults related to electrical and architectural issues
NTU Medical Centre	67936828	When in need to seek immediate medical aid (like big cut, sprained ankle, etc.)

1.4 Reporting of Accidents & Incidents

The School is required to keep a register of all accidents, however slight, that result or had the potential to result in an injury or an unsafe situation. The School is to ensure the implementation of the incident reporting and investigation procedures according to the Standard Operating Procedure (SOP) issued by the Office of Health and Safety (OHS).

It is the responsibility of all staff and students to report any accidents, near miss, unsafe condition, unsafe act, dangerous occurrence or occupational disease using the online Incident & Investigation Reporting Form (IIRF).

http://intranet.ntu.edu.sg/ohs/IIRF%20Online%20Form/Forms/AllItems.aspx

Incident Reporting Procedures:

- Staff/Student involved in the Incident reports **on-line (OHS Website)** - within 24 hours (Copy of report will be send to Chair/HoD)
- OHS / system receives report and informs Safety Officer/Representative

- Safety Officer / Representative / Reporting Officer / PI investigate. OHS will assist if necessary
- Reporting Officer /PI, Safety Officer / Representative submit investigation report, review risk assessment, and develop new safe work procedure.

If the accident occurs after office hours and weekends, staff should exercise common sense and discretion on the seriousness of the injury. Proceed to seek professional medical aid if necessary, followed by informing any staff and the School Safety Committee.

1.5 Laboratory Visit Policy

During office hours, all visitors/vendors to SBS research laboratories must first report to office staff at the General Office counter and record their visit in the Visitor Record. The office staff will then contact the host who must meet the visitor before proceeding to the laboratory. After office hours, visitors/vendors must arrange with host to meet at the office counter, record visit in the Visitor Record before proceeding to the laboratory. Family members/friends (especially pregnant women and young children, toddlers and infants) of the staff are encouraged to stay at the school lobby or lift lobbies. Pets are not allowed in the laboratories.

Visitors/Vendors Must:

1. Wear an “SBS visitor” badge at all times. For vendors conducting routine maintenance works, they must use the maintenance badge. These will be provided and collected by office staff.

2. Be accompanied by a staff member at all times. Staff member must inform visitors/vendors of the laboratory safety and fire escape routes.

3. Be provided with suitable personal protective equipment, if necessary, upon entering the laboratory, e.g. lab coat, gloves, safety glasses.

4. Comply with all laboratory rules and regulations including relevant codes of practice.

5. Sign the Visitor Record, located at Reception or General Store, upon entry and exit.

1.6 Evacuation Procedures

The SBS fire evacuation plan, a regulation enforced by the Fire Safety Act, is to assist the staff members or related members of the School of Biological Sciences (SBS) to response to evacuation in a systematic and orderly manner in times of fire occurring in the building.

SBS Building has installed with Simplex **4100EN single stage supervised fire alarm system**. The fire alarm system has the following features incorporated with the system:

- Fire automatic detection
- Fire zone indication
- Manual activation
- Sprinkler flow detector
- Pressurization fan engineering system

The main fire alarm panel is located within the SBS building fire command centre of North wing at the basement 4. The fire alarm system is also linked to the Fault Reporting Centre that located at North Academic Complex basement 1 and manned 24 hrs by FRC.

At each level, there is a floor fire alarm panel, emergency phone and break-glass fire alarm system located opposite the fireman's lift. The escape route sign boards are also shown at the passenger lift area. Fire extinguishers, sprinklers, smoke detectors, hose reel, gas leakage detector and break-glass fire alarm are found along the corridors and labs of each level. The fire extinguishers used for the SBS are as follows:

1. ABC dry powder – to fight fire Class A, B and C. Location install for all lab and common corridors
2. CO2 – to fight fire Class B and C. Location install for computer lab and electrical switch rooms.

When a fire was noticed, the OFPM, the ERT and the ECT should be rapidly notified. The school stores an extensive amount of flammable chemicals/items. These chemicals/items may result in an explosion causing death and building damages, if necessary actions are not immediately acted.

In such a critical event, the first priority is to evacuate every person in the building to a safe place. **Thus it is the responsibility of every staff member within SBS to cooperate and act on the instructions, given in the following plans.**

When You Notice A Fire, Do Not Panic

1. Shout "Fire" Loudly and call for help or notify personnel in the immediate vicinity.
2. Put out the fire by using appropriate equipment (e.g fire extinguisher, damp cloth, etc) with another person. Do it without any risk.
3. If someone is injured, make first priority to attend to the injured person.
4. Raise the alarm by breaking the glass panel if you fail to put off the fire.

When The Alarm Activates (All access card doors are deactivated)

GET READY to evacuate from your work stations. **Locked all chemical /biological agents' cabinets if possible (including freezers and fridges). For ARF Staff and Staff working in BSL3 lab, put the animals back to the cage. Remove all your Personal Protection Equipment.**

TURN OFF any power supply. Ensure all windows closed. Wait for instructions (During after office hours, there is no need to wait for instructions, leave building immediately)

LEAVE the building immediately when the staff of OFPM requested you to do so through the PA system. Close all doors when the last person makes an exit from a room or corridors.

DO NOT use lifts. Exit to the safest stairways that bring you to the meeting point on ground floor.

ASSEMBLE at the QUAD (Open space by the Auditorium)

REPORT to laboratory / department representative / ERT / ECT who will submit the list to the School Safety Officer.

DO NOT re-enter the building until further notice.

Fire escape routes are as below.

Floor / Place	Fire Escape Route
Level 1 (GO, TCM & Main lobby)	Exit by lobby glass doors to assembly point at the QUAD
Classroom 2 to Classroom 7 (01N)	Exit to the bridge and turn right
Basement 1 (B1)	Exit by car park and meet at assembly point
Level 2 (02N & 02S)	Exit by open stairways to the assembly point
Basement 2 (B2N), Level 3 to Level 5 (N & S)	Exit by stairways near cargo lift and go to assembly point
Animal House / BSL-3	Exit to Nanyang Drive and join the staff at the QUAD

If fire escape routes are on fire, the ERT / ECT / Fire Wardens will lead to assembly point via another exit.

1.7 Threatening or Suspicious Persons/Items

Threatening or Suspicious Persons

If possible, remove yourself immediately from the vicinity. Move calmly. Do not challenge the person, and avoid direct eye contact. Once clear, notify the first person you see who is known to you. As soon as possible, report the incident to the School Safety Committee.

If you cannot remove yourself from the vicinity without closing with the person, lock yourself in the nearest secure room with a telephone and call the police and NTU security: POLICE: 999 SECURITY: ext. 5200 (24 HOURS)

If the situation is not immediately threatening, ring Security on ext. 5200 (24 HOURS), give details and ask for immediate assistance.

In an extreme emergency, out of hours, where you are in physical danger and you cannot ring the police, activate the fire alarm. This will bring professional help within 5 minutes.

Threatening or Suspicious Items

During office hours, contact anybody you know, if possible notify the School Safety Committee first. After officer hours, contact anybody you know, and then immediately contact campus security.

1.8 After Office Hours Policy

Staff and students under attachment present in the building after office hours (Monday to Friday, 9 pm onwards), on Saturdays, Sundays and public holidays must record their presence in the After Hours Record, located at General Office Counter.

If work is being conducted after hours, let other laboratory/workplace personnel know of your presence.

Carrying out experimental laboratory work alone after hours is strongly discouraged.

If experiments are to be continued unattended overnight, place paste a note next to experimental apparatus indicating the chemicals involved, your name and a number where you can be reached in case of an emergency.

Small children and pets are not permitted in laboratories at any time.

Final Year Project Students and attachment Students should avoid working alone after office hours.

1.9 Staff Safety Training

Trainings on laboratory equipment will be conducted for staff working in the laboratories. In addition to these trainings, trainings that are mandatory by the local regulations are also organized by the OHS. The trainings for staff are listed below:
Safety Laboratory Practices (Safety Culture)
Safe Handling of Chemicals
Biological Hazards & Containment
Danger of Exposing to Radiation
Waste Management
Risk Assessment
First Aid and Occupational First Aid
Safe handling of Core Equipment
Laboratory Safety Devices & Personal Protection Equipment
Handling Compressed Gas & Liquid Nitrogen
Development of Chemical/Biological/Radio-isotope Inventory List
Response to Evacuation & Crisis Management
Spill Management

The safety topics shown above are not the exhaustive list. When necessary, the School will add in new courses for the well being and benefits of the staff.

1.10 New Staff Safety Briefing

It is compulsory for new staff or student to attend a safety briefing conducted by the School Safety Officer. Briefing session is regularly arranged and new staff or student will be informed accordingly.

New staff is also required to attend the Safety Induction Course that is common safety training for all NTU schools and organized by the OHS. The OHS contacts new staff members direct for training schedule.

The following Safety Videos are also available on the school website. Go to **"Resource"** and then click on **"Safety"** to link these on-line videos.

