

The Hong Kong Science & Technology Parks Corporation
(HKSTP)

Safety, Health, and Environment (SHE) Handbook

Date of Issue: December 2020

Version: 2.0

HKSTP SHE Handbook Acknowledgement

Accepted and agreed to on behalf of _____, *tenant / incubatee / licensee / contractor to HKSTP. I acknowledge that I am authorized to bind such company to the requirements herein in the HKSTP SHE Handbook.

_____ Signature	_____ Print Name	_____ Date
_____ Title	_____ Phone Number	_____ E-mail address

Company Address:

Business/ Job Nature and Scope:

*Please delete as appropriate

Please return this HKSTP SHE Handbook Acknowledgement to HKSTP SHE Office by post or by email to she_office@hkstp.org :

SHE Office

Hong Kong Science and Technology

Parks Corporation

5/F, Building 5E, 5 Science Park East

Avenue, Hong Kong Science Park

Please attach a business card of the individual who has signed above.

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Supplementary Document – Chinese Version of HKSTP Safety, Health and

Environment (SHE) Handbook (Part I)

If there is any inconsistency or ambiguity between the English version and the Chinese version of HKSTP SHE Handbook (Part I), the English version shall prevail.

HKSTP SHE Handbook Revision Log

Part / Section	Detail of Changes	Version Number	Date of Revision	Initiator
I/C02	Contact numbers of FMO were updated	2.0	12/2020	Jason Hon
I/C10	The contents were revised with additional requirement.	2.0	12/2020	Jason Hon
I/C12	Corrections made to some typos	2.0	12/2020	Jason Hon
I/C17	The contents were revised with additional requirement.	2.0	12/2020	Jason Hon
I/ Appendix	Contact information of Facility Management Office was updated.	2.0	12/2020	Jason Hon
II/A01	1. “Working Group” renamed as “Committee” 2. “Sub-Working Group” renamed as “Sub-Committee” 3. “Facilities Management (FM)” and “Facilities Management Office (FMO)” renamed as “Community and Facilities Management (CFM)” 4. Revised diagrammatic representation of the governance model (Annex 2) to reveal the new line of responsibilities	2.0	12/2020	Danny Fok
II/B01	HKSTP 24 hours Customer Service Hotline (26398008) is the unique emergency contact phone number for all premises at the Science Park	2.0	12/2020	Danny Fok
II/B02	HKSTP 24 hours Customer Service Hotline (26398008) is the unique emergency contact phone number for all premises at the Science Park	2.0	12/2020	Danny Fok
II/B03	HKSTP 24 hours Customer Service Hotline (26398008) is the unique emergency contact phone number for all premises at the Science Park	2.0	12/2020	Danny Fok
II/B05	Completed Laboratory Safety Clearance form should be returned to Lab FM instead of SHE	2.0	12/2020	Kenneth Chan
II/C01	Corrections made to some typos	3.0	12/2020	Danny Fok
II/C14	This is a set of new guidelines entitled “Guidelines for Handling Human Clinical Samples”	1.0	12/2020	Danny Fok

II/C15	This is a set of new guidelines entitled “Requirements for COVID-19 Related Research Projects”	1.0	12/2020	Christine Chiu
II/C16	This is a set of new guidelines entitled “Safety Guidelines for 3D Printing”	1.0	12/2020	Kenneth Chan
Form L07	Completed Laboratory Safety Clearance form should be returned to Lab FM instead of SHE	2.0	12/2020	Kenneth Chan
Supplementary Document	Updated the documentation for Section I/C02, I/C10, I/C12, I/C17 & I/Appendix by referring the English version	2.0	12/2020	Jason Hon

The Hong Kong Science & Technology Parks Corporation
(HKSTP)

Safety, Health, and Environment (SHE) Handbook

Part I

General Safety, Health and Environment Requirements

Section A Policy Statement

A01 Health & Safety Policy

HKSTP is committed to providing a healthy and safe workplace for all who work at or visit our facilities. We promote a culture of individual responsibility for the prevention of injuries and ill health by engaging our staff, partner companies, suppliers and contractors. To these ends, we will:

- Define clear health & safety accountabilities, roles and objectives within HKSTP;
- Comply with applicable legislation, regulations and related requirements;
- Provide resources and training to promote health & safety awareness and culture;
- Adopt a systematic approach to identify and manage health & safety risks; and
- Monitor, communicate and review our health & safety policy and performance, and involve staff participation for continual improvement.

A02 Environmental Policy

HKSTP aspires to a leadership role in promoting environmental stewardship. As a responsible corporate citizen, we commit to resource conservation, waste reduction, pollution prevention and climate change mitigation by:

- Adopting a systematic approach to manage the impacts of our activities and facilities;
- Embracing innovative, cost effective technologies and best-practices towards continual improvement;
- Fostering an environmentally responsible working culture across all levels of staff;
- Making partner companies, suppliers and contractors aware of our environmental standards and engaging their participation; and
- Fulfilling our compliance obligations, and communicating our performance to stakeholders.

Section B Importance Of Safety, Health And Environment

B01 SHE Expectation

At HKSTP, our workforce, tenants, incubatees and facilities are our most valuable resources. No one aspect of our business is more important than providing a safe and secure workplace and operating in an environmentally sound manner. Effective implementation of Safety, Health and Environment (SHE) programs can prevent injuries, control losses and minimize environmental impact. We expect our tenants, incubatees and contractors to join us in providing a workplace free of uncontrolled hazards to people and environment.

Everyone's responsibility of Health, Safety and Environment:

- Follow the legal requirement and HKSTP safety and environmental rules at all times
- Be actively involved in implementing health, safety and environmental measures
- Take reasonable care of self and others at work for their safety and health
- Report incident or accident relating to safety and health matters
- Not to interfere with or misuse, intentionally or recklessly, anything provided in the interests of health and safety

The preparation of this HKSTP SHE Handbook is to clearly communicate HKSTP's SHE requirements and expectations to all tenants, incubatees and contractors. However, it does not replace or limit the requirements of local regulation. It is the tenants, incubatees and contractors' obligation to meet applicable SHE requirements whether or not they are addressed in this document. Tenants, incubatees and contractors shall ensure their employees and subcontractors understand these requirements. For laboratory activity, additional requirements and expectations are applied and the tenants, incubatees and contractors shall refer to the SHE handbook - laboratory and research safety requirement.

Please see the acknowledgement at the beginning of this document. An authorized representative from the tenants / incubatees / contractors should sign the receipt prior to commencing work in the HKSTP's premises with a copy being submitted to the HKSTP. The signature should indicate an acknowledgement and understanding of the requirements of this

document. The information in this document should be communicated and jointly enforced by HKSTP personnel, Facilities Management Office (FMO) / Lab FMO, tenants, incubatees, contractors and sub-contractors.

Before moving in / starting work in HKSTP premises, tenants, incubatees, and contractors shall contact the appropriate HKSTP personnel and follow the requirements of SHE handbook. For work at all the buildings of HKSTP, contractor must register at the reception desk of that building.

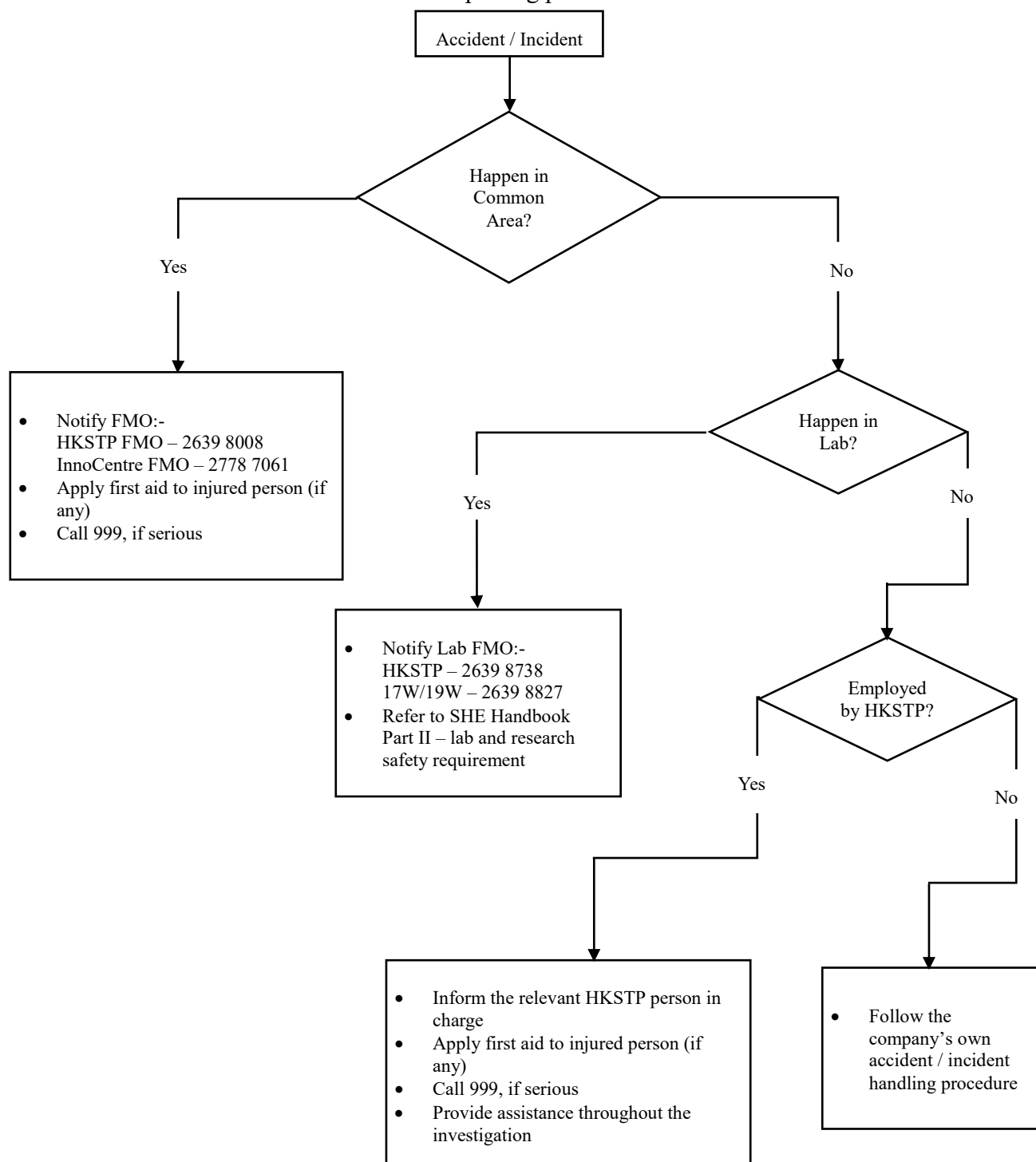
Section C SHE Requirements

C01 General Work Rules For Safety

- a. Sandals should not be worn in the workplace any time.
- b. Do not drink alcohol or take drugs while working.
- c. Horseplay at work is prohibited.
- d. Pay attention to personal hygiene.
- e. Clean up the workplace before leaving.
- f. Emergency evacuation route should not be obstructed at all time.
- g. Always follow the correct working procedures.
- h. Always know the emergency response plan for your workplace.
- i. Be alert and attentive on the job.
- j. Use proper equipment and tool for the job.
- k. Always wear proper personal protective equipment for the work task.
- l. Never touch on live equipment without any protection.
- m. Report any hazardous conditions including near miss case.
- n. Stop work when come across potential hazards.
- o. Do not use any machine or equipment unless you are properly trained.
- p. Smoking is prohibited at indoors and construction site.
- q. Specific training certificate should be obtained for work activities as required by relevant legislation such as work in confined space or electrical work.

C02 Incident Reporting

- a. The companies shall develop an incident handling procedure in case of any incident occurs within their own premises.
- b. If the incident happens in common/public area within HKSTP premise, please inform FMO and follow the reporting procedure below:



- c. People should familiarize with emergency reporting procedure. When reporting emergency by telephone, the following information should be provided:
- Exact location including the name of the building and room number
 - The type of emergency
 - Your name and contact number
 - The reporter should remain on phone until the emergency operator ends the call.
 - Emergency evacuation procedure shall be developed and implemented.
 - 24 hours emergency contact number should be submitted to FMO.

C03 SHE Inspection / Audit

- a. The purpose of site inspection is to identify any potential hazard in the working area and implement adequate control measures to prevent accident. To ensure people uphold the high safety standards, conducting self-inspection of the working environment, plant, equipment and work behavior is highly recommended.
- b. The inspection record should be kept for at least a year and available for auditing if required.
- c. Any observation of unsafe situation should be immediately addressed and reported to person in charge (PIC) if the premise is under the management of HKSTP. All rectification work should be recorded in report format and submitted to the PIC.
- d. HKSTP should have the right to assess tenants / incubatees / contractors working areas, including but not limited to offices, laboratories, and storage areas (including DG stores), for SHE inspections or audits whenever necessary.

C04 Emergency Programme

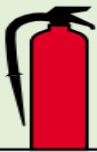
To well prepare for emergency situation, you are advised to work out the followings:

- a. In case you hear the emergency alarm bell or the broadcast message in HKSTP premises regarding any emergency:
 - Keep calm;
 - Stop using the telephone lines for emergency;
 - Switch off electrical appliances if possible;
 - If time permits, pick up your important personnel belongings;
 - Follow the instructions of the emergency coordinator / fire marshal, go to the nearest exit door and evacuate through the escape route to the designated Emergency Assembly Area. WALK, DON'T RUN;
 - Don't use the lift;
 - Report to the emergency coordinator / fire marshal and stay in the designated assembly area for further instructions;
 - Do not attempt any re-entry to your office premises until instruction has been given by the Facility Management Office / Emergency Coordinator / Fire Marshal.
- b. Emergency procedure should be developed to address different emergency situations. All personnel should familiarize with the procedure through training or regular drill.
- c. Appropriate emergency equipment must be available and easily accessible at workplace.
- d. First aid facilities shall be provided and maintained in accordance with the statutory requirement:
 - For construction site, a separate first aid facility shall be provided and maintained for every 50 workmen or part thereof employed on the site;

- For the workplace other than construction site, a separate first aid facility shall be provided and maintained for each 100 employers, or part of that number.
- e. The location of first aid box shall be readily and easily accessible.
- f. The name of responsible person of first aid box shall be affixed to it.
- g. Responsible person shall check and maintain the first aid provisions regularly in accordance to the requirement listed in the booklet “Hints on First aid”.
- h. Provision of emergency showers and eyewash units might be required if you use hazardous substances for particular work activity. User shall be trained in the use of and be made aware of the location of emergency equipment.