- Practicing Safe Science (General Laboratory Safety In A Molecular Biology Laboratory)
- Radionuclide Hazards
- Chemical Hazards
- Centrifugation Hazards
- Glassware Washing Hazards
- Mammalian Cell Culture Hazards (Working with Cell-Lines)
- X-Ray Diffraction Hazards
- Assessing Risk of Toxic Chemicals
- Emergency Response (Fire, Chemical Spill, Biological Spill, Radioactive Chemical Spill)
- Controlling Your Risks: HIV In The Research Laboratory

1.11 Undergraduate Student Attachment & FYP Student Policy

The policy for new staff safety briefing applies to the undergraduates under attachment and conducting final year project in the laboratories.

Undergraduate students are not allowed to carry out any experimental work or operate any laboratory equipment without supervision. Training on the use of equipment must be carried out by the staff in the laboratories that they are attached to. They are also discouraged to work alone in the laboratories at any time.

All Principal Investigators must assign “BUDDY” to these students. Depending on the number of staffs to undergraduate students, three undergraduates can be under the care of a staff or a graduate student. If there is not enough staff to take care of the undergraduates, the Principal Investigators may become the “BUDDY” of these students. It is the responsibility of the Principal Investigator to ensure that these students work safely in the laboratories.

1.12 School Safety Resources

The following safety manuals are available at the school website.

- Emergency Management Plan (EMP)
- Biosafety and Operations Manual (BSL-3 facility)
- Emergency Response Plan (ERP) for BSL-3 & Animal Research Facility
- Undergraduate Practical Safety Manual for Teaching Laboratory

NTU Office of Health and Safety (OHS) for university WSH policy, Directives, SOPs and Guidelines. Available at www.ntu.edu.sg/ohs.

Apart from the on-line safety videos, the school website contains other safety information from various institutions and websites:

National Institute For Occupational Safety And Health (NIOSH) Pocket Guide To Chemical Safety Hazards International Chemical Safety Cards Biosafety In Biomedical And Microbiological Laboratories

Toxicology Data Network (TOXNET) ChemIDplus Hazardous Substance Data Bank Oxford University Chemical & Other Safety Information From The Physical And Theoretical Chemistry

Office Of Environmental Health And Safety, University Of Virginia (USA) Laboratory Survival Manual

Materials Safety Data Sheets (MSDS)
J.T. Baker Merck Safety Data Sheets Safety Links: Material Safety Data Sheets

2.0 General Laboratory Safety

2.1 General Laboratory Rules

All laboratories globally function with a set of basic rules and specific regulations for experimental works. These rules and regulations are followed so that basic operations can be carried out accordingly and avoid unnecessary accidents. The list below describes the 10 basic rules that should be followed in the laboratories of the School of Biological Sciences. These 10 basic rules are not the final and only rules. Every page in the School Safety Guidelines describes safety rules to help us operate safely in this school.

Rule 1	No eating, drinking, smoking and running are allowed in the laboratory.
Rule 2	Working alone with hazardous chemicals (particularly after office hours) is discouraged
Rule 3	Disposed wastes according to specific instructions given and are to be disposed accordingly to the designated bins/areas. No disposal of chemicals into the laboratory sink. Rinsing is allowed.
Rule 4	All chemicals/biological agents must be properly labeled and stored.
Rule 5	The door between the laboratory and the ancillary office should be closed at all times.
Rule 6	Clear stagnant water in lab shower monthly and eyewash weekly.
Rule 7	Put on personal protection equipment when conducting experiment. Do not wear personal protection equipment into unauthorized areas. Avoid touching door knobs and press lift buttons when gloved.
Rule 8	When handling compressed gases and liquid nitrogen, always follow instructions.
Rule 9	Turn off the power supply of the equipment if it is not running. This includes computer and the monitors.
Rule 10	Read all safety manuals, safety data sheets and safety guidelines before commencement of any works in the laboratories.

2.2 Responsibility of Principal Investigator/Supervisor

Principal Investigators/Supervisors have a duty of care to the staff, students and visitors under their supervision. They also have a number of other obligations. Supervisors are required to fulfill the following criteria; failure to do so may result in closure of the work area.

All new staff and students must be trained. This includes general safety measures. Basic instructions to be given by the Principal Investigator/Supervisor are:

1. What the emergency phone numbers are

2. Where medical help can be obtained

3. What the fire alarm is and what to do when it sounds

4. Where fire extinguishers, fire blankets, spill kits (chemical and biological), medical assistance (in the school and campus medical centre) and web-based safety information can be found, and how to use these items. For the fire extinguishers, point out the different kinds and when they are to be used

5. What the general laboratory rules are

6. The school glove policy and laboratory coat policy

7. How to dispose of hazardous wastes
8. How to dispose of sharps, broken glass, and any special wastes (bodily fluids,

e.g. blood; radioactive, etc) produced in procedures in your laboratory

9. Special procedures for research techniques used in your group (e.g., use of liquid nitrogen, use of BSL-3 facilities, the use of animals, blood and blood products, etc.)

10. The need to ask for exact instructions on the use of new procedures or unfamiliar equipment

11. The need to have permits, approvals, and/or training for importing hazardous substances, organisms and biological agents, working with animals, bringing new pathogens or animals into the school/animal facility, making genetic modifications to any organisms, working with radioactivity, using communal microscopes, centrifuges, imaging equipment, autoclaves, etc

- New comers are required to attend the SBS Safety Briefing **before commencement of unsupervised duties**
- Safety Acknowledgement Form must be signed and submitted to School Safety Officer
- New comers are required to attend the Safety Induction Course organized by the OHS

2.3 Responsibility of Other Laboratory Staff & Students

It is mandatory, according to the Workplace Safety & Health Act 2006, that everybody working in laboratory (workplace) have the responsibility to take care of themselves by observing safety rules and guidelines and procedures adopted.

As much as the Principal Investigator/Supervisor can brief or trained staff to observe safety rules, eventually, everybody working in the laboratory must know how to carry out work safely, how to identify hazards and how to minimize risks.

As mentioned earlier, we are working with hazardous chemicals and biological agents; we would need to know the hazards and the control measures to prevent accident. Example, the fumes of concentrated hydrochloric acid are toxic and cause irritation to eyes and nose. Thus the control measure is to open/dispense concentrated hydrochloric acid in a fume hood and not in an open space bench top. Such knowledge can be obtained from safety data sheets and everybody must know the hazards of every chemical or biological agent that they are using. To assist the staff and students in obtaining the knowledge, everybody will receive training on **RISK ASSESSMENT** to identify the hazards.

Staff and student failed to observe and repeatedly violate safety rules may have to face school's expulsion and penalty from the government.

2.4 Personal Protection Equipment

Research laboratories and Biosciences Research Centre (BRC) core facility areas are classified as Biosafety Level 2 (BSL-2) where certain regulatory criteria must be met. Appropriate personal protective equipment are to apply while working in those areas.

Disposable gloves should be worn only when necessary, particularly when handling/working with:

- human blood or other body fluids
- hazardous chemicals
- infectious, or potentially infectious materials
- UV light boxes
- Radioisotopes

Disposable laboratory gloves are not to be worn in communal areas. Door handles, telephones, computer keyboards and mice (except in clearly labeled circumstances), lift buttons, etc. are not to be touched with gloves. If needed, wear one glove and use the ungloved hand to open doors, operate lifts etc.

Users need to wear safety goggles in the laboratory when (1) there are hazards identified in the workplace that may cause eye injuries and /or (2) risk assessment approved by the PI indicates to do so.

No open-toed shoes, sandals and slippers to be worn when working in the laboratory.

Long hair or loose clothing must be secured before commencing work. These can get caught in equipment, come into contact with chemicals or catch fire.

While working in the laboratory it is not allowed to wear a disc-man or MP3. If radio is turned on, volume must be acceptable to all members working in the vicinity.

Long pants (with covered ankles) must be worn at all times within organic chemistry laboratories and strongly recommended for work within all other laboratories.

Laboratory safety measures and practical applications should go hand in hand to keep the SBS as a productive as well as safe working place. **Laboratory coat bound areas have been identified** for those who need to wear laboratory coat while working.

Strict Laboratory Coat Areas
(Laboratory areas with limited public access)

- BSL-2 Laboratories
- Teaching laboratories
- Core facility areas
- NMR laboratory at B1
- X-ray laboratory at B1
- Gas cylinder area at B1

Optional laboratory Coat Areas
Researcher and student may or may not wear laboratory coat for purpose of transit from one laboratory to another or core laboratory area. Many laboratory equipment are located in core laboratory areas where they need to access and use the shared facilities.

- Laboratory corridor
- Corridor at B1
- Passenger lift and its lobby except at level 1 (North wing & South wing) and at B1 (North Wing)
- Cargo lift and its lobby

Strict No Laboratory Coat Areas
(Areas with most frequent public access)

- Offices
- Toilets
- Pantries
- Meeting rooms
- Classrooms and computer classroom
- Air-conditioned link at level 4
- Passenger lift and its lobby at Level 1 (North wing & South wing)
- Passenger lift and its lobby at B1 (North wing)
- SBS main lobby
- General store
- Car park at B1 except gas cylinder area

2.5 Risk Assessment

Risk Assessment must be conducted for all activities at workplace. Procedures in details are stated in the “Standard Operating Procedure on Risk Management”, which is issued by the Office of Health and Safety. Refer to NTU/OHS/SOP/04.1. Standard RA form is shown in the Annex (1).