C05 Fire Safety

- a. HKSTP prohibits smoking inside its facilities /premises. Violators will be asked to leave the premises.
- b. Properly use the fire extinguishing equipment in dealing with the identified fire risk.

Applications against different fire sources				
Types of fire extinguishers Categories of fires	Water agent 	Foam agent 	Carbon dioxide 	Dry powder agent 
Category I: ordinary fire sources - paper, cloth, wood, plastic, etc. 	✓	✓	✗	✓
Category II: flammable liquids or gases - solvents, fuels, LPG, etc. 	✗	✓	✓	✓
Category III: Electrical appliances - motors, electricity switches, etc. 	✗	✗	✓	✓

Source: Fire Safety at Workplace – Occupational Safety & Health Council

- c. Locate the fire extinguishing equipment in visible and easily accessible positions.
- d. Access to exits, exit routes, or fire equipment or prop open stairwell doors shall be free of obstruction.
- e. Do not use fire extinguishing equipment unless you are properly trained.
- f. Flammable liquid and combustible material are easily ignited and thus shall be properly stored.
- g. Annual inspection of the fire service installation shall be arranged by approved contractor under fire services department.
- h. All Science Park users should participate in regular fire drills. Contractor in construction site should arrange and conduct fire drill at regular interval.
- i. Know the fire evacuation procedure and get familiar with routes of escape and

location of the muster point.

C06 Personal Protective Equipment (PPE)

- a. Use of PPE is the last resort when other hazard control measures cannot eliminate all hazards.
- b. Appropriate PPE should be properly selected and provided when performing certain activities or working in designated areas.

Type of Protection	PPE
Head Protection	Safety Helmet with Y-chin Strap
Eye Protection	Safety Goggle, Face Shield, Welding Goggle
Hearing Protection	Ear Muff and Plug
Hand Protection	Safety Gloves (Cut Resistance, Thermal and Chemical Protective Gloves etc.)
Foot Protection	Safety Shoes, Safety Boots
Skin Protection	Lab Coats, Safety Gloves
Respiratory Protection	Face Mask for Particles (N95, half face mask with filter etc.), Respirator with Cartridge for Chemicals

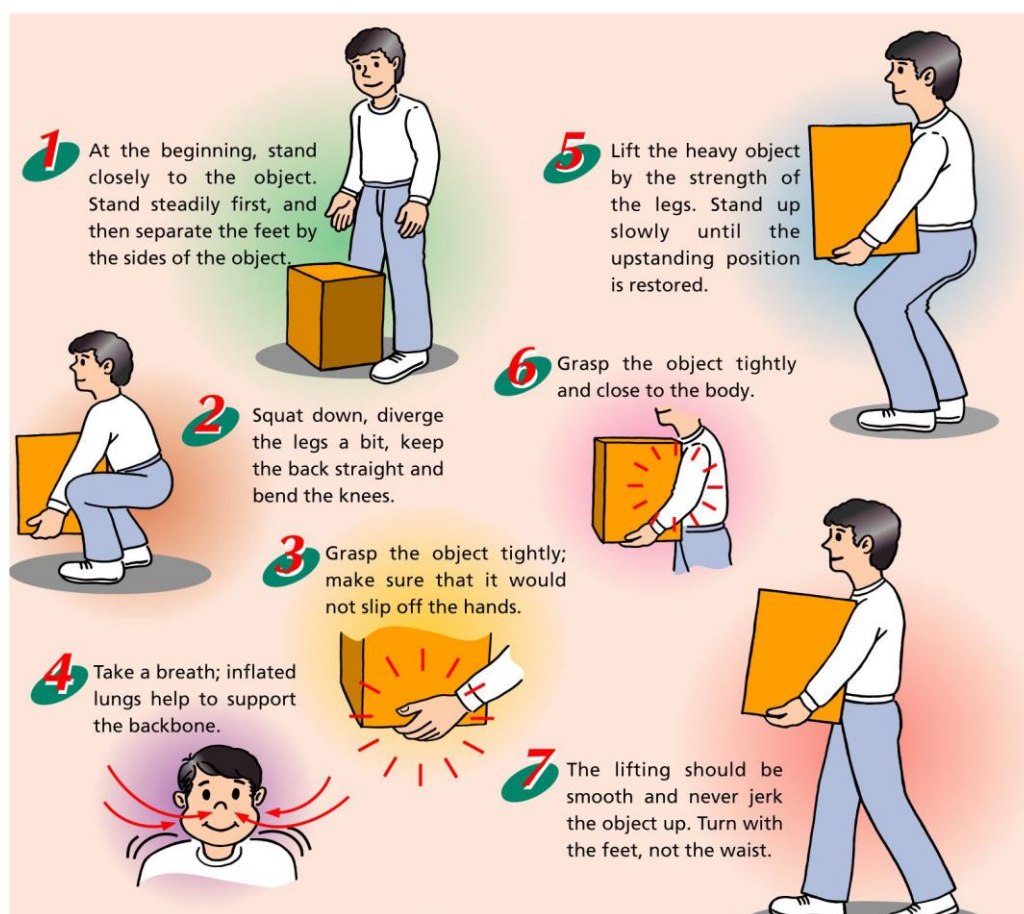
- c. All PPE should comply with the relevant statutory requirement/ specification or an equivalent standard acceptable to fulfill mandatory requirement of international safety standard.
- d. All PPE should be regularly inspected for performance and maintenance in good working conditions. Any defective or expired PPE should not be used and be replaced immediately.
- e. Adequate training should be provided to personnel on inspection and use of the PPE.
- f. All PPE should be provided with appropriate accommodation for the storage when it is not in use.
- g. HKSTP / FMO / Lab FMO will stop work if appropriate PPE is not used.

C07 Housekeeping

- a. Maintain workplaces and storage area tidy and clean.
- b. Stack and store all materials and equipment at a designated location. Material should be evenly and securely stacked to prevent from sliding, falling or collapsing. Heavy object should generally be stacked close to the ground to create a stable base with lower center of gravity.
- c. No one should be allowed to climb onto or from stacked materials.
- d. Temporary cords or hoses shall be hung at reasonable height level when routed across aisles.
- e. Keep clear from obstruction at all workplaces, passageways and stairways.
- f. Clean up spillage of liquid or other substances to eliminate slip and fall hazard. Display warning notice whenever necessary.
- g. Protect and fence off sharp objects and other material. Remove all protruded objects if possible.
- h. Regular inspect, clean and repair all equipment and tools. Remove damaged equipment and tools.
- i. Remove waste and debris at regular interval.
- j. Sanitary facilities should be kept clean.
- k. Inspect the workplace regularly to assure its tidiness.
- l. When machinery is being stripped for maintenance or repairs, plant components or parts should be stored in a neat and tidy manner.

C08 Manual Lifting / Material Handling

- a. For handling of load over 16kg, conduct manual handling operation assessment by a competent assessor.
- b. Provide adequate and suitable training to the manual handling operators.
- c. Consider the characteristics of the task, loads, working environment, individual capabilities and other factors before carrying out manual handling operation.
- d. Use suitable accessories or mechanical aids in avoiding or relying on the manual handling operation whenever required.
- e. An individual should not lift, lower or carry loads over 55kg without mechanical aids.
- f. Use the correct manual handling operation technique:

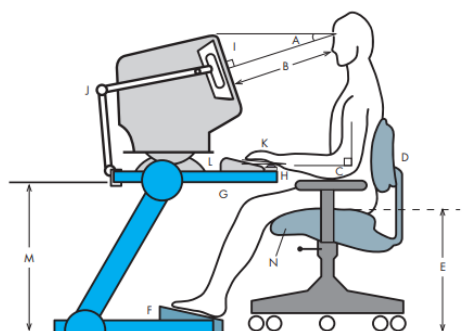


Source: General Safety Instructions for Manual Handling – Occupational Safety & Health Council

- g. For proper manual lifting / material handling, refer to “An Employee Guide to Manual Handling Operation” and “Guidance Notes on Manual Handling Operations”.

C09 Display Screen Equipment

- a. An employee would be a “DSE User”, if he, by the nature of his work, is required to use display screen equipment almost every day – (i) continuously for at least 4 hours during a day; or (ii) cumulative for at least 6 hours during a day.
- b. Work with DSE is subject to the requirements under Occupational Safety and Health (Display Screen Equipment) Regulation in Hong Kong.
- c. Perform a risk assessment of a workstation in the workplace before it is first used by users and review the assessment if there has been a significant change in the conditions of the previous assessment or in the workstation.
- d. Take appropriate steps to reduce any risk identified in a risk assessment to the lowest extent as is reasonably practicable.



- A Comfortable viewing angle, e.g. 15° - 20°
- B Comfortable viewing distance,
e.g. 350 - 600mm for text of normal font size
- C Forearm and arm at about right angle
- D Adjustable back rest
- E Adjustable seat height
- F Firm foot rest if required
- G Adequate knee clearance
- H Wrist rest if required
- I Screen at right angle to line of sight
- J Adjustable document holder
- K Wrist kept straight or at most slightly inclined
- L Screen support adjustable for rotation and tilting
- M Adjustable table height preferable
- N Rounded or scrolled edge seat pad

Source: A Guide To Work With Computers – Occupational Safety and Health Branch, Labour Department

- e. For more information, please refer to “Code of Practice for Working with Display Screen Equipment” and “A Health Guide on Working with Display Screen Equipment”.

C10 Electrical Safety

- a. All portable electrical appliances should be in good working condition.
- b. All portable electrical appliances should comply with the requirements as set out in relevant legislation.
- c. All portable electrical equipment should be provided with an effective switch to operate the equipment.
- d. For use of electrical equipment in outdoor environment, all power plug / connection should be of industrial splash proof type.
- e. All electrical cables of portable electrical appliance should be of flexible type.
- f. Rigid cable should only be used for fixed installation and should be securely fixed at all time.
- g. All portable electrical equipment used in areas containing combustible or flammable vapors, dusts, or fibers should be of explosion-proof type.
- h. The housing or casing of the equipment should be free from crack or damage.
- i. Plugs and extension cords should not be overloaded and shall be fitted with correctly rated fuse.
- j. Torn or fray cord should be replaced immediately.
- k. Defective equipment should be removed for use and repaired immediately once a deviation is identified.
- l. Ensure the portable electrical equipment are protected against leakage of current, such as double insulation, earth leakage circuit breaker (ELCB) or residual current circuit breaker (RCCB). Where residual current device is used, it should be checked on its functioning and followed by a test at regular intervals.
- m. Handheld tools and portable lamp operated by dry batteries or rechargeable batteries are strongly recommended.

- n. Do not leave electrical appliances on at night unless the appliances are designed to be left on (e.g. freezers).
- o. No more than one adaptor or one extension unit should be inserted into a socket outlet to prevent circuit overload and fire.
- p. Only use adaptors and extension units which comply with legal safety requirement.
- q. All general electrical installations should be properly installed and maintained in good working order by competent person, e.g. Registered Electrical Worker.
- r. All wiring should be installed and maintained in a safe condition according to specification or regulation.
- s. All exposed electrical conductors should be properly insulated, covered or segregated to prevent contact by personnel.
- t. No damage or faulty switches, plugs, jointing, fuse / boxes wiring or distribution boards etc. shall be used.
- u. No loose glands, unauthorized tampering, unsafe temporary wiring, temporary connections and incorrectly mounted switches are allowed.
- v. Access to the switchboard should be restricted to authorized electricians only.
- w. The notice on treatment for electric shock shall be displayed in all parts of the premises where electricity is generated, transformed, or used and at such other places in those premises.
- x. Electrical work should only be carried out by qualified electricians who are competent to the class of work to be performed.
- y. All temporary distribution board should be locked; the name and contact information of responsible electrical worker and statutory warning notice should be displayed at distribution board.

Source: Electric Shock – Labour Department

C11 Chemicals And Hazardous Substances

- a. Inventory list of all hazardous chemical substances should be developed and updated regularly.
- b. Periodic review of inventory list should be conducted.
- c. Use appropriate material of container to store chemical substance. All containers should be properly identified by proper labels and signs. Information contained in the labels shall be bilingual, i.e., in English and Chinese.
- d. A relevant Material Safety Data Sheet (MSDS) in either English or Chinese should be provided for every hazardous chemical substance used.
- e. Storage or conveyance of hazardous chemical substances shall comply with the relevant legislations:
 - Dangerous Goods Ordinance (Cap. 295)
 - F&IU (Dangerous Substances) Regulations (Cap. 59AB)
 - F&IU (Carcinogenic Substances) Regulations (Cap. 59AA)
- f. Storage of hazardous chemical substances shall not exceed the allowable maximum quantity as stipulated by Dangerous Goods Ordinance (Cap. 295). Dangerous good license is required if stores, uses or conveys hazardous chemical substances in excess of its individual exempt quantity or the following aggregate exempt quantity for Cat 5 dangerous goods:
 - i. Aggregate exempt quantity of Cat.5 Cl.1 dangerous goods is 40L;
 - ii. Aggregate exempt quantity of Cat 5 Cl.2 dangerous goods is 40L.

Some examples are:

Name	Cat. / Cl. / Div.	Exempt Quantity
Acetone (丙酮)	Cat.5, Cl.1, Div.2	20L
Ethyl Alcohol (乙醇)	Cat.5, Cl.1, Div.2	20L
Isopropyl Alcohol (異性丙醇)	Cat.5, Cl.1, Div.2	20L
Paint (漆油類)	Cat.5	See Cellulose (Not

		exceeding an aggregate of 250L)
Turpentine and Turpentine Substitutes (松節油及其代品)	Cat.5, Cl.2, Div.1	20L

- g. The general condition of storage area of hazardous chemical substances should be as follow:
- well ventilated;
 - located at a suitable distance from the public places and other hazardous materials;
 - different categories of substances are to be stored separately;
 - appropriate warning signs should be affixed to the outside of the store.
- h. Persons who require to handle and / or use, or supervise the handling and / or use of hazardous chemical substances should be properly trained in the handling of the substances, and have a knowledge of the potential hazards and the emergency procedure for handling substances.
- i. The wearing of personal protective equipment, e.g. gloves, safety goggles, etc. is essential if close contact with hazardous chemical substance is required.
- j. Do not leave any chemicals unattended and left container open without use; Chemical should be stored inside cabinet instead.
- k. A hazardous chemical substance should never be mixed with another material without a complete knowledge of any possible chemical reaction between the two.
- l. Flammable chemical substance shall not be applied onto live electrical apparatus and its proximity or naked flame and its proximity.
- m. Good ventilation should be maintained when flammable or volatile chemical substance is to be used.