It is the responsibility of the Management (Deans, School Chairs and Heads of Departments) to ensure Risk Management is being done for all the activities within the colleges, schools and departments. The Management should be consulted on the applicability of the control measures to minimize the risks. The Management can delegate the task to competent persons; the ultimate duty still rest with the Management.

The process of Risk Management for activities and works within any individual unit is the responsibility of the Principal Investigators, Reporting Officers and Immediate Supervisors. They must take all reasonably measures to eliminate or minimize any foreseeable risks to any persons who may be affected by their activities.

The Office of Health and Safety is responsible to ensure all colleges, schools and departments have the risk register and these are constantly reviewed to minimize foreseeable risks. The Office shall assist any department in the process of risk management if required.

Faculty, Staff and students are responsible to use the appropriate control measures, such as use of PPE and SOPs, prescribed within the risk register. They shall report any likely change in the frequency and severity of any incident and failure in any of the control measures.

2.6 Waste Management & Disposal

Before any waste is to be disposed, you may want to ask the following questions:

Question	Recommended Procedures
How do I dispose the mixed waste of biological agents, hazardous chemicals and radioisotope?	Decontaminate the mixed waste using chemical method (Do not autoclave) and then dispose as radioactive waste.
If the waste contains hazardous chemicals and biological agents, how do I dispose?	Decontaminate waste using chemical method (Do not autoclave) and then dispose as hazardous chemical waste.
How do I dispose biological waste?	If waste contains No antibiotic or No hazardous chemical, dispose into biohazard bag and bring down for autoclave service. After autoclaving, dispose as general waste. If waste contains antibiotic, dispose as "Biological waste with Antibiotic" in separate bag. After autoclaving, dispose as hazardous waste. For liquid waste, decontaminate with chemical and bring down to waste disposal room on every Friday 4:00pm – 4:30 pm.
If waste contains only hazardous chemicals, how do I dispose?	For solid waste bring down to waste room and dispose into big bin. Liquid waste is administered on every Friday 4:00 pm – 4:30 pm.
How do I dispose sharp items?	Dispose into puncture resistant sharp box in the lab. Mind maximum level of waste. Bring down for autoclave service.
How do I dispose radioactive waste?	Dispose into Perspex box in the lab. Bring the box down to radioactive waste room.

Non-hazardous waste, also called "general waste" is to be deposited into bins lined with black plastic bags. Do not overfill. These bins are emptied daily by contracted cleaners. Larger nonhazardous waste items must be deposited directly into the dumpster located outside the building at Basement 4. Under No circumstances must sharps, biohazardous, chemical or radioactive waste be included in non-hazardous general waste bins.

Empty Glass Bottles

Empty glass bottles containing flammable and fuming chemicals must be left without lid in a fume hood to evaporate remaining solution then rinsed with water and recapped. The bottle label must be removed or defaced. The bottle can then be disposed as general waste.

Broken Glassware

Place broken glassware in an appropriate broken glassware container. The container can be purchased from the General Store.

Sharps

Sharps such as needles must be disposed in a sharp bin. Do not overfill sharps bins. Sharp bins must be labeled with user name, laboratory name and date filled before transfer to waste storage in B1n-S2. Sharps bins containing biohazardous waste must be autoclaved before storage in waste room. Sharps bins containing radioactive waste must be treated as radioactive waste.

Liquid Chemical Waste

Liquid chemical waste must be disposed in designated containers. Liquid chemical wastes can be categorized into “Organic Solvent”, “Inorganic Solvent” and “Phenol/Chloroform”. However, there are some specific wastes from equipment like Kodak processors, HPLCs, GCs, and these wastes should be properly labeled according to the chemical that is/are present in the waste. When full, the chemical waste is to be transported to Chemical Waste room in B1n-08 for disposal. This waste room is open every Friday from 4.00 pm to 4.30 pm. **Organic solvent** waste containers must be stored in a fume hood or flammable cupboard because this waste is flammable and often produces pungent toxic fumes. Only very small quantities (< 1 ml) may be flushed down the sink with an excess of water. Chloroform and acetone must not be poured into the same bottle as they react to form an explosive chemical.

Not all chemicals can be thrown into the sink. Check with the MSDS, or your supervisor whether the chemical is safe for discharge into the sink. If not, follow the waste disposal procedure mentioned above. As a general guideline, flammable, organic and acute toxic chemicals must not be discharged into the sink. Acids and bases must be neutralized before discharging into the sink.

Solid Chemical Waste

Solid chemical wastes are usually gloves, papers, used plastic reagent bottles, tubes, etc. These should be placed in a bag, tied-up before sending them to B1n-S2 for disposal. Waste such as pipettes, tips, plastic tubes and empty containers must be placed in separate designated waste bags and double bagged. Solids that sublime at room temperature and produce toxic gases must be converted to a stable form and chemically inactivated. Refer to MSDS for details. All electrophoresis **gels** must be double-bagged before being transferred to waste room. All used charcoal filters must be treated as hazardous chemical waste

Management and Disposal of Ethidium Bromide

Ethidium bromide (EtBr) is commonly used as a stain for the visualization of nucleic acids in agarose gels. It is used widely because of its high sensitivity, rapid staining and low price. It is known to possess mutagenic properties and can present a serious hazard if it is not managed properly.
Personal Protection: When handling EtBr always wear a long sleeved lab coat, eye protection and nitrile gloves. When using the UV light source, use UV face shield and nitrile gloves.

Electrophoresis Gels: Agarose gels usually contain low amounts of EtBr (0.1% or less), and thus can be treated as solid chemical waste.

Solutions: These include electrophoresis buffers contaminated with EtBr after use, and EtBr solutions. To decontaminate the solution use the provided charcoal filtration system. Filtering the aqueous EtBr waste solution through a bed of activated charcoal is an effective method for EtBr removal. EtBr is bound to the charcoal and the filtrate may be poured down the drain with copious amounts of water. Used charcoal filters must be disposed of as solid chemical waste.

Radiation Waste Disposal

The control, safe packing and identification of radioactive wastes are the responsibility of the Principal Investigator until they are delivered to the designated secured waste assembly area. Only radioactive waste that has been left to decay to negligible proportions as required by the HSA Centre for Radiation Protection can be disposed of by landfill or controlled discharge into sewer. All other radioactive waste must be kept in designated secured waste storage areas or returned to original suppliers.

In SBS, a designated secured waste assembly area is provided to allow the radioactivity level of the waste to decay prior to ultimate disposal by landfill or controlled discharge into the sewer.
Only Radiation Workers who have been licensed to be engaged in radiation work are allowed to handle radioactive waste resulting from radioactive materials they have used. They are to ensure proper control; safe packaging and identification of the waste before the waste is packed into containers for safe handling by non-radiation workers.

Dry Solid Radioactive Waste
All solid wastes must be deposited into the bench-top beta shield waste bins containing small waste disposal bags with radioactivity symbol. When full, the small bags must be transferred to large bags in large beta shield bins located under the bench. Each large disposal bag should contain waste only contaminated with a single isotope.

Each large bag when full shall be closed and securely sealed with masking tape. The lab name, name of person preparing the bag, the date of last use, activity, content and isotope shall be entered on the radioactive waste container label (RAD03) which is to be securely attached to the waste disposal bag. No compaction of radioactive waste is permitted.

All large bags labeled with RAD03 must be delivered (using the beta shield bins) to the Radioactive Waste room (in B1n-10) and deposited into the beta shield bin labeled with the isotopes.

Glassware and sharps such as vials and syringes are to be packed separately into designated radioactive sharps bins or cinbins. The sharps bins must be labeled with form RAD03, delivered (using the beta shield bin) to the Radioactive Waste room (in B1n-10) and deposited into the beta shield bin labeled with the isotopes.

Waste will be stored in waste holding facility until activity is below One Exemption Limit for Activity or Activity Concentration (Bq/gm) specified in the First Schedule of the Radiation Protection (Ionising Radiation) (Amendment) Regulations, 2001.
Activity per bag must not exceed:

Isotope	Bq/g	Ci/kg
P32, C14	300	8.1
H3, S35	3000	81

Waste contaminated with more than one isotope must satisfy the following condition before it can be accepted for disposal:

A1/M1 + A2/M2 + A3/M3 +… < 1

where A1, A2, A3, etc. are the activity or activity concentration of the isotopes involved, and M1, M2, M3, etc, are the corresponding exemption limit for each of the isotopes.

Solvent Radioactive Waste

Contaminated solvents must be solidified by absorption into vermiculite (an absorbent material) at point of use and disposed of as dry solid radioactive waste.

Aqueous Radioactive Waste

First and 2nd rinses and other aqueous waste must be collected in containers. No aqueous and solvent type radioactive wastes are to be mixed in the same container. Whenever possible each container should contain waste contaminated with only a single isotope.

Rinse water from 3rd and subsequent rinses of apparatus should be discharged into the sewer directly at the point of use.

When full, aqueous waste containers must be labeled with Form RAD03 and transferred to the Radioactive Waste Room (in B1n-10). The Safety Officer will then make use of storage and dilution to render aqueous radioactive waste safe for disposal into the sewer.

Waste container must be closed with a plastic screw cap. Only containers > 500ml may be left in waste facility for disposal. No tubes are to be used to store aqueous waste in the waste facility.

For sewer disposal by Safety Officer: All aqueous waste must be neutralized to pH ~7.0. The level of radioactivity allowed in the sewer should be controlled to 1/10 the Exemption Limit for Activity or Activity Concentration (Bq/gm) specified in the First Schedule of the Radiation Protection (Ionising Radiation) (Amendment) Regulations, 2001.

Biohazardous Waste

Following steam sterilization or chemical disinfection, innocuous liquids may be disposed off via the laboratory drainage system. Flush with sufficient clean water to purge the drain immediately after disposal of all liquids. Bio wastes containing hazardous chemicals and radioisotopes must not be disposed of in this manner.

All laboratories which manipulate potentially hazardous biological agents (and materials containing such agents) are responsible for the separation, packaging and treatment of their laboratory waste prior to its removal and disposal. The culturing and preparation of cell or organ tissues generates liquid wastes which must be disinfected prior to disposal. The tissues contained in the media waste constitute a biological waste requiring proper disinfection prior to disposal.

Hazardous chemical waste contaminated with viable bio-hazardous agents must first undergo biological decontamination. The remaining waste can then be disposed of as a hazardous chemical. Similarly, radioisotope waste containing biohazardous agents must be treated so as to inactivate viable cells, bacteria, viruses, etc. After the biological decontamination, the treated waste can be handled as radioactive waste. For laboratory wastes contaminated with, or containing, viable biological agents in the absence of hazardous chemicals or radioisotopes, decontamination and disposal should be in accordance with the following scheme. Waste must be subjected to autoclaving or chemical disinfection prior to disposal.

Autoclaving (steam sterilization) is the preferred (and generally regarded as the most reliable) method of sterilizing biological waste. The duration of exposure to high temperature steam under pressure may have to be extended depending on the volume to be sterilized. Liquid waste containers designed to withstand autoclaving temperatures must be used. To allow pressure equalization, they should not be sealed. Containers of liquid waste must be placed into a tray or pan of sufficient capacity to contain all liquid in the event of vessel failure or breakage inside the autoclave chamber. The recommended temperature and time for sterilization is 121°C for 20 min – 30 min.

Non-sharp, solid laboratory waste (gloves, absorbent tissues, empty plastic culture dishes and tubes, wrappers, etc.) which may be, or are known to be, contaminated with biological agents should be collected in autoclave-able bags. These plastic bags display the bio-hazard warning symbol. Close the bags but do not seal them airtight before placing them into the sterilizer's chamber. After autoclaving and cooling, these bags of sterilized waste must be placed into black plastic garbage bags before disposal at the appropriate bins.

Decontamination of Biohazardous Waste By Chemical Disinfection

ADD DISINFECTANT: Fill the waste flask with 1% VIRKON (flask's volume). If a different approved disinfectant is utilized, add the volume of disinfectant required to achieve the manufacturer's recommended concentration. Do not use alcohol-based disinfectants. Note that when disinfectant and water are mixed together, the solution's disinfectant qualities only last 24 hours. Additional disinfectant may be required.

1 **LABEL**: Label the flask indicating tissue culture media, disinfectant used, and other chemical constituents.

2 **FLASK 75% FULL**: Stop using the flask once it is ~75% full.

3 **ADD ADDITIONAL DISINFECTANT**: Add an additional volume of disinfectant required to achieve the manufacturer's recommended concentration.

4 **SIT**: Let sit 10 hours to ensure proper disinfection (Overnight).

2.7 Carrying Large Heavy Objects

Large bottles, flasks and containers must be supported on the base with one hand and held by the neck with the other. Use a tray or trolley if several items need to be transported. Bottles containing chemicals must be transported using solvent carriers.

2.8 Electrical Safety

To avoid power overloading, ideally, one electrical outlet connects only to one piece of equipment. If the outlet is used for more than one connection, the adaptor with the Singapore Productivity and Standard Board (PSB) logo must be used, and each adaptor must not exceed more than two connections. Do not leave the power on overnight for equipment that is not in-use, including the computer monitor.

2.9 Compressed Gas Safety

General Information

- Only persons trained in handling of compressed gas cylinders are authorised to transport cylinders and change regulators.
- Gas cylinders must not be allowed to become completely empty before replacing them.
- If you smell a gas leak, inform somebody in the school and evacuate the lab immediately. The source should later be traced and action taken by the appropriate safety personnel.
- Gas cylinders must always be transported secured to the trolleys designed for the purpose and when located, the cylinders must always be chained to a wall or bench to prevent them from falling. If unsecured, a tilt of a few degrees will cause the cylinder to fall with sufficient force to crush a foot or break a leg of anyone standing in the way. In addition, if the valve breaks off, the escape of gas will turn the cylinder into an unguided rocket.
- Cylinders must not be stored near heat sources (eg. ovens), as heating can cause a rise in the internal pressure. They should always be stored in a well ventilated area.
- Cylinders have colour coded bodies, labels or tags. Always read the cylinder label before connecting it to ensure that it contains the gas that you require. If a cylinder is supplied with an unreadable label, do not use.
- Gas regulators must be recommended for the particular gas by the manufacturer. The hosing and connections must also be compatible with the gas being used.
- Do not use oil or grease on gas regulators.
- Only those cylinders required for the work at hand shall be kept in the laboratory. Cylinders not in use shall be kept in the storage facility.

Drawing & Returning Gas Cylinder

1 All full and empty cylinders not in use are stored at B1 Gas cylinder corner near car park exit. The key is kept in S2 autoclave room and available 24h.

2 The trolleys used to transport cylinders are stored at B1 Gas cylinder corner.

3 Empty cylinders are replaced with full ones by a vendor.

4 If you take the second last full cylinder from B1 Gas cylinder corner you must inform **Andy Ang,** the BRC Asstant Manager (65137652) so extra cylinder delivery can be arranged.

5 Procedure

- Collect key to B1 Gas cylinder corner, fill in key Sign Out Sheet.
- Take trolley to lab and transport empty cylinder to B1 Gas cylinder corner. Ensure cylinder is fastened to trolley
- Exchange empty cylinder for full cylinder. Make record.
- Transport full cylinder to lab
- Return trolley to B1 Gas cylinder corner
- Lock when finished
- Return key

Emergency Contact

- Please direct any queries concerning gas cylinders to the BRC Assistant Manager (65137652). If you wish to use extra cylinders or change location of cylinder use, contact the School Safety Officer for installation of secure brackets.
- SOXAL (One of the compressed gas vendors) operates a 24-hour emergency response service primarily to attend to emergencies. Phone: 265 3788 / 9638 9142

2.10 Liquid Nitrogen Safety

Handling Liquid Nitrogen

The temperature of liquid nitrogen is -196^{o}C. Thus, direct skin contact with liquid nitrogen or objects that have been in liquid nitrogen can cause severe frostbite. Note also that contact with objects at room temperature causes rapid boiling and splashing of liquid nitrogen. The eyes and face are best protected from splashing liquid by a full face shield. The eye can be damaged by liquid nitrogen after very small exposure times. Safety glasses without side shields do not give adequate protection. Fully closed shoes must be worn.

Always wear suitable protective gloves when handling anything that has been in contact with liquid nitrogen. The gloves should fit loosely, so they can easily be removed if liquid nitrogen spills or splashes into them. Do not put gloved hands directly into liquid nitrogen spills to retrieve dropped ampoules. Use the scoop provided.

During routine procedures involving liquid nitrogen, avoid making contact with any uninsulated metal (tanks, piping, etc), as they will have become extremely cold and cause unprotected skin to stick fast. Help and information regarding liquid nitrogen can be obtained from Lew Yi Liang (63162803).

Transporting Liquid Nitrogen

One litre of liquid nitrogen evaporates to form 687 litres of nitrogen gas. Thus, liquid nitrogen must only be handled in well ventilated areas to prevent the risk of asphyxiation due to the displacement of air. Special procedures apply to the transport of liquid nitrogen in lifts (see below).

Liquid nitrogen must never be stored or transported in sealed containers to prevent explosion due to volume expansion during evaporation.

Only approved containers should be used for the transport of liquid nitrogen. Such containers have loose fitting lids or vents to allow the gas produced from the liquid boiling off at room temperature to escape. Vents should be regularly checked to prevent ice build-up caused by water vapour. Thermos flasks are not suitable, as they have tight fitting lids.

NOTE: Ice buckets should never be used to carry liquid nitrogen, as they are often perforated by tiny holes that could allow the liquid nitrogen to run down onto your legs and feet.