- n. Emergency response plans including information of emergency contact numbers and / or contact person should be established based on the risks of the hazardous chemical substances being evaluated.
- o. Chemical waste producer is required to be registered with Environmental Protection Department.
- p. Chemical wastes shall be collected by the registered chemical waste collector. Do not throw chemical waste as general refuse.
- q. Chemical substance user shall immediately report to FMO / Lab FMO, in case of chemical related incidents such as spillage happens in public area / laboratory respectively within HKSTP premises.
- r. For more information, please refer to “Fire Protection Notice No. 4 – Dangerous Goods for more information”, “Hazards During Chemicals in Use and Safety Guidelines” and “A Guide to the Chemical Waste Control Scheme”.

C12 Compressed Gas Cylinders

- a. All gas cylinders shall:
 - be labeled or marked to identify contents and properly stored;
 - not be stored in exits or egress routes, damped areas, near salt or corrosive chemicals, fumes, heat, or where exposed to weather;
 - be stored within a well-ventilated areas;
 - be properly stored by grouping together in racks or banks with individual chains to secure them in an upright position;
 - be kept away from all flammable, combustible or incompatible substances;
 - not be dragged or physically carried. Move cylinders with a hand truck designed for the transport of cylinders. Cylinders caps shall be secured during transport;
- b. To prevent chemical reactions, cylinders with dis-similar contents shall not be grouped together.
- c. Close valves when cylinders are idle, empty or moved. Valve protection caps should be in place when cylinders are moved or stored.
- d. Release residual gas pressure from the hoses after the valve is turned off.
- e. Shall not store compressed gas cylinder exceeding the allowable maximum limit as stipulated by Fire Services Department (refer to Fire Protection Notice No. 4 – Dangerous Goods for more information). Some examples are:

Name	Cat. / Cl. / Div.	Exempt Quantity
Acetylene (乙炔)	Cat.2, Cl.3	2 cylinders
Argon (氬)	Cat.2, Cl.1	1 cylinder
Carbon Dioxide (二氧化碳)	Cat.2, Cl.2	1 cylinder
Nitrogen (氮)	Cat.2, Cl.1	1 cylinder
Oxygen (氧)	Cat.2, Cl.1	2 cylinders

- f. Dangerous good license is required if stores, uses or conveys dangerous goods in

excess of its individual exempt quantity in respect of that type of dangerous good or the following aggregate exempt quantity for Cat 2 dangerous goods:

- Aggregate exempt quantity of Cat.2 dangerous good is 5 cylinders or 25L of gases where 1 cylinder is deemed to be equivalent to 5 L.
- g. Transportation of compressed gas cylinder in passenger lift is prohibited. Transportation must be by service lift only after registration with the relevant FMO Customer Service Counter.
- h. Regulators, hoses, and torch assemblies shall be in working order and checked for leaks prior to initial use or installation. If a leak develops, remove the cylinder to a safe location outside the building and report the case to HKSTP relevant department, FMO and government authorities if needed.
- i. Cylinders must be only of types approved by the Authority with (for permanent and liquefied gases) approved examination and testing of cylinders within the preceding 5 years and (for dissolved gases) approved examination within the preceding 12 months.
- j. Users are required to allow the FMO to record the types and quantities of compressed gas cylinders to and from Science Park building at the time of collection or delivery by their vendors.

C13 Hot Work (Electric Arc Welding, Gas Welding And Flame Cutting)

If hot work shall be performed, it is HKSTP's expectation that contractors shall prepare and submit method statement and risk assessment to FMO (for works within premises of Science Park) or HKSTP Project Development Division (for works at construction site). The assessment shall include evaluation of other work in the vicinity that has the potential to create hazard. Hot work permit shall be granted and checked by FMO or management of contractor (applicable to construction site) before carrying out the activity.

- a. Risk assessment shall be carried out by competent person with implementation of hot work permit system for carrying out hot work activities.
- b. Factors to be considered in assessing risk include the gas supply system, working environment, particular of the works, size and shape of the workplace.
- c. Verify hot work equipment is in proper working order.
- d. All sources of flammable/ combustible substance should be isolated/ kept away.
- e. Provide suitable ventilation system.
- f. Firefighting equipment, e.g. portable fire extinguishers, fire blankets, sand buckets, etc., should be provided.
- g. Use non-combustible or flameproof shields to protect nearby personnel from direct rays of welding arcs.
- h. Any person carrying out hot work activities should be properly trained for use of the relevant equipment.
- i. Equip gas cylinder with suitable flashback arrestor and non-return valve.
- j. Wear proper personal protective equipment such as safety goggles, safety masks/ face shield and protective glove.
- k. For manual electric arc welding, the workpiece should be earthed.
- l. Place the welding transformer and regulator outside the confined space where

practicable for electric arc welding operation in a confined space.

- m. Stay on insulation mat or non-conductive stand when carrying out electric arc welding operation in a damp workplace.
- n. Ensure that slag, sparks and workpiece are completely cooled down before leaving the work area.
- o. Prior notify HKSTP Project Development Division/ FMO / Lab FMO with the date, time and location for any temporary operation involving open flame or which produces sparks. This includes but not limited to welding, cutting, grinding and brazing.
- p. Refer to “Code of Practice: Safety and Health at Work for Gas Welding and Flame Cutting”, and “Code of Practice: Safety and Health at Work for Manual Electric Arc Welding” for more information.

C14 Boiler And Pressure Vessels

- a. The owner of a new boiler, air receiver or pressure vessel shall, not less than 30 days preceding the day on which it is intended to be used, apply to the Boilers and Pressure Vessels Division of the Labour Department for registration (Form 3).
- b. Every boilers and pressure vessels shall be examined by a boiler inspector / air receiver inspector periodically (Boiler: every 14 / 26 months, depends on the type of boiler and period of boiler usage; Air receiver / Steam receiver: every 26 months). After extensive repair or change of premises, the boiler / pressure vessel shall be examined by inspector again. A certificate of Fitness (Form 1 for a steam boilers/ Form 2 for pressure vessel other than a pressurized fuel container) should be issued by the inspector in accordance with ordinance.
- c. The certificate of fitness shall be kept in premises / location at which boiler or pressure vessel is installed.
- d. All boilers and pressure vessels shall be identified and numbered. Test pressure and maximum permissible operating pressure shall be marked on the boiler and pressure vessel.
- e. No boiler or steam receiver shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate all classes or types of boiler and steam receiver / competent to operate boilers or steam receivers of the class or type in question.
- f. No boiler or pressure vessel shall be operated at a greater pressure than the maximum permissible working pressure specified in the latest certificate of fitness.
- g. Nobody shall be allowed to remove the lead seal of the safety valve or attempt to adjust the setting of the safety valve to increase the steam pressure.
- h. In case an accident happens to a boiler or pressure vessel or its accessories with the

risk of loss of life or property damage, the boiler or pressure vessel must be shut down immediately. The owner should report the accident to the Boiler and Pressure Vessels Division within 24 hours.

- i. Refer to Chapter 56 – Boiler and Pressure Vessels Ordinance for more information.

C15 Working At Heights

- a. Wear safety harness and attach the lanyard securely to the designated anchorage point or independent lifeline with fall arrester when working at heights. Information, instruction and training on use of fall protection equipment should be provided.
- b. Inspect fall protection equipment before use.
- c. Wear safety helmets with chin straps when working at heights.
- d. Do not perform overhead work when there is a danger of falling objects striking a person below. Isolate such work areas with barriers.
- e. Throwing or dropping tools and equipment is prohibited.
- f. For working at height of 2 meters or more, use of working platforms (Scaffold / mobile platform / elevating working platform) should be the first consideration. Ladders should not be used for working at height of 2 meters or more.
- g. Working platforms shall either be closely boarded, planked or plated. Every board or plank forming part of the working platform shall be:
 - i. Wider than 200mm and thicker than 25mm; or
 - ii. Wider than 150mm if it is thicker than 50mm
- h. Working platforms shall be at least 400mm wide. For use as a passage of transporting materials, the working platform has to be at least 650mm wide.
- i. Working platforms shall be provided with a guardrail to a height of 900mm to 1150mm and an intermediate guardrail to a height of 450mm-600mm.
- j. Toe-board shall be at least to a height of 200mm to prevent materials falling from the working platform.
- k. For working at height below 2 meters, light-duty working platform (Step platform (figure 1) / Hop-up platform (figure 2)) / mobile platform (figure 3) should be adopted as far as reasonably practicable.



Figure 1: Step Platform



Figure 2: Hop-up Platform



Figure 3: Mobile working platform

1. If it is not practicable to follow the above requirement due to special reason, use of ladder including stepladder (A – ladder) shall be justified by an assessor through risk assessment on site with permit to work system.

C16 General Safety Precaution Of Using Ladder

- a. Wooden ladder shall not be used in HKSTP premises.
- b. Ladders are intended for access to heights only.
- c. Check the ladder before use and maintain record on a comprehensive checklist.
- d. Ladders with broken steps or rails, missing anti-slip feet, or other defects are prohibited.
- e. Fiberglass ladder should be used for any electrical work.
- f. Facing the ladder and maintain a three-point contact with it when climb up or down.
- g. Place ladder on flat and firm level ground with non-slippery surface.
- h. Haul materials with a rope rather than carry up by ladder.
- i. Only one person uses ladder at a time.
- j. Place the ladder on a 1:4 ratio of setback distance to height.
- k. Keep at least 1 meter above the landing point.

C17 Scaffolding Safety

- a. Erection, alteration and dismantling work of scaffold must be carried out by competent persons and trained workmen.
- b. Wear safety harness and attach lanyard to an anchorage point or independent lifeline with fall arrester for the scaffolding work.
- c. Working platforms shall be provided with a guardrail to a height of 900mm to 1150mm and an intermediate guardrail to a height of 450mm-600mm.
- d. Toe-board shall be at least to a height of 200mm to prevent materials falling from the working platform.
- e. The scaffold should be erected on a firm and stable ground.
- f. Inspection on the scaffold should be arranged and conducted by the competent person every 14 days with completion of the statutory inspection form (CSSR Form 5).
- g. Fence off the working area with display of warning notice.
- h. No throwing or tipping of scaffolding material from height.
- i. A contingency plan for adverse weather shall be prepared. Inspection of the scaffold is required after adverse weather.
- j. Construction and planking arrangement of metal/bamboo scaffolding should be in accordance to the technical requirement of manufacturer's instruction and Code of Practice for Bamboo Scaffold Safety and Code of Practice for Metal Scaffolding Safety published by Labour Department.
- k. Any setting of scaffold that may affect the structure of the building shall seek prior approval from FMO.
- l. Approval of design or checking from Profession Engineer of structural or civil discipline may be required for certain types of metal/bamboo scaffold. Please

comply with the requirement stated in the “Code of Practice for Bamboo Scaffold Safety” and “Code of Practice for Metal Scaffolding Safety”.

- m. Refer to “Code of Practice for Bamboo Scaffolding Safety”, “Code of Practice for Metal Scaffolding Safety” and “Guidelines on Planking Arrangement for Providing Working Platforms on Bamboo Scaffolds” for more information.

C18 Powered Operated Elevated Working Platform

- a. Risk assessment should be carried out to identify all potential hazard associated with the operation of a power-operated elevated working platform.
- b. Safe work methods and procedure for the operation should also be required.
- c. Only competent person who is undergone training for the relevant model of power-operated elevated working platform is allowed to operate that working platform.
- d. The power-operated elevating work platform should be thoroughly examined and tested by a competent examiner before use or after undergoing substantial repair.
- e. Visible permanent markings or notices to indicate safe working load, maximum number of person to be carried, and maximum reaching height and radius of the power-operated elevated working platform should be clearly displayed.
- f. Weekly inspection should be carried out by a competent mechanic or the operator.
- g. Wear a suitable safety harness with its lanyard anchored to a specified anchorage point.
- h. Suitable guardrail and toe-boards should be provided on the working platform.
- i. Emergency stop function should be installed at prominent position to enable power to all systems to be cut off.
- j. The machine should be fitted with an effective lock-on brake or other means to hold the unit on the maximum slope it is designed for while loaded with its safe working load.
- k. Consider the working environment, the ground conditions, etc. for use of power-operated elevating work platform.
- l. For more information, please refer to the “Guidance Notes on Safe Use of Power-operated Elevating Work Platforms”.

C19 Safe Use Of Suspended Working Platform

- a. Only trained person is allowed to work on suspended working platform.
- b. Wear suitable safety harness and attach the lanyard to an independent lifeline with fall arrester suitable anchorage and fittings on suspended working platform.
- c. Display notice of safe working load (SWL) and number of persons allowed.
- d. Do not overstretch the body outside a suspended working platform or overload a suspended working platform.
- e. Suspended working platform should not be used under adverse weather conditions.
- f. Maintenance record of suspended working platform should be kept.
- g. Consult competent person for erection, alteration and dismantling of a suspended working platform.
- h. All the suspension ropes and safety ropes should be inspected by a competent person.
- i. Weekly inspection should be carried out by competent person and recorded in statutory inspection form (SWP Form 1).
- j. Suspended working platform must comply with thoroughly inspected, examined and tested periodically in accordance with the statutory requirement.
- k. Facilities Management Office (FMO) is responsible to control the person who can operate the suspended working platform of the building; only the person on the authorization list can operate the suspended working platform.
- l. Get an approval from FMO before assemble / use temporary suspended working platform.
- m. Refer to “Code of Practice for Safe Use and Operation of Suspended Working Platforms” for more information.