Procedure for Transporting Liquid Nitrogen

Small volumes (up to 1 litre) may be transported from the approved storage facilities to your laboratory. The preferred route of transport is via the cargo lifts, to avoid harm to other stairway users in the event of a spill.

1 Liquid nitrogen must travel unaccompanied in the cargo lift (1 litre of liquid nitrogen evaporates to form 687 litres of nitrogen gas).

2 Two people must work together to transport liquid nitrogen via the cargo lift.

3 One person must be stationed on the relevant floor to receive the liquid nitrogen when the lift arrives.

4 The second person places the approved liquid nitrogen container in the cargo lift, places the WARNING SIGN (A-frame, kept in liquid nitrogen storage area) immediately behind the lift door so it will bar entry to the lift, and then selects the floor/level and exits the lift before the doors close.

5 The first person removes the liquid nitrogen and the sign when it arrives.

6 The warning sign must be returned to the storage facility immediately, before further work commences.

Storage Of Liquid Nitrogen

The liquid nitrogen storage area and laboratory must be constantly ventilated. Bulk liquid nitrogen (greater than 1 litre) MUST NEVER be stored in areas other than approved school storage facilities.

Only approved containers should be used for the storage liquid nitrogen. Such containers have loose fitting lids or vents to allow the gas produced from the liquid boiling off at room temperature to escape. Vents should be regularly checked to prevent ice build-up caused by water vapour.

2.11 Core Equipment Safety

Contact with items at the temperatures reached by these ovens (100 C -200 C) can produce burns to the fingers, hands, forearms and upper arms. When loading or unloading hot ovens, always wear protective heat resistant gloves, preferably elbow length and have gown sleeves rolled down to protect the upper arm in case of accidental contact with the hot door or sides of the oven. Unload the hot objects directly onto an adjacent bench or trolley.

Insulated gloves must be worn when accessing and handling material from low temperature freezers (i.e. -70 C to -80 C), as direct contact with items, particularly metal objects, can cause frostbite.

2.12 Dry Ice Safety

Dry ice (solidified carbon dioxide) has a temperature of about -60 C. Thus, direct contact with dry ice, or objects which have been in contact with it, can produce frostbite to unprotected skin. Protective leather gloves must be worn during all handling procedures.

One kilogram of dry ice evaporates to give 535 litres of carbon dioxide gas. Thus good ventilation is required in areas where dry ice is in use, as an excess of carbon dioxide gas will displace the normal air leading to asphyxiation. As carbon dioxide is heavier than air, pockets of CO2 can collect in enclosed low spaces.

NOTE: Carbon dioxide is the body's regulator of the breathing function. It is normally present in the air at a concentration of 300 ppm by volume. Appreciable increases above this level will cause acceleration of breathing and heart rate. Concentrations in the order of 10% can cause respiratory paralysis. As the gas is odourless, colourless and tasteless, it cannot be detected by human senses. Therefore, this may happen without warning.

NOTE: Ear protection should be worn during the production of dry ice due to the noise level.

2.13 Ultraviolet Light Safety

The wavelengths of ultraviolet light used either for germicidal action (eg. in laminar flow and biohazard units) or visualisation of DNA (eg. transilluminators) are extremely damaging to the eyes, and prolonged exposure can also produce dangerous "sunburning" of the skin.

For this reason biohazard units are fitted with safety interlock switches to ensure that the UV lamp is off when the visible light and fans are on. Biohazard units are also provided with "night covers", which should be fitted to close off the work face opening when the UV lamp is in operation. The safety glasses supplied by the School provide full screening of the eyes from UV light, but full UV absorbing face masks and gloves must be worn when you are working at a transilluminator.

2.14 Safety in Teaching Laboratories

"Undergraduate Policy and Safety Manual for Teaching Laboratory" has been developed. Main purposes of this document include:

- to provide guidelines for the policy and safety rules in the teaching laboratory;
- to encourage students to adopt good laboratory practices;
- to provide safe and conducive environment for the students in the teaching laboratory.

This policy is mandatory for undergraduate students of the School of Biological Sciences in teaching laboratory. Students must observe correct procedures and practices outlined in this manual. The school may notify the students from time to time any changes to the policies and safety rules in the teaching laboratories. This is to ensure that all students of SBS will receive the latest information and best practices for safe and conducive environment in the teaching laboratory.

2.15 Procedures for Medical Emergency

Chemical or Biological Splash to the Eye

1. Immediately flush the eye with gentle stream of water for 15 min.
2. Be careful not to wash the contaminant to the other eye.
3. Use the emergency eyewash provided in the laboratory.

4. Seek medical attention if necessary.
5. Record incident (IN01) and report to the PI and Safety Officer.

Cuts and Abrasions

1. Immediately cleanse the wound and surrounding skin with antiseptic soap and running water and encourage bleeding.
2. Get first aid box and hold a sterile or clean pad firmly over the wound and apply a plaster.
3. If the cut is severe, keep the victim lying down and raise the bleeding part higher than the rest of the body.
4. Seek medical attention if necessary
5. Record incident (IN01) and report to the PI and Safety Officer.

Thermal Burns

1. If skin is unbroken, submerge the burned area in clean water.
2. Do not break any blister and do not use any medication.
3. Seek medical attention if necessary
4. Record incident (IN01) and report to the PI and Safety Officer.

Serious Medical Emergencies

(The victim is unconscious due to some medical complications such as heart attack, fall and head injury, etc.)

1. Let the victim rest lying down.
2. Take off all personal protected equipment (PPE) if he put on any.
3. Call the ERT personnel who have training in First Aid, Occupational First Aid (OFA), etc.
4. Call NTU Medical Centre and SCDF Hazmat team for help.
5. Inform the PI and Safety Officer.
6. Document the incident in details.

3.0 Chemical Safety

3.1 General Chemical Storage Rules

Laboratories must not store large volumes of hazardous chemicals. Purchase only minimum amounts necessary to accomplish work and dispense amounts only necessary for immediate use.

Permit or licence for hazardous substance issued by local authority always comes with maximum storage limit and expiry date. Therefore, validity of the permit is important and user must comply with terms and conditions stated.

3.2 Chemical & Reagent Inventory

Every laboratory is required to set up and maintain an electronic Chemical & Reagent Inventory (CRI). The CRI must list all chemicals and reagents stored within and by the laboratory. Individual CRIs must be forwarded to the Safety Officer upon request to update the School CRI. The CRI file may be obtained from the Safety Officer. A hard copy of the CRI should be placed in the ancillary office. The inventory record format for hazardous substances, issued by the NEA is shown in annex 2.

3.3 Chemical Storage

Apply international hazard symbol and material safety data sheet (MSDS) for storage conditions recommended. The MSDS file must be maintained for all chemicals used in the laboratory. Below is table that shows the proper storage requirement:

Chemical	Proper Storage Requirement
Flammable & Highly Flammable	Fire rated doors cabinets (Yellow or Grey) – FM / UL Maximum 250 L/cabinet
Corrosive	Corrosive cabinet
Explosive	Keep in a cool and dry place under lock and key. For water reactive chemicals like sodium metal, use double container if possible
Oxidizing materials	Keep away from flammables and combustible chemicals. Open shelf is preferred.
Toxic & Extremely Toxic	Keep in locked cabinet. Also known as “Poison”.
Harmful & Very Harmful	Open shelf storage is allowed
Endanger Environment	It usually comes with another symbol. Make decision based on the above requirements.

Periodic checks should be made of the chemical stores in order to ensure that the conditions of the containers are satisfactory. These include but are not restricted to:

- the physical state of the primary and secondary containers
- the state of the seals of these containers
- the cleanliness of the containers (salt deposits indicating leakage, etc.).
- the presence of moisture in the bottle or any other form of precipitation and/or caking.

Adequate ventilation must be available for storage and handling.

3.4 Flammable Chemical Safety

There is a common storage room for flammable chemicals. The room is equipped with approved flammable cabinets inside. The idea is that individual laboratory is to keep minimum quantity of flammables in the laboratory and bulk quantity will be kept in this common storage room. Approved flammable cabinet is under lock and key and is belong to the laboratory. It depends on storage quantities, the cabinet may be shared among laboratories.

Individual laboratory also keeps minimum quantity of flammables for current use inside the approved cabinet. Maximum limit per cabinet is 250 litres.

The General Store usually keeps bulk quantity of flammables, especially Duty Exempted Ethyl Alcohol (DEEA), for which the school has applied special permit from the Singapore Customs. The room is under the care of General Store staff.

3.5 Chemical Handling

All laboratory workers must be familiar with hazards and recommended procedures associated with the chemicals they are dealing with. When in doubt, refer to the MSDS and/or books such as Merck Index.

All works with hazardous chemicals, particularly those producing vapours, must be done in fume hoods.

Appropriate protection apparel must be worn when working with hazardous chemicals. These include but are not limited to nitrile gloves, lab coat, face shield and goggles.
Handling of phenol:

- Handle in full safety dress and in the fume hood
- Phenol should be stored in resistant containers made of glass or teflon.
- If skin comes in contact with phenol, rinse immediately with lots of water, then wash with soap and water.