Legal Requirement of Suspended Working Platform	
Applicable Regulation:	F & IU (Suspended Working Platforms) Regulation
Item	Inspection Form No. (SWP)

Suspended Working Platform	1	2	3
Period	7 days	Preceding 6 months before put into use or after substantial repair, re-erection, adjustment to any member of the suspended working platform, failure or collapse	Preceding 12 months before use

C20 Lifting Appliances And Lifting Gear

- a. All lifting appliance and gear must comply with thoroughly inspected, examined and tested periodically in accordance with the statutory requirement.
- b. Implementation of colour coding system is recommended to indicate the lifting gear is being inspected and found to be in safe working order.
- c. All safety features of the lifting appliance must be provided and maintained in good condition including the automatic safe load indicator.
- d. Operator of the lifting appliance shall be properly trained and competent.
- e. Operator shall conduct inspection of the lifting appliance and complete the statutory inspection form (LALG form 1).
- f. Do not leave suspended loads unattended! No one should stay underneath the transportation route. Riggers and banksman shall alert any passerby during the lifting operation.
- g. Riggers and banksman shall be thoroughly trained and competent for the lifting operation.
- h. Establish a restricted work area with use of barricades and other appropriate controls to minimize the hazards to personnel from swinging or falling objects.
- i. Check the working environment and weather condition before carrying out the lifting activity.
- j. Consult competent person for erection, dismantle and alteration operation of the lifting appliance.
- k. Risk assessment should be arranged to identify potential hazard and formulate method statement and control measure prior to the lifting activity.
- l. Refer to the publication of “Code of Practice for Safe Use of Tower Crane”, “Code of Practice on Safe Use of Mobile Crane” and “Guidance Notes on Inspection,

Thorough Examination and Testing of Lifting Appliance and Lifting Gear” for more information.

Legal Requirement of Lifting Appliance and Lifting Gear							
Applicable Regulation:	Lifting Appliance and Lifting Gear Regulation						
Item	Inspection Form No. (LALG)						
	1	2	3	4	5	6	7
Crane	√		√		√		
Crane with anchoring or ballasting devices	√	√	√		√		
Winch, Crab	√		√		√		
Pulley Block, Ginwheel, Sheerlegs, Pile Driver, Pile Extractor, Excavator, Overhead Runway, Dragline, etc	√			√	√		
Lifting Gear						√	√
Fibre Rope							√
Period	7days	After erection	4 years		12 months	Before put into use	6 months
			Before use or after substantial repair, re-erection, failure, overturning or collapse				

C21 Mechanical Plant

- a. Mechanical plant refers to any power-operated mobile machine which is operated by a person riding on the machine including excavator, bulldozer, loader, forklift, cranes, and cherry picker etc.
- b. Only trained operator can control the mechanical plant in compliance with regulation.
- c. Inspection should be arranged regularly and recorded in an inspection form to assure it is in safe working condition.
- d. Plant with malfunctioning safety features shall be removed from service until repairs are completed.
- e. Refueling shall be performed in area with adequate ventilation. Do not refuel vehicles while the engine is running.
- f. All mechanical plant should be maintained at its proprietary status. Any modification for the plant shall not be made unless it is being allowed by the manufacture's authentication or permission in written form.
- g. All mechanical plants shall comply with the requirement of the Non-road mobile machinery (NRMM) regulation with display of approved or exempted labels.
- h. Refer to publication "A Guide to the Factories and Industrial Undertaking (Loadshifting Machinery) Regulation", "Guidance Notes on Safe Use of Loadshifting Machines for Earth Moving Operations on Construction Sites" and "Guidelines on Safety of Site Vehicles and Mobile Plant" for more information.

C22 Woodworking Machinery

- a. Woodworking machine must only be operated by persons who are competent for this purpose.
- b. All dangerous parts of the woodworking machinery should be properly guarded.
- c. Push stick/block must be available and used to prevent worker's hands from moving near the saw.
- d. Emergency stop must be installed to stop the machine in case of emergency.
- e. A stopping and starting devices should be provided to control the woodworking machine.
- f. Woodworking machine must be regularly checked and maintained in good condition. Operators must not use the machine if there is any sign of defect.
- g. The working area should be kept clean and free of obstruction. Wood chips should be regularly removed.
- h. The floor where the woodworking machine is installed should be maintained in good and level condition.
- i. Proper personal protective equipment (safety goggle and ear protectors) should be used when using the woodworking machine.
- j. Please refer to publication of "A Guide to the Factories & Industrial Undertakings (Woodworking Machinery) Regulation" for specific requirement on safety in the use of woodworking machines.

C23 Machinery Guarding

- a. All hazardous moving parts of machinery within normal reach of personnel shall be completely guarded to prevent personnel from coming into contact with the moving parts of machinery or equipment.
- b. Make sure that effective guards are in place and working properly.
- c. Every guard should be rigid and of substantial construction.
- d. All plant and machinery should be regularly checked and maintained in good condition including the associated guarding.
- e. Guards should be secured in position at all times when the parts are in motion.
- f. Any attempt to alter or remove the guarding is not allowed.
- g. Turn off the machine for replacement or maintenance of guard.
- h. Please refer to the “Handbook on Guarding and Operation Machinery” for the design and installation requirement of the guarding.

C24 Abrasive Wheel

- Mounting of abrasive wheel shall only be carried out by competent person who receives competence training.
- Do not use defective wheels.
- Ensure the maximum permissible speed of abrasive is clearly marked.
- Ensure the spindle speed is marked on the machine in both English and Chinese.
- Ensure the maximum permissible speed of abrasive wheel is higher than the spindle speed of machine.
- Ensure the guard is in place after mounting of the abrasive wheel.
- Ensure the statutory warning notice for use of abrasive wheel is clearly displayed near the abrasive wheel or in a conspicuous location.

此告示已由勞工處處長批准，並須根據
工廠及工業經營(砂輪)規例第14條所規定而張貼

使用砂輪時 應注意下列

危險	安全預防措施
(1) 砂輪爆裂之原因： 砂輪之內有雜質	用適當試驗辦法，檢查砂輪之 完整性。
超速轉動	依標砂輪標籤之指示， 不可超過最高允許轉速。
錯誤安裝	砂輪須由一位專人安裝及 於砂輪之安裝時，人須留神。
使用不當	勿用砂輪磨削 或磨削之位置與砂輪外圓面打滑時， 應特別小心。
(2) 裝固輪子與軸點之破裂	勿用過度緊力裝固之砂輪。 勿用過度緊力裝固之砂輪。 勿用過度緊力裝固之砂輪。
(3) 與砂輪接觸	使用：護罩、枕墊、防護網 (或護身用具)。
(4) 飛濺之微粒引起眼部受傷	砂輪須正確安裝。

使用前須檢查清楚

This warning notice has been approved by the Commissioner for Labour
and must be posted for the purpose of Regulation 14 of the Factories and
Industrial Undertakings (Abrasive Wheels) Regulations

WARNING NOTICE WHEN USING ABRASIVE WHEELS

DANGERS	SAFETY PRECAUTIONS
(1) Bursting of wheel, due to: Latent defect of wheel	Check soundness of wheel by ring test.
Overspeeding	Do not exceed maximum permissible speed of wheel as specified by manufacturer.
Faulty mounting	The wheel must be mounted by a trained and competent person appointed in writing.
Misuse by operator	Never use excessive pressure on the wheel. Use particular care when grinding on the side of a straight-sided wheel.
(2) Fractures of mounted wheels and points	The overhang not to exceed that is permissible by the manufacturer. The mandrel to be secured properly in the collet of chuck.
(3) Contact with wheel	Use: Wheel guards, work-rest, protective screen (or eye protectors).
(4) Eye injuries from flying particles	Wheels must be properly trued and dressed.

ALWAYS CHECK
BEFORE YOU OPERATE

Source: Warning Notice When Using Abrasive Wheels – Labour Department

- The abrasive wheel shall be regularly inspected and maintained by the competent person.
- Ensure the ground is in good condition, free from obstruction and not slippery when

operating the machine.

- j. For carrying out grinding operation, proper protection of eye such as safety goggles is required.
- k. For more information, please refer to the publication of “Safety In The Use of Abrasive Wheel”.

C25 Work In Confined Space

- a. Confined space is defined to mean any place in which, by virtue of its enclosed nature, there arises a reasonably foreseeable specified risk, and without limiting the generality of the foregoing, includes any chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft or silo in which such risk arises.
- b. Specified risk means a risk of
 - Serious injury to any person at work arising from a fire or explosion;
 - The loss of consciousness of any person at work arising from an increase in body temperature;
 - The loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour, or the lack of oxygen;
 - The drowning of any person at work arising from an increase in the level of liquid; or
 - The asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid.
- c. Any person who enters in the confined space must attend an approved safety training course in connection with confined space work and holds a relevant certificate.
- d. Risk assessment shall be conducted by competent person who receives approved safety training course and holds a relevant certificate before entry to confined space as required by regulation. Any changes in environment must be re-assessed.
- e. The result of risk assessment should be displayed at the entrance of confined space with warning notice.
- f. Before entry into confined space, the confined space should be adequately purged

by inert gas purging, steam cleaning and forced ventilation. Atmospheric testing should also be carried out from outside of the confined space.

- g. Make sure safety equipment and personal protective equipment are used including atmospheric testing equipment, protective clothing, safety helmet, respirators, life-line, ventilation equipment and safety harnesses etc.
- h. A worker should be assigned to standby at the entrance of confined space throughout the time of operation for emergency communication and coordination.
- i. Ensure all relevant control measures such as isolating critical valves or purging of fresh air are implemented before entering to the confined space.
- j. Establishment of an emergency rescue procedure to handle any emergency situation of the confines space work.
- k. Refer to “Code of Practice for Safety and Health at Work in Confined Spaces” for more information.

C26 Excavation And Trenching

- a. Ensure underground utility marking, signage, barricades and shoring are in place before excavation work.
- b. Mark location of underground utilities before digging to prevent service interruption or hazards from damaging utility lines. If the location of underground cables are identified and exposed, hand digging may be required.
- c. Excavation plant should be properly selected and maintained to ensure it is suitable for the work to be carried out.
- d. Operator of excavator should be competent and trained in the use of machine. Weekly inspection of excavator shall be arranged and recorded in the statutory inspection form (LALG Form 1).
- e. Place warning signage and barriers on all sides of excavated trench to prevent pedestrians from crossing.
- f. Inspection of excavation should be carried out by a competent person as required by law and recorded in the statutory inspection form (CSSR Form 4).
- g. Proper access should be provided for all excavation.
- h. Contact HKSTP Project Development Division / FMO before beginning of excavation work.
- i. For more information, please refer to “code of practice for safe use of excavator”

Legal Requirement of Excavation			
Item	Applicable Regulation	Inspection Form No.	Period
Inspection of Excavation	Construction Site Safety Regulation	Form 4	7 days
Inspection of Excavator	Lifting Appliance and Lifting Gear Regulation	Form 1	7 days
		Form 4	Before use or after substantial repair, re-erection, failure, overturning or collapse

		Form 5	12 months

C27 Traffic Safety

- a. All workers working along roadside must wear reflective vest at all time.
- b. The boundaries of all road works on carriageway must be clearly delineated by traffic cones. The requirement of traffic cone should conform to the general requirements of BS EN 13422:2004 and shall be of appropriate height. The white portion must be retroreflective and the red portion may be retroreflective or have a fluorescent finish.
- c. Traffic cone should be placed close enough together to give an impression of continuity and an appearance of substance. The maximum cone spacing can refer to the requirement listed under Code of Practice for the Lighting, Signing and Guarding of Road Works (COP-LSG) issued by Highway Department.
- d. Obstruction and excavation shall be adequately guarded at all time.
- e. Pedestrians shall be protected from the works and vehicles by rigid barriers (ex. Water-filled or temporary tubular barriers) which can clearly separate pedestrians from the work and trafficked carriage and warn pedestrian of their presence. The barriers should be placed with sufficient clearance to excavation, materials or plant to prevent dangers to pedestrians.
- f. Water-filled or temporary tubular barriers shall provide a clear and uniform overall appearance. Adjacent panels shall be interlocked together without gaps affecting their guarding purpose. The containment level of the barriers should be designed to meet BS EN 1317-2:2010 containment level T2 or above.
- g. During the hours of darkness or at times of poor visibility, all obstructions or road works must be properly delineated with prescribed road hazard warning lanterns to indicate to road users the limits of the works.
- h. General Road Works Signs shall be properly displayed on site. The method for display of signage shall align with the standard and requirement stated in COP-LSG.

- i. Approach and exit tapers shall be in place to guide any road-user to safely pass the works area. The use of traffic cones and barricades shall provide a uniform and consistent indication to road user of the obstruction or excavation on carriageway. Barricade signs should be used with flash arrow sign at location where visibility could be a problem.
- j. Adequate length of approach tapers and height and spacing of traffic cones shall be provided and it is recommended to refer to COP-LSG for general standard and requirement. All traffic arrangement shall be agreed by Facility Management Office (FMO).
- k. A minimum clear footway width of 1.5 meters should be maintained for pedestrians when work is carried out on footway. If it is impractical to provide the minimum width for the footway, an alternative route should be provided or a permission from FMO should be granted for reducing the width of footway.
- l. Any material storage on carriageway or footway shall be adequately guarded by continuous barriers. Stored plant and material should be kept as far back as possible from the edge of carriageway and in such a position that sightlines are not obstructed. A permission must be granted by FMO if material is needed to be stored on carriageway.
- m. If works are carried out on cycleway, a desirable minimum clear width of 1.8 meters should be maintained for cyclist.
- n. A lateral safety clearance shall be maintained between the works area and any part of trafficked carriageway.
- o. A longitudinal safety clearance shall be maintained between end of the approach taper and the works area which provides a margin of safety for both the traffic and road works personnel and should not be used as a working space. A minimum length of 10 meters longitudinal safety clearance zone shall be provided as recommended in the COP-LSG.

Whereas the provision of longitudinal safety clearance zone is not feasible, FMO must be informed of the situation with implementation of alternative arrangement.

- p. Emergency Vehicular Access (EVA) shall not be blocked at all times.

C28 Noise At Work

- a. Ensure appropriate action to be taken to reduce risk of hearing impairment such as mechanical maintenance and provision of information, instruction and training.
- b. Carry out preliminary noise assessment with noise meter if the noise level is deemed to be unacceptable. E.g. It is difficult to be heard between people around 2 meters apart. If the noise level is identified to be 85dB(A) or above, a noise assessment is required to be conducted by a competent person.
- c. A workplace where the noise level reaches 90dB(A) or above is classified as ear protection zone. Any person staying inside ear protection zone shall put on suitable approved ear protectors. Demarcate and identify ear protection zone with labelling at the zone.
- d. Reduce noise intensity such as providing noise barrier.
- e. For more information, please refer to the “Guidance Notes on Factories and Industrial Undertaking (Noise at Work) Regulation”.

C29 Provision Of Safety Officers And Safety Supervisors

The Factories and Industrial Undertaking Ordinance (F&IU) provides for the safety and health protection to worker in the industrial sector. It applies to industrial undertaking, i.e. construction sites, catering establishments, repair workshops and other industrial workplace. Under F&IU (safety officer and safety supervisors) regulation, employment of safety officer and supervisor is required to assist the proprietor of the industrial undertaking in managing safety and health.

- a. One registered safety officer shall be employed on a full-time basis when the total number of persons employed in the construction site or sites is 100 or more.
- b. One safety supervisor shall be employed where the total number of persons employed in each construction site is 20 or more.
- c. The workplace of contractor activities can be classified as construction work.
Construction work means: -
 - i. The construction erection, installation, reconstruction, repair, maintenance (including redecoration and external cleaning), renewal, removal, alteration, improvement, dismantling, or demolition of any of the Specified Structures and Works;
 - ii. Any work involved in preparing for any operation referred to in paragraph (i), including the laying of foundations and the excavation of earth and rock prior to the laying of foundations;
 - iii. The use of machinery, plant, tools, gear, and materials in connection with any operation referred to in paragraph (i) or (ii).
- d. For more information, please refer to “Cap. 59Z Factories and industrial undertakings (safety officers and safety supervisors) regulations”.

C30 Permit And License

- a. Any person require to carry out contractor works in HKSTP premises are required to submit method statement and risk assessment to HKSTP Project Owner/ FMO for review. Work permit should be acquired from FMO if the work is commenced within HKSTP Science Park/ InnoCentre. Examples of work activities requires submission of method statement and risk assessment:
- Metal/Bamboo scaffolding
 - Excavation
 - Welding work
 - Lifting operation
 - Use of mechanical plant for work at height
 - Use of chemical substance
- b. Tenants / incubatees / contractors are always responsible for ensuring that any work that requires a specific license is only performed by individuals who are appropriately registered and / or licensed.

C31 Hazardous Waste Management

- a. Tenants / incubatees / contractors are fully responsible to comply all applicable local legislation for disposal of hazardous waste they generate at HKSTP premises. Hazardous waste may be generated from operation, maintenance, construction, and renovation activities and a variety of other activities in HKSTP premises.

Common hazardous wastes generated at HKSTP premises may include:

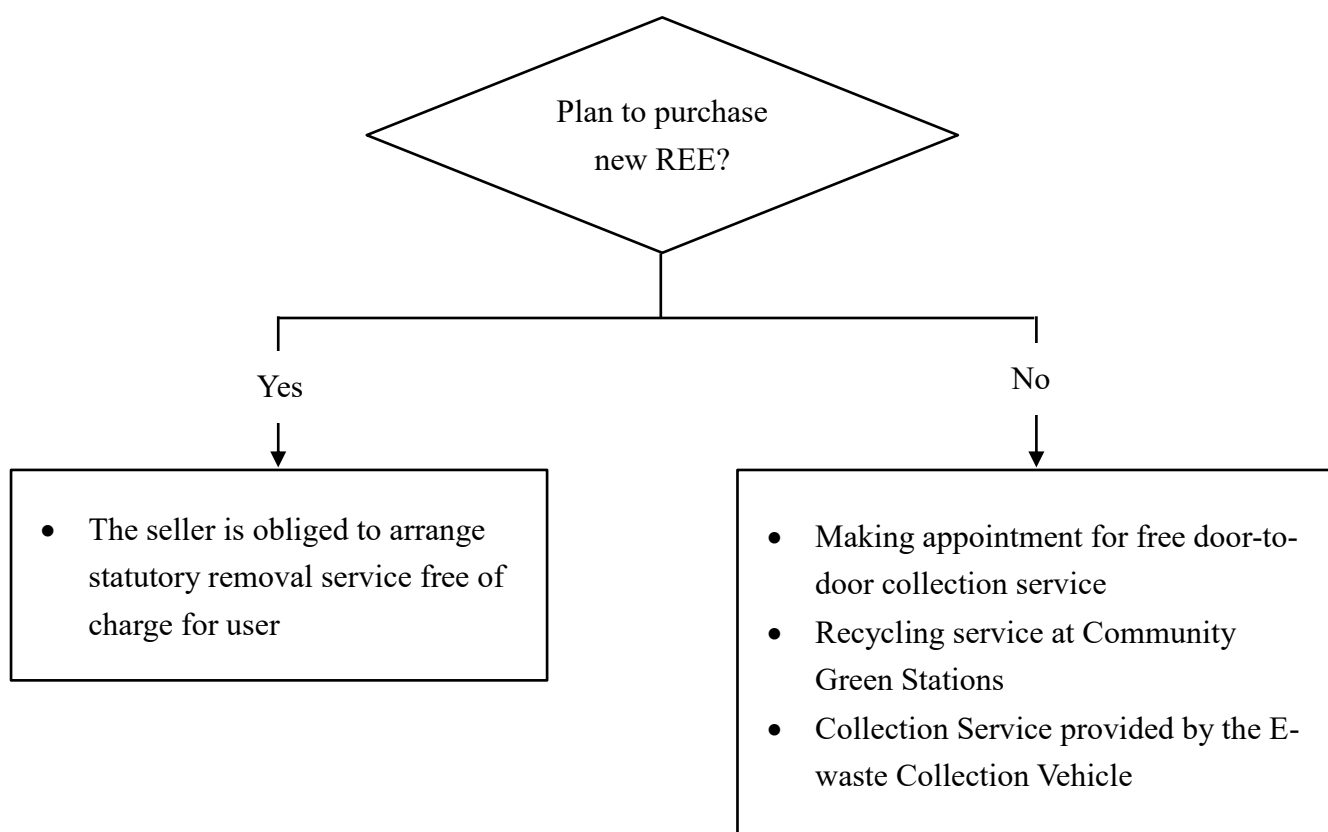
- Biological / Clinical waste;
 - Radioactive waste;
 - Air emission, including greenhouse gases and regulated pollutants generated from transportation;
 - Used solvents and chemicals;
 - Waste oils and lubricants generated by a variety of operations;
 - Unused chemicals and other hazardous substances, such as strong acids and bases, paints, aerosol cans, etc. that are no longer needed, do not meet specifications, are contaminated, have exceeded their storage life, or are otherwise unusable;
 - Used ethylene glycol and other coolants;
 - Printed circuit board (PCBs), batteries, lead paint and other miscellaneous materials including, contaminated rags and wipes, broken mercury-containing lamps (fluorescent lamps) and thermometers.
- b. In the event a hazardous material is released to the environment during the course of work in HKSTP premises, tenants / incubatees / contractors shall contact the HKSTP relevant division / FMO / Lab FMO and government authorities.

C32 Disposal Procedure For Chemical Bottles

- a. Solvent bottles, glass or plastic, which were used to store chemical should not be recycled because of possible contamination.
- b. If chemical bottles are disposed as general waste, these bottles must be rinsed 3 times before being discarded. Make sure to always perform this procedure in a working fume hood or well-ventilated area. Do not perform this procedure for any water-reactive chemicals (organometallics, metal hydrides and pyrophoric reagents) or highly toxic reagents (phenol, mercury reagents, cyanide reagents or others).
 - Three – time Rinse:
 - i. Each rinse should consist of minimal water being sloshed around the capped container;
 - ii. First water rinse is considered chemical waste and must be collected in the appropriate waste container. Second and third water rinses can go down the drain. Ensure water is running when flushing rinse water down the drain;
 - iii. For water-insoluble materials, an appropriate solvent (e.g. ethanol or acetone) must be used to pre-rinse the container prior to the water rinses. Collect all solvent rinses as chemical waste;
 - iv. If the chemical is harmful to the environment then all three rinses must be collected, and;
 - v. If unsure about the toxicity of the chemical, refer to its MSDS.
 - Remove or cross out the original product label and indicate “rinsed”.
 - Disposal of the waste bottles the same way as domestic waste.
- c. For more information, please refer to “Notification of Certain Chemical Waste for Disposal”: http://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentin_hk/waste/guide_ref/files/guide_e.pdf

C33 Waste Of Regulated Electrical Equipment Management

- a. Tenants / incubates / contractors shall take the producer's responsibility on disposal of Regulated Electrical Equipment (REE). REE includes: air-conditioners, refrigerators, washing machines, televisions, computers, printer, scanners and monitors.
- b. Producer shall dispose REE properly in accordance with statutory requirement:



- c. Disposal of REE at HKSTP common / public area is not allowed.
- d. For more information, please refer to the website of Waste Electrical and Electronic Equipment (WEEE): <https://weee.gov.hk/>

C34 Food Safety And Hygiene

- a. Food and Beverage Operators in HKSTP properties shall comply with all regulatory requirements and their lease requirements in the management of the Food Safety and Hygiene in their areas.
- b. Food and Beverage Operators in Science Park shall complete independent audits on Food Safety and Hygiene by external testing laboratory on a regular basis and such audit reports shall be copied directly to HKSTP.
- c. The Food Safety and Hygiene audit reports shall include swapping and microbiological tests, as well as the food quality standard, hygiene standard, and quality of stored merchandises and products.
- d. Food, water and ice samples are expected to be taken in each food serving counter of the Food and Beverage Operators for swapping and microbiological tests. If the Food and Beverage operator is serving different meals in a day (breakfast lunch, and dinner), food samples should be taken from each meal at each serving counter in the audit.
- e. In the event that HKSTP is not satisfied with any aspect shown in the audit results, the Food and Beverage operator shall, at its own expenses, rectify such non-compliance immediately and carry out a follow up audit. (Details of re-audit can be found in the lease contract between HKSTP and the operator).
- f. Wastes (Solid, Liquid, and Gaseous) discharged during the Food & Beverage operator's operation must comply with all regulatory requirements. Operators should take sample of their wastewater and perform wastewater quality test regularly.
- g. Operators should not discharge hazardous material and substandard wastewater to drains in any HKSTP premises.
- h. Food and Beverage Operators are responsible for the operation and maintenance of

wastewater treatment facilities (for example grease traps) and pest control in their areas regularly. HKSTP reserves the right to request operators to submit the operation and maintenance records / schedules of their wastewater treatment facilities and wastewater quality testing reports for review.

- i. Should substandard waste was found discharged from a Food and Beverage operator, the operator will be responsible for all liabilities and costs that incurred due to the discharge.
- j. Refer to “Food Hygiene Code” published by Food & Environmental Hygiene Department for more information.

https://www.fehd.gov.hk/english/publications/code/code_all.pdf

Appendix

Appendix 1 – Contact Information Relevant Safety & Health

HKSTP SHE Office Contact Information:

Should you have any questions on this document or on HKSTP SHE requirements, please contact HKSTP SHE Office through:

Email: she_office@hkstp.org

Tel: 2629 6793

Hong Kong Science Park FMO / Lab FMO Contact Information:

Hong Kong Science Park Facilities Management Office

Customer Service

Facilities Management Office (HK Science Park)

Urban Property Management Limited

Unit 213 – 215, Core Building 1, No. 1 Science Park East Avenue, Hong Kong Science Park

Tel: 2639 8008

Lab FMO Contact Information:

Laboratory Facilities Management Service Centre (HK Science Park)

Linde HKO Limited

Unit 317, 3/F, Core Building 2, No.1 Science Park West Avenue, Hong Kong Science Park

Tel: 2639 8738 Pager: 71163322 (a/c 8410)

Laboratory Facilities Management Service Centre (HK Science Park 17W & 19W)

MGI (Far East) Limited

GM/F, Building 19W, 17 & 19 Science Park West Avenue, Hong Kong Science Park

Tel: 2639 8827

InnoCentre FMO Contact Information:

InnoCentre Facilities Management Office

ISS EastPoint Property Management Ltd.