Appropriate gloves for handling corrosives, hot/cold objects, organic solvents and other specific chemicals are available.

The appropriate mask should be worn when a process is known to produce chemical fumes or toxic particles, such as acrylamide. Note that normal surgical masks and dusk masks are not suitable protection against chemical fumes.

3.6 Emergency Equipment

Spills must be attended to immediately and not left to dry. Stains left by chemical spills should be cleaned up immediately. Spill control kits for spillage of flammable chemicals are available. Lab workers must be familiar with the contents of chemical spill kits. Supervisors must ensure that workers understand the correct procedure for use of chemical spill kit contents. Risk Assessment Form should indicate control measures for such an emergency.

Fire extinguishers are located near the exit and not near the chemical cabinets. In the event of an explosion, a fire extinguisher near the explosion area might be rendered inaccessible or damaged. Laboratory workers must be familiar with the type of extinguisher used on chemical fires. If a chemical fire occurs, the appropriate type of fire extinguisher, i.e. Class B extinguisher such as carbon dioxide or foam, must be used. Fire blankets are also available for use on chemical fires.

Workers must be familiar with the location and contents of SBS First Aid Kit, safety shower and eye wash stations. No obstruction or blockage to emergency equipment.

4.0 Biological Safety

4.1 Laboratory Biosafety Levels

Laboratory facilities are designed as basic - Biosafety Level 1, basic - Biosafety Level 2, containment – Biosafety Level 3 and maximum containment – Biosafety Level -4 according to definitions in the WHO Laboratory Biosafety Manual. Biosafety level designations are based on a composite of the design features, construction, containment facilities, equipment, practices and operational procedures for working with agents from the various risk groups.

Laboratories in the school can be classified as:

1. **Basic Biosafety Level 1** – Basic teaching and research laboratories where good microbiological techniques (GMT) are in place.
2. **Basic Biosafety Level 2** – Research laboratories with GMT plus protective equipment, biohazard sign, controlled laboratory access and biological safety cabinet (BSC). The SBS research laboratories are classified as BSL-2 and the principal investigators (PIs) are leaders of research groups.
3. **Biosafety Level 3 -** Containment laboratory with practices as Level 2 plus special clothing, strict controlled access, directional air flow, BSC and other primary devices for all activities. This special facility is set up as a core facility for research work involving biological materials of potential biohazard.

4.2 Risk Group Classification

Under the present Biological Agents and Toxins Act (BATA), biological agents are classified into schedules. The law differentiates between higher risk group and lower risk group biological agents and also those with potential to be weaponized. Five schedules in the BATA cover a wide spectrum of biological agents and toxins and different levels of controls have been adopted for each schedule. The BATA also defines the facility requirements to handle biological agent with different risk level.

The NTU-SBS BSL-3 laboratory is allowed to perform research experiments involving high risk biological agents that fall into Risk Group 3 in the WHO classification or Schedule 1 in the BATA classification.

However, the SBS research BSL-2 laboratories are allowed to handle biological agents with low or moderate risks, for example, Risk Group 1 (Schedule 4) and Risk Group 2 (Schedule 3). To handle Risk Group 4 agent that is the highest (Schedule 2 in the BATA), a BSL-4 facility is required. But the school does not have such facility.

4.3 Institutional Biosafety Committee

The Institutional Biosafety Committee (IBC) is formed to meet the requirement of the Biological Agents and Toxins Act and registered with the MOH. This committee consists of members from other schools and the Office of Health and Safety and stands for the whole university. All policy matters, Biosafety programmes, operating procedures, review and approval of research projects, including the utilization of BSL-3 facility are the responsibility of the Institutional Biosafety Committee. The IBC develops code of practices and standard operating procedures and decides the Biosafety level required for the research projects.

4.4 Biosafety Precautions for BSL-2 Laboratories

The school has adopted standard precautions for BSL-2 laboratories where researchers conduct experiments involving low or moderate risk biological agents (schedule 3 & schedule 4) and category B genetically modified organisms (GMO). They are fundamental to laboratories of all biosafety levels and are to meet minimum requirements recommended in the WHO Laboratory Biosafety Manual (3rd edition).

Facility Considerations

1. Ample space must be provided for safe conduct of laboratory work.
2. Walls ceilings and floors should be smooth, easy to clean, impermeable to liquid and resistant to chemicals and disinfectants. Floors should be slip-resistant.
3. Bench tops should be impervious to water and resistant to disinfectants, acids, alkalis, solvents and moderate heat.
4. Adequate illumination should be provided for all activities.
5. Adequate storage space for hazardous substances and biological agents should be provided.
6. Safety systems should cover fire, electrical emergencies, first-aid, safety shower, eyewash facility and emergency evacuation procedures.
7. Hand-washing basins with running water should be provided in each laboratory, preferably near the exit door.
8. Mechanical ventilation systems should provide inflow of air without recirculation.

Restricted Laboratory Access

1. The international biohazard warning symbol and sign must be displayed on the doors of the rooms where biological agents or GMOs are handled.
2. Laboratory doors should be kept closed.
3. Only authorized persons should be allowed to access laboratory working areas.
4. Access to animal house should be specially authorized.

Personal Protection

1. Laboratory coats, gowns must be worn at all times for work
2. Appropriate personal protective equipment (PPE), gloves, safety glasses, face shields or other protective devices must be worn when it is necessary.
3. Open-toe footwear, shorts, skirts are not allowed.
4. Eating, drinking, smoking, applying cosmetics and handling contact lens is prohibited.
5. Storing foods or drinks in the laboratory is prohibited.
6. It is prohibited to wear PPE outside laboratory, e.g. in offices, staff rooms, pantries and toilets.
7. Wash hands after handling infectious materials and animals and before leaving laboratory working areas.

Biosafety Equipment

1. Designed and constructed of materials that are impermeable to liquids, resistant to corrosion and meet structural requirements.
2. Pipetteing aids – to avoid mouth pipetting.
3. Biological safety cabinets, to be used whenever infectious materials are handled; there is an increased risk of airborne infection; procedures with a high potential for producing aerosols are used.
4. Screw-capped tubes, bottles and centrifuge buckets are to be used.
5. Autoclaves or other appropriate means to decontaminate infectious materials.
6. Plastic disposable laboratory wares and pipettes to avoid glass.

Procedures

1. Mouth pipetting must be strictly prohibited.
2. Works involving biological agent or infectious material must be done inside the BSC.
3. All technical procedures should be performed in a way that minimizes the formation of aerosols and droplets.
4. The use of hypodermic needles and syringes should be limited.
5. All spills, accidents and potential exposures to infectious materials must be reported to the supervisor and a written record of such accidents should be maintained.
6. A written procedure for the clean-up of all spills must be developed and followed.
7. Contaminated liquids must be decontaminated chemically or physically (autoclave) before discharge to the sanitary sewer.
8. All contaminated materials, specimens and cultures must be decontaminated before disposal or cleaning for reuse.

9. Written documents that are expected to be removed from the laboratory need to be protected from contamination while in the laboratory.
10. The laboratory should be kept neat, clean and free of materials that are not pertinent to the work.
11. Work surfaces must be decontaminated after any spill of dangerous material and at the end of working day.

Spill Management

1. Alert all personnel inside the laboratory immediately and ask them to leave.
2. Stop all activities, post a "No Entry" at the door.
3. Wear the PPE and clean up the spill under supervision of the PI.
4. Pick up broken sharp items, if any with forceps and discard into sharp box.
5. Cover the spill with paper towels. Carefully pour freshly prepared 1% hypochlorite or disinfectant solution around the edges of spill then into the spill. Minimum contact time is 20 min.
6. Use paper towels to wipe the spill, working from the edges into the centre.
7. Wipe clean the spill area with fresh paper towels.
8. Place all materials in biohazard bag for autoclaving.
9. Wash hands and exposed skin areas with antiseptic soap.
10. Document the incident in details.

Waste Management

1. Discard all solid wastes generated in the BSC into waste container with yellow biohazard bag inside the BSC.
2. Discard other solid wastes into container with yellow biohazard bag in the laboratory.
3. Seal biohazard bags, not too tight to allow steam enter inside during autoclaving and put into autoclave-able white bag.
4. Seal the autoclave-able bag (Not too tight), apply autoclave control tape and label laboratory number and the PI's name.
5. Bring down to B1 waste room where all biological wastes are autoclaved at 121 C for 15 min (a total of 90-min cycle).
6. Solid waste containing Antibiotics should be treated similarly but in separate bag using biohazard bag and autoclave-able bag. (The NEA wants this waste separated)
7. All wastes which have been autoclaved are collected by the authorized contractor.
8. Dispose sharp items into sharp box provided. Seal sharp box and put into autoclave-able bag and apply autoclave control tape.
9. Label "Sharp Item" and bring down to B1 waste room for autoclave service.
10. Sharp item wastes are collected for incineration.

Other Precautions

1. Appropriate training is essential to maintain safety awareness among laboratory staff. Close supervision and on-the-job training need to be in place.
2. Exclusion of highly susceptible individuals (e.g. pregnant women or immunocompromised individuals) from highly hazardous laboratory work.
3. A pre-employment or pre-placement health check is necessary. Records of illness and absence should be kept by the laboratory.
4. Compliance with active guidelines from government agencies or committees upon use, possess, import, transport, transfer of biological agent, infectious material or animal.