G/F, Management Office, InnoCentre, 72, Tat Chee Avenue, Kowloon Tong, Kowloon

Tel: 2778 7061 Fax: 2778 4782

Industrial Estates Contact Information:

Tseung Kwan O, Tai Po & Yuen Long Industrial Estate

Mr. Alex Chan

Tel: 2623 9619 / 9491 0034

GMP Centre Management Office, Taipo Industrial Estate

Mr. Kwok Man Fai

Urban Property Management Limited

Tel: 2660 0165

PMC Building Management Office, Taipo Industrial Estate

Mr. Ronnie Kwok

ISS EastPoint Property Management Limited

Tel: 2856 3178

Appendix 2 – Relevant Safety And Health Legislations

The followings are the ordinances and regulations related to occupational safety and health in Hong Kong:

1.	Gas Safety Ordinance	Cap 51
2.	Boilers and Pressure Vessels Ordinance	Cap 56
3.	Factories and Industrial Undertakings Ordinance	Cap 59
4.	Factories and Industrial Undertakings Regulations	Cap 59A
5.	Factories and Industrial Undertakings (First Aid in Notifiable Workplaces) Regulations	Cap 59D
6.	Factories and Industrial Undertakings (Notification of Occupational Diseases) Regulations	Cap 59E
7.	Factories and Industrial Undertakings (Woodworking Machinery) Regulations	Cap 59G
8.	Factories and Industrial Undertakings (Electrolytic Chromium Process) Regulations	Cap 59H
9.	Construction Sites (Safety) Regulations	Cap 59I
10.	Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations	Cap 59J
11.	Factories and Industrial Undertakings (Abrasive Wheels) Regulations	Cap 59L
12.	Factories and Industrial Undertakings (Work in Compressed Air) Regulations	Cap 59M
13.	Factories and Industrial Undertakings (Spraying of Flammable Liquids) Regulations	Cap 59N
14.	Factories and Industrial Undertakings (Goods Lifts) Regulations	Cap 59O
15.	Factories and Industrial Undertakings (Guarding and Operation of Machinery) Regulations	Cap 59Q
16.	Factories and Industrial Undertakings (Cartridge Operated Fixing Tools) Regulations	Cap 59R
17.	Factories and Industrial Undertakings (Protection of Eyes) Regulations	Cap 59S
18.	Factories and Industrial Undertakings (Noise at Work) Regulation	Cap 59T
19.	Factories and Industrial Undertakings (Fire Precaution in Notifiable Workplaces) Regulations	Cap 59V
20.	Factories and Industrial Undertakings (Electricity) Regulations	Cap 59W

21.	Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations	Cap 59Z
22.	Factories and Industrial Undertakings (Carcinogenic Substances) Regulations	Cap 59AA
23.	Factories and Industrial Undertakings (Dangerous Substances) Regulations	Cap 59AB
24.	Factories and Industrial Undertakings (Suspended Working Platforms) Regulation	Cap 59AC
25.	Factories and Industrial Undertakings (Asbestos) Regulation	Cap 59AD
26.	Factories and Industrial Undertakings (Confined Spaces) Regulation	Cap 59AE
27.	Factories and Industrial Undertakings (Safety Management) Regulation	Cap 59AF
28.	Factories and Industrial Undertakings (Loadshifting Machinery) Regulation	Cap 59AG
29.	Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation	Cap 59AI
30.	Fire Services (Installations and Equipment) Regulations	Cap 95B
31.	Dangerous Goods Ordinance	Cap 295
32.	Radiation Ordinance	Cap 303
33.	Waste Disposal Ordinance	Cap 354
34.	Noise Control Ordinance	Cap 400
35.	Electricity Ordinance	Cap 406
36.	Builders' Lifts and Tower Working Platforms (Safety) Ordinance	Cap 470
37.	Fire Safety (Commercial Premises) Ordinance	Cap 502
38.	Occupational Safety and Health Ordinance	Cap 509
39.	Occupational Safety and Health Regulation	Cap 509A
40.	Occupational Safety and Health (Display Screen Equipment) Regulation	Cap 509B
41.	Fire Safety (Buildings) Ordinance	Cap 572
42.	Hazardous Chemicals Control Ordinance	Cap 595

The Hong Kong Science & Technology Parks Corporation
(HKSTP)

Safety, Health, and Environment (SHE) Handbook

Part II

Laboratory and Research Safety Requirements

Section A Policy

A01 Laboratory And Research Safety Policy

1. Preamble

Hong Kong Science and Technology Parks Corporation is committed to the health and safety of everyone involved in or affected by laboratories and research activities on its premises by:

- a) Complying with all applicable local statutory safety, health, and environmental regulations;
- b) Adopting applicable international standards and best practices in laboratory and research safety;
- c) Building a standard laboratory environment with well-maintained infrastructures and facilities;
- d) Promoting a culture of safety among the research communities in the Science Park.

2. Purpose

This Laboratory and Research Safety Policy provides a safety management framework for controlling the environmental, health and safety risks arising from laboratory and research activities with hazardous chemicals, biological agents and physical agents. It provides the foundation for the development of guidelines and procedures for various indispensable laboratory and research safety programs.

3. Scope

In this policy, the governance and responsibilities for managing health and safety in laboratories are defined. Laboratory and research safety requirements are applicable to all corporate management units, Clients and visitors.

4. Definitions

Building Provisions: Refers to building services and utilities in accordance with the building plan, which include the MVAC system with preinstalled duct works, electrical services, fire Installation services, building drains, plumbing and town gas, etc.

Clients: These include tenants, incubatees and any affiliated laboratory users including licensees, registered members, etc.

Corporation: Refers to Hong Kong Science and Technology Parks (HKSTP) Corporation (also referred to as “HKSTP”).

Laboratory: A laboratory is a space, building or part of a building which is specially designed and built for conducting scientific research, experiments, tests and related works with potential hazards.

Laboratory Provisions: Laboratory services and utilities that are fitted out in later stage to provide certain utility services for laboratory operation, such as compressed air, nitrogen, carbon dioxide, pure water, chemical drain with neutralization plant and fume exhaust system.

Laboratory Person In-Charge: A competent person delegated to manage the health and safety issues of an individual laboratory.

Laboratory Worker/User: A laboratory worker or user is any person (including employee, student, or visitor) who works in a laboratory with or without pay.

Management Units: Refer to divisions and departments of HKSTP Corporation (A list of concerned management units is shown in Annex 1).

Risk: Means, in relation to any potential injury or harm, a measure of the likelihood and consequence of injury or harm occurring.

Science Park: Refers to the location where the Corporation’s premises are situated.

5. Governance and Responsibilities

A diagrammatic representation of the governance model is attached in Annex 2.

5.1 The Board of Directors

- a) Establishing the Corporation's health, safety and environmental policies, standards and procedures through the Project and Facilities Committee (PFC).
- b) Overseeing their implementation through the Chief Executive Officer (CEO) in the Central Safety Committee.

5.2 The Chief Executive Officer (CEO)

- a) Having the overall responsibilities for health, safety and environmental matters within the Corporation.
- b) Leading the Central Safety Committee, as its Chairman, in the implementation of the corporate health, safety and environmental policies, standards and procedures established by the Board of Directors.
- c) Managing to provide adequate resources on health, safety and environmental programs at all levels.

5.3 The Central Safety Committee

The Central Safety Committee serves as an executive team of the Corporation reporting directly to PFC for overseeing and implementation of the corporate health, safety and environmental policies, standards and procedures. Its responsibilities include:

- a) Formulating policies, standards and procedures for adoption by the Corporation.
- b) Implementing and monitoring of the adopted policies, standards and procedures.
- c) Monitoring and review of the overall health, safety and environmental performance and compliance with applicable government regulations and relevant standards.

- d) Establishing Sub-committees or special advisory groups, as appropriate to deliver advice and guidance on special policies and to monitor risk control in affected areas.
- e) Developing effective communications channels with different management units.
- f) Having regular discussions at least twice a year.

5.4 The Laboratory Safety (LS) Sub-Committee

The LS Sub-Committee is a special advisory group and is responsible to the Central Safety Committee for overseeing and implementation of laboratory safety related policies, standards and procedures. Its responsibilities include:

- a) Formulating laboratory related health and safety policies, requirements and guidelines.
- b) Developing mechanism for a coordinated and consistent approach to managing laboratory safety risks across the Corporation.
- c) Setting laboratory related health and safety performance targets for the Corporation.
- d) Monitoring laboratory and research safety performance in compliance with relevant legislations, policies, standards and procedures.
- e) Reviewing particular laboratory related health and safety issues.

5.5 Safety, Health and Environment Office (SHE):

SHE assists the Central Safety Committee and LS Sub-Committee in execution of health, safety and environmental policies, guidelines and procedures across the Corporation. It has the following responsibilities with respect to laboratory and research safety:

- a) Developing and implementing the corporate laboratory and research safety policies, guidelines and procedures.

- b) Providing and maintaining the necessary laboratory facilities applicable to the Clients in safe and sound conditions.
- c) Advising the management units and Clients on all aspects of laboratory and research safety including laboratory design, laboratory safety practices, and compliance with local legislation, corporate policies, and international best practices.
- d) Monitoring the management of laboratory and research safety by conducting audits, inspections, etc.
- e) Investigating laboratory related incidents and accidents and devising preventive measures to avoid recurrence.
- f) Assessing the need for and developing training programs to promote laboratory and research safety.
- g) Suspending or prohibiting any laboratory operation that poses an imminent risk of serious injury or ill health.

5.6 Community and Facilities Management (CFM)

The Director of CFM leads the Community and Facilities Management (CFM) and has the following roles with respect to laboratory and research safety:

- a) Liaising with the Clients, where appropriate, and vets the corresponding layout plans in respect of building regulations and building provisions requirements.
- b) Ascertaining if the building provisions including essential and backup power, cooling, etc. meet with the Clients' requirements or provides alternative solutions.
- c) Maintaining the building provisions including central MVAC system to meet the committed level of services.
- d) Serving as advisor for the LS Sub-Committee.

5.7 Laboratory Safety Coordinators (for concerned Clusters of HKSTP)

Management Units of the Corporation with operation of laboratories and research facilities (refer to Annex 1) have responsibilities to ensure health, safety and environmental compliance for their laboratory operations. Each of these Management units (i.e. the concerned Clusters) shall appoint at least one Laboratory Safety Coordinator, preferably at senior manager grade, and ensure sufficient training and resources are provided to such appointed person in order to perform the assigned tasks.

General duties of the Laboratory Safety Coordinator include the followings:

- a) Serving as ex officio member of the LS Sub-Committee.
- b) Formulating laboratory safety management system specific to the laboratory concerned including rules and guidelines in consultation with SHE of the Corporation.
- c) Monitoring the implementation of applicable laboratory and research safety policies and guidelines in the respective laboratories and research facilities.
- d) Liaising with relevant parties on laboratory and research safety issues.

5.8 Laboratory Persons In-Charge

Laboratory Persons In-Charge are designated by individual HKSTP's Management Units or Clients, as the case maybe (in consistent with the content of the "Health, Safety and Environment Compliance Declaration" form). They should have received relevant safety training, be familiar with the laboratory operations and safety procedures in the laboratories. The Laboratory Person In-Charge is responsible for:

- a) Managing on a day-to-day basis the health and safety of the laboratories or parts of the laboratories under their supervision according to the established laboratory safety policies and regulations of the Corporation and the Clients where applicable.

- b) Providing laboratory safety orientations to all new laboratory workers or users.
- c) Preparing safety instructions or standard operating procedures (SOP) for certain hazardous operations and arrange training to laboratory workers or users accordingly.
- d) Carrying out or delegate an appropriate person to carry out regular self-inspection of the laboratory or parts of the laboratory.
- e) Reporting any laboratory related incident or accident timely to the Corporation via SHE.

5.9 All Laboratory Workers / Users

- a) Completing laboratory safety orientations and special safety trainings as required by individual Client's research facility/center.
- b) Conducting laboratory activities in a safe manner in compliance with all applicable laboratory safety rules and regulations.
- c) Reporting any unsafe conditions, incidents or accidents timely to their Laboratory Persons In-Charge or the emergency response team where appropriate.

6. Essential Elements of Laboratory Safety Management

6.1 Space Allocation and Laboratory Design

Laboratories having activities liable to generating contaminants or involving the use of hazardous chemicals, biological agents, radioactive substances, electrical/mechanical equipment such as high power laser system, etc. shall be assigned to a laboratory space and appropriately designed with safety features for those particular laboratory activities. In the Science Park, many aspects including the premises use classification, building provisions, laboratory provisions, etc. shall be taken into consideration to ensure that

appropriate space is allocated for the intended laboratory operations. Office premises are generally not suitable to be retrofitted for laboratory operations. The following regarding requisition of laboratory space and its design shall be observed:

- a) All laboratory space requests shall be reviewed by CFM and SHE. Approval of the space is based on information provided by applicants including intended laboratory function, types of research activities, hazardous materials, equipment and instrument involved.
- b) Laboratory has to be designed to meet all applicable local statutory requirements as well as the requirements and principles stated in the HKSTP Laboratory Design Guidelines.
- c) Commissioning of laboratories shall be carried out by the responsible service providers and relevant testing/commissioning reports should be available for checking.
- d) SHE and CFM shall arrange a joint laboratory pre-occupancy safety check with the Client once the construction work is completed.

6.2 Designation of Laboratory Persons In-Charge

- a) To ensure the laboratories or research activities are effectively managed following the applicable laboratory safety management requirements, a Laboratory Person In-Charge shall be designated by each laboratory or research facility of the Corporation or tenants. His/her duties are described in Section 5.8.
- b) The name and contact details of the Laboratory Person In-Charge shall be displayed on the placard at the entrance of each laboratory for communication in case of emergency or whenever necessary.
- c) Changes of the Laboratory Persons In-Charge must be reported timely to the SHE

of the Corporation.

6.3 Hazard Identification and Placard System

- a) Hazards associated with the laboratory operations shall be identified by the management of the Clients or their delegates.
- b) Alerts on these identified hazards as well as the emergency contact details for each laboratory shall be displayed at the entrance of each laboratory in the form of a placard following the Corporation's requirement as set out in the HKSTP Laboratory Design Guidelines.

6.4 Access Control and Laboratory Security

- a) Laboratories shall be equipped with self-closing doors and the doors shall be locked at all times under normal situation.
- b) Entry to any laboratory shall be restricted to individuals who are authorized by the Laboratory Persons In-Charge. Authorization criteria shall be clearly identified, such as training needs, proper laboratory attire and etc.
- c) Report any entry of suspected persons or unaccounted loss of hazardous materials to ensure the security of laboratories.

6.5 Laboratory Safety Training

- a) Laboratory Persons In-Charge shall ensure that laboratory safety orientations are provided to all new laboratory workers before they are allowed to work in a laboratory.
- b) In addition, the Laboratory Persons In-Charge should identify the training needs of individual laboratory workers and arrange for specific training as soon as

practicable. Especially for certain hazardous operations, standard operating procedures (SOP) should be written and training should be provided accordingly.

- c) All laboratory safety training records shall be kept readily available for checking during periodic laboratory safety inspections or audits.

6.6 Laboratory Safety Inspection and Audit

- a) SHE shall carry out laboratory safety inspection at all laboratories periodically. A report for each inspection or audit with detailed findings shall be issued to the management of the laboratory. Corrective actions shall be taken by the management and replied to SHE within the prescribed period.
- b) SHE shall conduct laboratory safety audits on any specific research areas or facilities where appropriate and whenever necessary.
- c) Each Laboratory Person In-Charge or his/her delegate shall carry out self-inspection of the whole laboratory or part of the laboratory he/she is responsible for regularly at an interval in accordance with the Corporation's requirements. Completed self-inspection records and follow-up actions shall be kept for future audits by internal or external management bodies or authorities.

6.7 Local Laboratory Rules and Procedures

- a) Management of the Clients shall prepare local rules and safety procedures for their operations in the laboratories.
- b) Emergency procedures shall also be prepared for emergency situations such as spillage of hazardous materials, leakage of hazardous gases, fire, etc.
- c) Such rules and procedures are preferably displayed at conspicuous areas inside the laboratories for all laboratory workers to follow.

- d) Rules and procedures should be based on a risk assessment process.

6.8 Hazardous Waste Management

- a) Hazardous wastes, including chemical waste, clinical waste and radioactive waste, shall be properly managed following local statutory regulations.
- b) Laboratory users shall dispose of hazardous waste into appropriate waste containers.
- c) Laboratory Persons In-Charge shall ensure that waste containers are kept temporarily in the laboratories under proper conditions.
- d) Individual Clients that possess hazardous waste disposal licenses shall arrange collection of wastes by licensed waste collectors.

6.9 Personal Protective Equipment (PPE)

- a) Laboratory workers shall wear proper personal protective equipment in the course of their operations in the laboratories.
- b) Laboratory Persons In-Charge shall ensure that all necessary PPE is readily available to the laboratory workers and properly maintained.

6.10 Laboratory Safety Clearance and Decommissioning

- a) Management of the Clients shall ensure that the whole or parts of a laboratory, whichever applicable, are cleared of all hazardous materials before they vacate the laboratory or parts of the laboratory.
- b) For certain laboratories or parts of a laboratory which have been involved in the use of highly toxic chemicals, infectious agents or radioactive substances, management of the Clients shall exercise proper decommissioning procedures to ensure that areas are free from contamination.

6.11 Suspension of Dangerous Laboratory Operations and Termination of Tenancy

a) Notice of Breach and Rectification:

Laboratories shall be operated by Clients in compliance with all applicable health, safety and environmental legislations and the Corporation's policies and rules. In case any of such is breached, a notice or report shall be issued by Director of SHE of the Corporation to the corresponding Client for rectification immediately or within a prescribed period of time.

b) Suspension of Dangerous Laboratory Operations:

i) Director of SHE of the Corporation has the authority to stop any laboratory operations constituting (1) a clear and imminent danger to health and safety of the personnel inside the laboratory or in the neighboring areas; or (2) a breach of local legislation or the Corporation's policies and rules. The decision of the Director of SHE shall be final and conclusive in this regard.

ii) In the event of such suspension of laboratory operation, Director of SHE shall immediately notify the Chairman of Central Safety Committee of the Corporation for issuance of a suspension notice to the management of the corresponding Client.

iii) Laboratory operations shall not be resumed until the management of the Client has verified to the satisfaction of SHE that appropriate hazard control measures are in place or relevant local legislation or the Corporation's policies and rules are followed through.

c) Termination of Tenancy:

In case the management of the Client fails to take remedial actions to the satisfaction of SHE, the Corporation has the right to terminate the tenancy for the concerned space following procedures laid down in the tenant's agreement of the

Lease.

7. Essential Elements of Research Safety Management

Some of the most promising opportunities for research in science, technology, and medicine carry with them new hazards and significant risks. The Corporation places the highest priority on its responsibility to mitigate these risks and to protect the health and safety of lab personnel, research participants, the general public, and the environment.

7.1 Research Safety and Risk Assessment

- a) Risk assessment shall be conducted to anticipate any new potential health and safety hazards associated with the advanced facilities and techniques. Some research technology can be so advanced that local safety legislation framework may not have been established. In such situation, international best practice, guidelines of professional institutions and prudence principle should be applied.
- b) Upon completion of a risk assessment, appropriate safety control measures shall be in place in order to safeguard laboratory personnel and protect the environment. Risk assessment records should also be properly kept for audit.
- c) Risk assessment should be reviewed regularly or whenever necessary.
- d) For Clients from university or research institutions, those research projects to be conducted in the Science Park are required to be reviewed by their relevant research safety offices.

7.2 Research Ethics

Research protocol shall be reviewed by a research ethics committee in accordance with local regulatory requirements and international ethical standards governing research involving human participants and or animals before that particular part of research

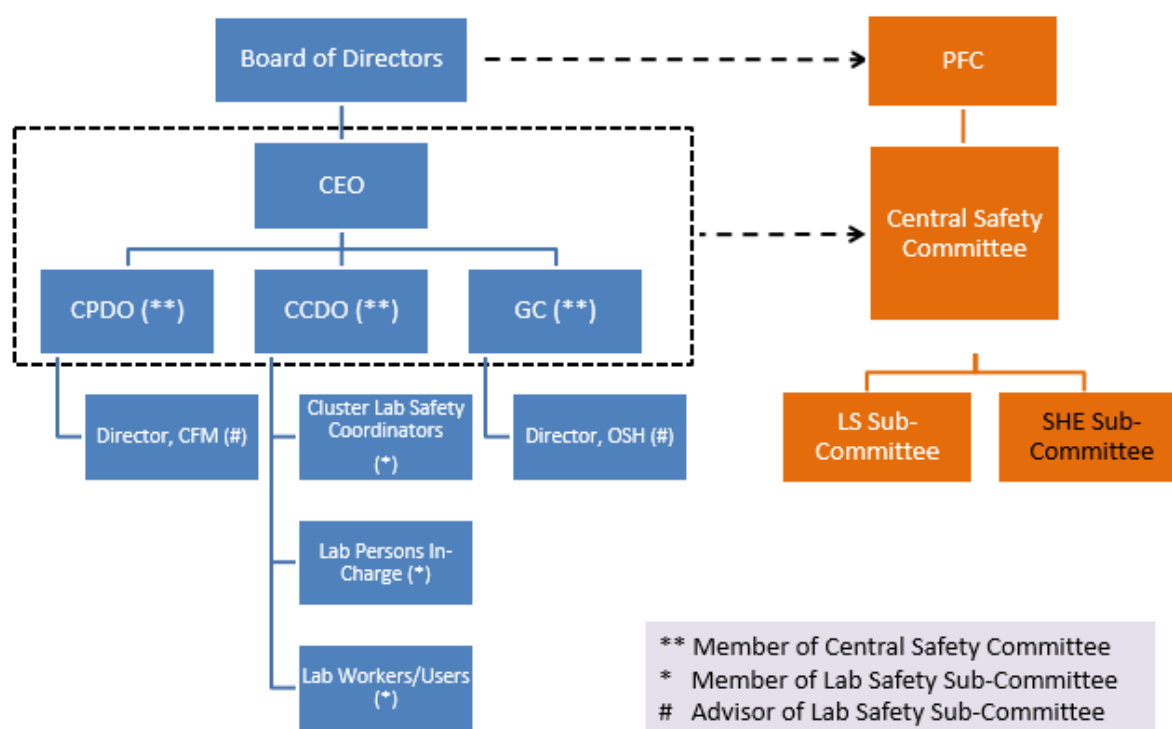
activities are allowed to be conducted in the Science Park.

- a) Any research activity involving human participants for scientific research purposes must be reviewed and approved by an institutional and/or national Human Research Ethics committee (HREC).
- b) All research activities involving the care and use of animals for scientific research purposes shall be subject to ethical review, approval and monitoring by an Animal Ethics Committee (AEC).
- c) All procedures performed in the Science Park shall be in accordance with the protocols approved by the research ethics committee.
- d) All research activities must cease if approval from the ethic committee is suspended or withdrawn.

Annex 1. Management Units of HKSTP with Laboratory and Research Facilities

<i>Management Units of HKSTP</i>
Clusters:
<i>Biomedical Technology (BMT)</i>
<i>Electronics & Electrical (EE)</i>
<i>Green Technology (GT)</i>
<i>Information & Communication Technology (ICT)</i>
<i>Material & Precision Engineering (MPE)</i>
Incubation:
<i>Incutech</i>

Annex 2. A Diagrammatic Representation of the Governance Model



Section B Laboratory & Research Safety Management

B01 General Laboratory Emergency Procedures

1. Introduction

Personnel working in the laboratories at Hong Kong Science Park are recommended to follow the procedures in this document in case of emergency when lives, and/or properties in the laboratories are endangered.

2. Emergency Situations

Emergency situations that may happen in the laboratories include the followings:

- a) Fire
- b) Spillage of hazardous substances
- c) Leakage of gases
- d) Electric shock
- e) Flooding
- f) Personal injuries
- g) Other incidents or accidents endangering lives and/or properties/environment

3. General Emergency Procedures

- a) Keep calm. Inform other laboratory personnel to evacuate if necessary.
- b) Activate HKSTP Emergency Call Button normally located near the entrance of a laboratory.
- c) Turn on the Emergency Ventilation break glass button to activate the system in case of chemical spillage or gas leakage.
- d) Leave the laboratory immediately.

- e) For life threatening situations, contact the local emergency hotline by calling **999**. For other situations, call HKSTP 24hrs Customer Services Hotline for assistance at 2639-8008.
- f) Report to the HKSTP Facilities Management Office's customer front desk at the main building entrance.
- g) Assemble at a nearby safe area as instructed by HKSTP staff and provide information and assistance to emergency responders as needed.
- h) For spillage of hazardous substances, decontamination shall be proceeded following the procedures as detailed in relevant sections of HKSTP's SHE Handbook.

B02 Accident And Incident Reporting Procedures

1. Introduction

According to the Laboratory and Research Safety Policy of HKSTP, all accidents and incidents that happened in or originated from any laboratories shall be reported to HKSTP. The purpose of reporting is to identify causation and determine corrective actions in order to prevent recurrence. This laboratory related accident/incident reporting requirement applies to all laboratory operators including HKSTP clusters, tenants, incubates, licensees, etc.

This document outlines the actions to be taken in reporting an accident or incident and the investigation procedures to be followed.

2. Terminology

An accident – any unplanned event that resulted in injury or ill health of people, or damage or loss to property, materials or the environment.

An incident – any unexpected event that may result in property damage, but does not result in an injury or illness.

3. Responsibilities

Laboratory Worker – S/he who suffers injury due to an accident or witnesses an incident that happen in any laboratory environment is required to report the case to the Laboratory Person In-Charge or his/her supervisor. For emergency situation, s/he shall call the 999 emergency hotline or report the cases directly to HKSTP 24hrs Customer Services Hotline at 2639-8008 following the procedures as delineated in the “General Laboratory

Emergency Procedures” of HKSTP’s SHE Handbook.

Laboratory Person In-Charge – S/he shall assist the injured in an accident or witness of an incident to complete the Accident / Incident Report Form (Appendix 1) and send the completed form to SHE Office within 72 hours.

4. Reporting Procedures

- a) In the event of an accident or incident constituting an emergency or life threatening situation, immediately report and seek assistance in accordance with the “General Laboratory Emergency Procedures” in HKSTP’s SHE Handbook.
- b) After an accident or incident, the concerned laboratory worker (either the injured in an accident or the witness of an incident) is required to inform his/her supervisor and the Laboratory Person In-Charge.
- c) The Laboratory Person In-Charge shall assist the concerned laboratory worker to fill in the Accident / Incident Report Form (Appendix 1) and send the scanned copy of the completed form to the SHE Office of HKSTP by email (she_office@hkstp.org) within 72 hours of the accident / incident.
- d) In addition to the reporting of accidents or incidents to HKSTP by completion of the Accident / Incident Report Form (Appendix 1), concerned employers are required to inform the Labor Department of any serious accidents in accordance with local legislations, i.e. the Occupational Safety and Health Ordinance (Cap 509) and Employees’ Compensation Ordinance (Cap 282).

5. Causes of Accident and Incident

In the Accident / Incident Report Form (Appendix 1), the Laboratory Person In-Charge

or laboratory supervisor is required to identify the causes of an accident or incident in an objective manner. As a simple investigation, interviewing the concerned personnel who may provide clues to the causes may be necessary.

6. Remedial Actions

According to the causes having identified, the Laboratory Person In-Charge or laboratory supervisor shall put down appropriate remedial actions or preventive measures to avoid recurrence of similar accident or incident cases. S/he shall also ensure the implementation of such remedial actions and monitor their effectiveness.

For very serious laboratory related accidents or incidents, HKSTP may demand for an independent group for investigation and following up actions.



Appendix 1 Accident / Incident Report Form

Report No.: _____

Hong Kong Science and Technology Parks Corporation

Note: This report form should be completed and sent to the Safety, Health & Environment (SHE) Office of HKSTP within 72 hours of the accident or incident. The information provided herein will be used for investigation and compiling accident statistics. In case of work-related accident to employee resulting in death or partial incapacity, the concerned unit of HKSTP or the client should fill in the relevant form provided by the Labor Department of Hong Kong and return it in duplicate to the Commissioner for Labor within the statutory required period.		
1. Accident / Incident Information		
Date:	Time:	Location:
Type of Area: ☐ Office ☐ Laboratory / Workshop ☐ Others (Please specify):		
2. Nature of Accident / Incident		
☐ Personal injury	☐ Fire / Explosion	☐ Spillage of hazardous substances
☐ Flooding	☐ Unpleasant smell	☐ Damage to property / equipment
☐ Others (Please specify):		
3. Personal Details (For the injured or person concerned)		
Name:	Sex: ☐ Male ☐ Female	
Post Title:	Phone No.:	
Division / Company Name:		
Company Address:		
Nature of Injury: ☐ Amputation ☐ Burn ☐ Contusion ☐ Fracture ☐ Laceration ☐ Sprain ☐ Others (Please specify):		
Part of Body Injured: ☐ Hand ☐ Leg ☐ Head / Face ☐ Eye ☐ Others (Please specify):		
The injured received medical treatment: ☐ Yes ☐ No		
The injured was hospitalized: ☐ Yes ☐ No		
The injured took sick leave: ☐ Yes (No. of days:) ☐ No		
4. Accident / Incident Reported By		
Name:	Signature:	
Post Title:	Date:	
5. Accident / Incident Report Endorsed By		
Name:	Signature:	
Post Title:	Date:	

Please fill in details about the accident / incident in the next page.



Appendix 1
Accident / Incident Report Form

Report No.: _____

Hong Kong Science and Technology Parks Corporation

6. Brief Description of Accident / Incident
7. Causes of Accident / Incident
8. Recommendation for Prevention of Recurrence

B03 Laboratory Emergency Response Plan

1. Introduction

A laboratory emergency response plan addresses different types of emergency situations in the laboratory environment. Its objectives are:

- a) To prevent fatalities and injuries;
- b) To reduce damage to buildings, stock and equipment;
- c) To protect the environment and the community; and
- d) To accelerate the resumption of normal operations.