<u>Note:</u> Standard precautions are given as minimum requirements pertaining to laboratories of Biosafety level 2 (BSL-2). Additional precautions and specific procedures must be in place for a BSL-3 laboratory.

4.5 Biosafety Precautions for BSL-3 facility

Essential elements of BSL-3 containment include standard microbiological practices, specialized safety practices which must be in keeping with the hazards associated with the agents and procedures, primary barriers consisting of safety equipment and containment devices, and secondary barriers such as laboratory facilities that are designed to protect personnel inside and outside facility. A comprehensive Biosafety and Operations Manual has been adopted for users of the NTU-SBS BSL-3 laboratory. Full and precise details of the operational and safety procedures for the facility can be observed in the document.

4.6 Disinfection, Decontamination and Sterilization

“Disinfection” is defined as a physical or chemical means of killing organisms, but not necessarily their spores, on inanimate surfaces or objects. Laboratory benches and workspace must be kept clean of dust and dirt. Benches and workspace must be cleared of clutter, e.g. excess paper, books, reagents not in use, empty and used containers. Prior to work, benches must be disinfected by wiping with 70% ethanol. At completion of work the bench must be again wiped down with 70% ethanol.

“Decontamination” is defined as a process for killing and/or removing microorganisms. The same term is used for removing or neutralizing hazardous chemicals and radioactive materials. Appropriate decontamination procedures for laboratory equipment most commonly BSC, centrifuge etc. and biological spill management inside the laboratory must be established

“Sterilization” is defined as a process that destroys and removes all classes of microorganisms and their spores. The use of steam under pressure (autoclaving) is the method of choice.

What to do with waste?

Type	**First Step**		**Second Step**	**Last Step**
Solid	Double bag	AND	Autoclave	Discard / Incinerate
Liquid	Disinfect	AND/OR	Autoclave	Sewer
Sharp	Sharp Box	AND	Autoclave	Incinerate
Chemical	Disinfect	DO NOT	Autoclave	Discard
Radioactive	Disinfect	DO NOT	Autoclave	Decay
Equipment	Decon. / Fumigate	OR	Autoclave	Repair / Discard
Laundry	Bag	AND	Autoclave	Wash

4.7 Storage of Biohazardous Materials

- Hazard warning signs, indicating the risk level of the agents being used, must be posted on laboratory doors and refrigerator and freezer doors.

- All containers used to store biohazardous agents in refrigerators and freezers must be labeled clearly with scientific name, date of storage and person who stored them. Unlabelled and obsolete items should be autoclaved and discarded. The containers must be robust and not leak. No material should remain on the outside of the container.

- An inventory must be maintained of refrigerator and freezer contents. Inventory must be posted on refrigerator or freezer door.

- Contaminated glassware and plastic-ware must not leave the lab and decontamination must be carried out before disposal.

4.8 Packaging of Biological Agents for Transfer

1. The biological agent is placed in a securely closed, watertight container (Primary container: vial, test tube for small volume).
2. The primary container is enclosed in a durable watertight container (secondary container). The space at the top, bottom and sides between the primary and secondary container contains sufficient absorbent material (e.g. paper towel).
3. Each set of primary and secondary containers are then enclosed in an outer container (Fireboard, cardboard or material of equivalent strength) including list of contents and relevant information. If dry ice is required it must be placed outside the secondary container.
4. The package must bear a proper label which includes required information and biohazard symbol.
5. For transfers within NTU-SBS laboratories, the specimen container is watertight and leak-proof. It is tightly capped and secured in a rack to hold it an upright position. The specimen container and rack are placed in robust, leak-proof transport box with secure tight fitting cover.
6. Document the detailed information for the transfer and update the inventory of biological agents kept in the laboratory.

4.9 Procedures for Receiving and Unpacking

1. Check the conditions of specimen package and information provided carefully. Register the received items.
2. Apply appropriate PPE for unpacking the specimen container.

3. The unpacking must be done inside the BSC and carefully observe any leakage inside the pack. Any sign of leakage or broken specimen container is observed, the specimen may be contaminated and is not suitable for experiments. The whole package must be destroyed by autoclaving (90-minute cycle, 121C for 20 minute sterilization time).
4. The specimen (in the primary container) is taken for processing. The packing materials are discarded into biohazard bag and autoclaved.
5. Update the list of biological agents in the laboratory.

4.10 Accidents during Transportation of Biological Agents

The BATA Transportation Regulations are to be adhered to when transporting Schedule 1, 2, 3 (quantities aggregating 10 litres or more) and Schedule5 agents on public roads.

1. The driver has undergone Hazmat training course and possessed Hazardous Materials Transport Driver Permit issued by the SCDF. It is applicable to researchers who transport BA in their own vehicles.
2. Vehicles have a biohazard label for schedules 1, 2 and 3 or a toxin label for schedule 5 toxin.
3. The driver or transporter has been provided a 24-hr emergency contact number of transferor or transferee.
4. Materials to be transported must be packed and labeled according to the regulations.
5. On the vehicle, stock safety items – gloves, absorbent materials, mask, goggle, disinfectant, tong / forceps, biohazard bags and tape / masking tape, reflective vest.

Road Traffic Accidents

6. The driver or transporter puts on reflective vest, gloves and mask.
7. Inspect the package for any damage. If the package is intact he can proceed to deliver the package.
8. Turn off the engine and seal or close doors to contain biological agent.
9. Call SCDF Hazmat team.
10. Call the responsible personnel (transferor and transferee).
11. Keep the public away from accident site and wait for rescue.
12. Carry out Cleaning and decontamination under supervision of biosafety officer.
13. Report to the MOH Biosafety branch.
14. Document the incident in details.

5.0 Radiation Safety

The following practices are set by the School Safety Committee for radiation safety in the SBS laboratories.

5.1 Radiation Protection

The Radiation Protection Act, 1991 regulates, by means of licensing and penalty, the importation, manufacture, sale, transport, keeping and use of radioactive materials and irradiating apparatus. The devices under control are high power lasers and entertainment lasers (class 3b and class 4), ultrasound, microwave ovens, sunlamps, X-ray machine and radioactive materials. The activities requiring licences include manufacture, sale, keep, use, importation and exportation of devices.

5.2 Radiation Worker

“Permit to work” system applies. Only registered and trained users are permitted to use radioactivity. Registered users are provided with a one-time medical check-up and a badge for monitoring radiation exposure. The film in the badge is changed monthly.

The issued radiation badge must be worn at all times when working with radioactive material. It is recommended that radiation workers fix the radiation badge to their lab coat and wear all the time to avoid taking badge off and on before and after radiation work.

All new radiation workers must report to Safety Officer for registration. This includes staff, graduate and undergraduate students.

Only registered and trained users are allowed to make use of the X-ray generator for X-ray diffraction experiments. Registered users will undergo one medical check-up and should wear a badge when they are doing X-ray diffraction experiments.

Following registration, radiation workers must seek instruction from their supervisor and read the safety rules and regulations before proceeding to work with radioisotopes.

Wear full safety gear when working with radioisotopes. A double layer of gloves must be worn. The long-sleeved lab coat may be tucked into the first pair of gloves and taped securely. The second pair of gloves is then worn over the first pair.

Never work with cuts or breaks in the skin unprotected, particularly in the hands and forearms. These must be securely bandaged or plastered.

5.3 Work Area

Work with radiation may only proceed in areas designated by the School. These designated areas are marked with the radiation hazard sign and the type of isotope used. Conduct the experiment on a plastic tray lined with benchcoat or tissue paper, behind the perspex screen that can effectively block beta emissions of H3, C14, P32, P33 and S35.

5.4 Storage Activity

Radioactivity may be stored in perspex containers clearly marked with radiation hazard symbol.

Refrigerators containing radioactivity and equipment commonly used for radioactive work must also be similarly marked.

For each batch of radioactivity received, the following information should be recorded: the type of radioisotope present, date of receipt, activity at a date specified by the manufacturer, the quantity used each time, and the date and purpose of use.

5.5 Monitoring Radioactivity

Check that the batteries in the Geiger-Müller counter or survey meter have not run out.

Work with radioactivity such as P32, P33 and S35 must be accompanied by the use of the survey meter, which must be switched on and pointed to the source

Emission of H3 and C14 can be monitored by wipe test (swab the work area with cotton wool soaked in ethanol, then monitor the swab in a scintillation counter).

Monitor the work area before and after work with radioactivity to check for spills. Clean up any contamination immediately upon detection.

5.6 Record of Usage

A new form RAD01 must be prepared by the lab for each new batch/vial of isotope received. Usage must be recorded on form RAD01 and upon completion (for each vial) the original must be filed in the lab and a copy forwarded to the Safety Officer.

NOTE: Spot checks will be conducted by SBS Safety Committee, during which record of isotope usage will be reviewed.

5.7 Clean-Up Procedure

- **Use a Geiger counter to monitor all potentially-contaminated equipment,** gloves, clothing and work area (including bench, walls and floor).
- Follow the manufacturer’s directions to prepare De-Con detergent
- Clean up all spills with De-Con detergent.
- Persistent ' hot spots' should be covered in aluminium foil and radiation tape. Contact supervisor then Safety Officer for further treatment.
- Where appropriate, soak contaminated equipment, glassware, pipettes in De-con detergent.
- Dispose of waste, including tissues used for cleaning, into red color radioactive waste bags.
- Use the Geiger counter to monitor the work area, equipment and yourself one last time after cleaning up.
- Swab the cleaned area with an alcohol swab and measure activity using scintillation counter to confirm complete clean-up.

6.0 Animal House Safety

6.1 **General Information**

The researcher/PI's who would like to use our Animal Research Facilities should follow this Procedure:

6.1.1 Regardless of whether PI/ Investigators are from SBS, NIE or outside, all PI / Investigators should approach the secretariat of NTU-IACUC and get an application form (ARF-SBS/NIE 1a), for the usage of the facilities.

6.1.2 The application must be completed and signed by PI accordingly, and submitted softy copy as well as hard copy of the application to secretariat of NTU-IACUC.

6.1.3 In accordance with the SOP-001.03 Chart for the PI Proposals approval process by NTU-IACUC, after the pre-reviewers approval NTU-IACUC secretary compile the application and submit to IACUC meeting.

6.1.4 Approval reference will be given once approved. This reference must be quoted in subsequent applications (Example purchase of animals).

6.1.5 Once the PI gets an approval from NTU-IACUC, he / his team member must liaise with the Animal Research Facility manager regarding availability and allotment of the holding space for the animals according to his requirements.

6.1.6 In the situation of unavailable animal holding space or insufficient holding space Facility Manager would advise the investigator to wait until the animal holding space is vacant and this space then be allocated according to the waiting list.

6.1.7 Once Facility Manager advises the PI to commence on the use of our facility, he will proceed to order the animals for his experiment.

6.1.8 The investigators/ researchers who would like to terminate their animals in the Animal Research Facility during or after completing the experiment and in the event whereby there is an increase in population in their animal colony, the Animal Termination Form ARF-SBS which can be obtained from Facility Manager Office must be filled and forwarded to Facility Manager for the purpose of updating the Animals stock account.

6.1.9 At the end of every month Facility Manager would compute the animal maintenance charges as per the rate of charges would be imposed by facility administration. It would be forwarded to Finance Manager –SBS for incurring the charges from the respective PI's.

6.1.10 During the experiment, the investigator (PI) need to extend his experimental study period or modify his procedure/ experiment on the animals, before the modification of his procedure or expiry of approved study period, he has to get an approval from NTU-IACUC by using the (SOP-001.02 ARF-SBS/NIE IACUC Ethics Review Form for Modifications i.e. ARFSBS/NIE 1b) Ethics Review form for Modifications can be obtained from the secretariat of NTU-IACUC.

6.2 Evacuation Procedure

6.2.1 When the fire alarm activates, stop all your activities and turn off any power supply if possible.

6.2.2 Leave the building immediately when OFPM requested you to do so through the PA system. Evacuation route as follows.

6.2.3 Staff at the SPF area (1st Storey) Experimental rooms, preparation area and clean hall way should exit through the emergency exit glass door near the preparation area.

6.2.4 Staff at (1st storey) the animal holding rooms and dirty hall way are try to exit through dirty hall way leads to exit adjacent to roller shutter near loading bay or exit near the lift.

6.2.5 Staff at the facility manager office, changing room and lounge area should exit via near water dispenser exit.

6.2.6 Staff at the second storey either exits via in front exits which leads to Nanyang Drive or behind exit near the lift.

6.2.7 Close all doors when the last person makes an exit from a room or corridors.

6.2.8 When you evacuate the building do not use lifts. Exit through stairways that bring you to the meeting point on ground floor.

6.2.9 Before leaving the building researchers/ ARF-staff holding the cages with animals at the experimental room/ laminar flow hood in the animal holding room should put back to the respective cage rack system but should not bring the cages out from the building. If you bring the cages with animals from the SPF area to assembling point, the animal must be sacrificed and disposed off. If you bring the cages with animals from the (second storey) conventional area, they can be put back when you resume back to normal.

6.2.10 When you leave the building, you should not release the animals from the cages. If you release the animals from the SPF area (1st storey), they must be sacrificed & disposed off if able to capture back. If you release the animals from the conventional area (2nd Storey) try to capture and put back to when you resume back to normal.

6.2.11 **Normal** staff assemble at the Quad. **Abnorma**l staffs assemble near the tree at Nanyang Drive which is in front of the SBS signage board until further notice.

6.2.12 Since notice said that persons can re-enter to the building and resume back to the work, please follow the below procedure.

6.2.13 All the normal staff from the SPF area enter via changing room with replaced by new PPE.

6.2.14 All the normal staffs from the conventional area resume back to the building as per normal.

6.2.15 Regardless of whether abnormal persons from SPF area or conventional area, they must be treated at hospital and return back to work only when certified by medical doctor as normal.

For details of Animal House Laboratory operating procedures, please seek advice and assistance form SBS Animal House Facility Manager.

7.0 References & Annexes

1. Biosafety in Microbiological and Biomedical Laboratories at: http://www.cdc.gov/od/ohs/biosfty/bmbl4/bmbl4toc.htm

2. Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets at: http://www.orcbs.msu.edu/biological/bsc/bsc.htm

3. World Health Organisation Laboratory Biosafety Manual at: http://www.who.int/csr/resources/publications/biosafety/who_cds_csr_lyo_20034/en/

4. Mohun, Janet 2002 First Aid Manual (8th Edition). Dorling Kindersley. United Kingdom.

5. Diberarrdinis, Loius J. 2001 Guidelines For Laboratory Design: Health & Safety Considerations. Wiley

6. Interscience. New York. 6.Furr, A. Keith 1995 CRC Handbook of Laboratory Safety (4th Edition). CRC Press, Inc. USA.

7. Fleming, Diane O. 2000 Biological Safety: Principles & Practices (3rd Edition). ASM Press. USA.

8. Workplace Safety & Health Act 2006. Singapore.

9. Biological Agents & Toxins Act 2005. Singapore

Annex (1)

RISK ASSESSMENT FORM

School / Department & Exact Location Of The Work Performed: (Example NBS 01a-23)	Project / Work Description:
Risk Assessment Team (Name/s):	Approved By Supervisor / Reporting Officer: (Name, Date & Signature)
Date Conducted / Next Review Date	

Hazard Identification				Risk Evaluation				Risk Control					
1a.	1b.	1c.	1d.	2a.	2b.	2c.	2d.	3a.	3b.	3c.	3d.	3e.	3f.
S/N	Work Activity	Hazard	Possible Accident / ill health to persons, fire or property loss	Existing Risk Control	S	L	RPN*	Additional Risk Control Measures	S	L	RPN*	Follow up by (name) & date	Remarks

*RPN - Risk Prioritization Number

Annex (2)

HAZARDOUS SUBSTANCE RECORD (NEA Document)

Under the Environmental Protection and Management Act and its Regulations, you are hereby issued with a hazardous substances permit. As a permit holder, you are to comply with the following requirements at all times:-

(a) A proper record on the purchase, store and use of hazardous substances in accordance with the form set out below must be kept in the office/factory.

Name of hazardous substance: _____

Percentage of Purity :_____

Date	Qty Rec'd	Invoice No/Delivery Order No	Name & Address of Supplier	Qty Used	Qty Stored	Signature of Permit Holder

(b) The hazardous substance (s) must be kept in a container, which is:

i) designed, constructed and maintained in accordance to a code/standard acceptable to the Director-General;

ii) restricted to authorised personnel; and

iii) labelled in accordance to a code/standard acceptable to the Director-General

(c) The hazardous substance (s) must not be stored for purpose (s) other than those specified in the permit.

(d) Ensure that the employees have received adequate instruction and training to enable them to understand the nature of the dangers of the hazardous substances being stored and the emergency action plan to be implemented in the event of any accident or emergency involving any hazardous substances stored.

(e) Should the permit be misplaced or lost, a statutory declaration is necessary before a certified true copy of the permit may be issued.

(f) The permit shall be returned to Pollution Control Department if the holder is no longer under the employment of the firm.

(g) Special condition(s) that are stipulated in the permit must be observed at all times.

(h) For permit renewal, the holder may submit the renewal electronically at NEA web site at http://app1.env.gov.sg/pcls/controller?event=WELCOME at least four weeks before the expiry date of the permit.

(i) The Pollution Control Department should be informed of any unwanted remnant stock of hazardous substances. These unwanted substances shall be disposed of through an NEA-licensed toxic industrial waste company.

(j) Permit holder shall notify Pollution Control Department (the licensing authority) of any loss of hazardous substances immediately upon discovery of such loss.

Please note that any violation of the Environmental Protection and Management Act and its Regulations shall constitute an offence punishable by law.