At Hong Kong Science Park, laboratory tenants or other laboratory operators are required to formulate their emergency response plans based on their laboratory settings and operations. Such plans shall be revised periodically or whenever necessary. Briefing or induction of the emergency response plan for individual laboratories shall be provided in order that laboratory personnel are familiarized with the respective plans. Drills for certain emergency situations are also recommended to be arranged on a regular basis.

This document provides a framework for laboratory tenants or other laboratory operators at Hong Kong Science Park to develop their laboratory emergency response plans with essential elements laid down in the following section.

2. Essential Elements

A laboratory emergency response plan should include the following essential elements:

- 2.1. Personnel responsibilities and roles – Laboratory operators shall assign responsible personnel who are trained to be liaison personnel, emergency coordinators or responders for different emergency situations. These personnel shall be made known to all laboratory

workers and HKSTP Laboratory Facilities Management (Lab FM) with their contact details.

- 2.2. Emergency notification / communications – In case of an emergency situation, concerned laboratory personnel shall follow the established emergency procedures and report the case using the 999 emergency hotline (for life threatening situations) and/or other emergency coordinators or responders (depending on the situations). The contacts for these personnel (also apply to non-office hours as far as possible) together with HKSTP's 24hrs Customer Services Hotline shall be made available or displayed in the laboratory. A sample of emergency contact directory is shown in the table below.

Emergency Contact Directory

Name	Post	Phone No.
HKSTP 24hrs Customer Services Hotline		2639-8008

- 2.3. Emergency evacuation routes / maps – If an emergency requires an evacuation to ensure the safety of laboratory personnel, all personnel shall stop work immediately, evacuate, and proceed to the assembly point. The emergency escape / evacuation route / map for an individual laboratory shall be displayed at a conspicuous location nearby each emergency exit.
- 2.4. Emergency equipment / devices – Locations of emergency equipment or devices in a laboratory or its nearby areas shall be indicated in the plan. These equipment include fire extinguisher, emergency shower / eyewash unit, spill kit, first-aid kit, fire alarm button, emergency call button, and emergency exhaust ventilation button.

2.5. Emergency procedures / protocols – Actions and protocols in response to the various possible emergency situations shall be carefully devised in consideration of the specific settings and operations of a laboratory. Such emergency situations may include fire / explosion; spillage of hazardous chemicals / biological agents / radioactive substances; leakage of gases; accidental exposure to hazardous fumes, high energy beams (such as ultra-violet, X-ray, high power lasers), strong magnetic fields; flooding; electric shock; power failure; dangerous machinery failure, etc.

For compiling these procedures or protocols, laboratory tenants or other laboratory operators are recommended to refer to HKSTP's other guidelines where appropriate.

3. Documentation

The Laboratory Emergency Response Plan shall be properly documented and easily available in the laboratory for reference and checking. For laboratories involving the handling of hazardous chemicals, a copy of each relevant Material Safety Data Sheet (MSDS) should be kept in a location easily accessible to laboratory personnel.

B04 Laboratory Safety Inspection Program

1. Introduction

To line with the Laboratory and Research Safety Policy, the Safety, Health and Environment (SHE) Office of HKSTP endeavors to promoting and maintaining a safe and healthy working environment in the laboratories at Science Park where cutting edge technologies and researches are employed. SHE Office conducts regular inspections to identify hazards, recommend remedial measures as well as safeguard personnel working in the laboratories. Self-inspection is also required to be conducted periodically by individual laboratories.

2. Scope and Applicability

This laboratory safety inspection program applies to all laboratories at Science Park, either operated by HKSTP or clients. It also applies to laboratory which may be operated by more than one client. In this situation, individual clients shall be responsible for overseeing the safety of their own laboratory facilities and working areas.

3. Responsibilities

Persons In-Charge of individual laboratories shall be responsible for taking care of the health and safety of their laboratories. They should cooperate with SHE Office in the arrangement of regular laboratory safety inspection. Persons In-Charge or their delegates should participate in the inspections and communicate closely with SHE Office in following up the remedial actions afterwards.

Persons In-Charge or their delegates are also required to carry out regular self-inspections at their laboratory areas.

4. Laboratory Self-Inspection

As the duty of managing laboratory safety rests with individual clients, Persons In-Charge or their delegates shall conduct periodic safety inspection at their laboratory areas using the Laboratory Self-Inspection Checklist provided by HKSTP. Completed checklists with records of following up actions shall be kept for at least one year for future checking during the inspection or audit arranged by SHE Office of HKSTP.

5. Frequency of Inspection

The required frequency of inspection arranged by SHE Office and self-inspection to be conducted by individual clients are delineated in the following table:

	Frequency of Inspection (per year)		
	Category 1 Labs	Category 2 Labs	Category 3 Labs
Inspection by SHE Office	≥ 1	≥ 1	≥ 2
Self-inspection	≥ 1	≥ 2	≥ 2

The frequency depends on risk category of individual laboratories. Category 1, 2 and 3 represent laboratories of low, medium and high risk levels respectively*. The inspection arranged by SHE Office is at least once every year for low to medium risk laboratories; and twice for high risk laboratories. As for self-inspection to be conducted by individual clients, the frequency is at least once every year for low risk laboratories and twice for medium to high risk laboratories. These frequencies will be subject to change depending on the associated risk level and safety performance of individual laboratories.

** Note: please refer to Annex 1 for details about the categorization of laboratories*

6. Inspection Report and Remedial Actions

After each inspection conducted by SHE Office, an inspection report will be issued to the corresponding Person In-Charge within 14 working days. Each identified laboratory safety issue will be rated as I, II or III according to the action levels. Required remedial actions shall be completed within the time period prescribed for each action level as described in the table below. The report, with the remedial actions recorded, shall be returned to SHE Office for information and following up actions or verification if necessary.

Action Level	Required Remedial Action and Time Line
I	Recommended good practice / required maintenance work to follow the planned schedule
II	Remedial action required within 4 weeks
III	Immediate remedial action required

The concerned Person In-Charge shall also return the report with records of completed remedial actions to SHE Office within the prescribed period for reference and following up whenever necessary.

7. Overall Laboratory Safety Performance

According to the findings from the inspection, the overall laboratory safety performance of the corresponding client will be stated in the report issued by SHE Office. This would be either “**good**”, “**fair**” or “**unsatisfactory**” subject to the number of safety issues and their action levels.

As the inspection report associated with unsatisfactory performance reveals a great number of laboratory safety issues or issues of imminent dangers to laboratory personnel,

Director of SHE has the right to issue a suspension notice to the concerned client.

Laboratory operation shall not be resumed until remedial action has been followed through to the satisfaction of the Director of SHE.

HKSTP also has the right to terminate the tenancy for a client's laboratory space in case the client violates local legislation or breaches the leasing requirements with respect to laboratory safety.

Annex 1. Risk Categorization of Laboratories at the Science Park

Laboratories at the Science Park are currently classified into three risk categories, i.e. Category 1 (Low Risk), Category 2 (Medium Risk) and Category 3 (High Risk). The criteria for classification is based on a simple 3x3 risk heat map as described below.

Impact		Likelihood		
		Unlikely	Possible	Likely
	Significant	Medium (Cat 2)	High (Cat 3)	High (Cat 3)
	Moderate	Low (Cat 1)	Medium (Cat 2)	High (Cat 3)
	Minor	Low (Cat 1)	Low (Cat 1)	Medium (Cat 2)

The factors associated with “Impact” and “Likelihood” in the risk heat map for laboratory categorization are described in the following table.

Impact		Likelihood	
Minor:	- Only common chemicals of limited quantities are handled or kept in the lab - No other hazardous substances are involved in the lab operations	Unlikely:	- Applicable lab safety control measures are in place - Good performance with respect to lab safety has been recorded
Moderate:	- Considerable quantity of hazardous chemicals are handled or kept in the lab - Risk group 1 microorganisms are handled in the lab - Closed beam X-ray equipment or sealed radioactive substances are used - Class 3B lasers are used - Other lab operations of moderate hazardous nature	Possible:	- Applicable lab safety control measures are in place but not strictly followed or implemented - Fair performance with respect to lab safety has been recorded - Minor lab incident or accident has been recorded

	are involved		
Significant:	• Highly hazardous chemicals are handled or kept in the lab • Risk group 2 microorganisms or clinical specimens are handled in the lab • Open beam X-ray equipment or unsealed radioactive substances are used • Class 4 lasers are used • NMR or MRI are used • Other high risk operations are involved	Likely:	• Not sufficient lab safety control measures • Applicable lab safety control measures not implemented or followed through • Unsatisfactory performance with respect to lab safety has been recorded • Major lab incident or accident has been recorded

B05 Laboratory Safety Clearance

1. Introduction

Hazardous materials are frequently involved in research activities in the laboratories. These include, but not limited to, chemicals, biological agents, and radioactive substances, high energy equipment, etc. HKSTP's Laboratory and Research Safety Policy requires the client to remove all hazardous materials and vacate the laboratory area before tenancy is due or the laboratory is closed out for renovation, modification or other reasons. Decommissioning is also necessary for those laboratory areas in which radioactive substances, highly toxic or infectious materials had been handled to ensure the areas are free from contamination.

2. Arrangement for Laboratory Safety Clearance

The Laboratory Person In-Charge or his/her delegate should plan the laboratory safety clearance exercise well before the tenancy is due or the laboratory is closed out. The following arrangement is recommended:

- a) Clean up all experimental set-ups, apparatus, equipment and areas of work;
- b) Decontaminate or disinfect the areas where necessary;
- c) Properly label all unwanted hazardous materials and properly dispose of them following statutory requirements;
- d) Carefully pack up other hazardous materials to be kept for use and deliver them safely to the target location.
- e) Vacate the area and inform the Laboratory Facilities Service Centre.
- f) Fill in the "Laboratory Safety Clearance Form" (Appendix 1) and return the completed form to Laboratory Facilities Management Service Centre timely.



Appendix 1 Laboratory Safety Clearance Form

Hong Kong Science and Technology Parks Corporation

Reference No.: _____

Note:

Upon completion, this form must be returned to Lab FM of HKSTP for documentation or following up actions if necessary.

Part 1 – Particulars

Name of Client:			
Type of Client:	☐ Tenant ☐ Incubatee ☐ Licencee ☐ HKSTP ☐ Others:		
Lab Location:		Person In-Charge:	
Date Checked:		Phone No.:	
Checked By:		Signature:	
Witnessed By:		Signature:	

Part 2 – Checklist (please tick where appropriate)

No.	Check Item	Yes	No	NA
1.	All client's belongings (including chemicals, biological agents, experimental animals, radioactive substances, hazardous waste materials, laboratory equipment and apparatus) have been removed.			
2.	All work surfaces (including bench tops, floors, fume cupboard worktops, shelves, etc.) with potential hazardous substances contaminations have been cleaned and decontaminated.			
3.	Others:			
Remarks:				

B06 Risk Assessment Procedures And Guidance

1. Introduction

Modern scientific laboratories may be associated with a variety of hazards arising from hazardous chemicals, infectious agents, ionizing and non-ionizing radiation sources, etc. Risk assessment, as one of the essential elements of laboratory safety management, shall be adopted as a tool for assessing the potential risks in connection with these hazards. This document briefly explains the assessment procedures and provides guidance for completing HKSTP's Risk Assessment Form.

2. Hazard and Risk

A *hazard* is any source of potential damage, harm or adverse effects on something or someone.

Risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss, or harmful effects on the environment. It may also be elaborated as:

Risk = Severity of hazard x Probability of occurrence

3. Risk Assessment Procedures

A simple five steps method for risk assessment is introduced in this document. These five steps are explained as follows:

3.1. Identify the hazards:

- a) Be aware of any changes to the on-going experiments or any new experiments to be conducted, and consider the potential associated hazards;
- b) Walk around the laboratories and look afresh at what is reasonably be expected to cause harm;
- c) Check manufacturer's instructions;

- d) Look back at the accident or incident records;
- e) Remember to think about long-term hazards to health.

3.2. Decide who may be harmed:

- a) Think about some workers who might have particular requirements (e.g. temporary workers, contractors, people with disabilities, lone workers, etc.) and who might not be in the laboratories all the time (e.g. visitors, contractors, maintenance workers, etc.);
- b) If you share the laboratory with other parties, consider how your work affects others and how their work affect you and your workers;
- c) Ask your workers if there is anyone you may have missed.

3.3. Evaluate the risks

- a) Check if all the safety control measures required by laws, HKSTP's safety guidelines or other relevant international standards are in place;
- b) Then ask yourself if you can get rid of the hazard altogether;
- c) If not, think about how you can control the risks in the priority of substitution, engineering controls, administrative controls or personal protective equipment, so that the harm is unlikely;
- d) Consider if the proposed safety control measure create another hazard.

3.4. Record your findings: Use HKSTP's Risk Assessment Form to record the findings.

Fill in the necessary information as well as assessment results:

- a) The identified hazard;
- b) People at risk;

- c) Existing control measures;
- d) Risk rating – this is the current risk rating based on the risk matrix as described in the next section;
- e) Proposed action(s) to further reduce risk – think of any remaining hazard and propose further practical action(s) to reduce the risk;
- f) Residual risk rating – the is the prospective risk rating if the proposed further action is completed;
- g) Responsible person – refers to the person who will take action or assign a delegate to take action;
- h) Completed by: refers to the date when action is completed.

3.5. Review your risk assessment: Laboratory setups, including equipment, materials, or procedures, may subject to frequent changes that could lead to new hazards. Risk assessments should be reviewed annually. It also makes sense to review what you are doing on an ongoing basis, look at your risk assessment again and ask yourself:

- a) Have there been any significant changes?
- b) Are there improvements you still need to make?
- c) Have the laboratory workers spotted a problem?
- d) Have you learnt anything from accidents or near misses?

Make sure your risk assessment stays up to date.

4. Risk Matrix

Risk matrix is used as a tool in the process of qualitative risk assessment. A two-dimensional 5x5 risk matrix is adopted in HKSTP's Risk Assessment Form. The likelihood or probability of an occurrence is expressed along the Y axis whereas its

severity of consequences on the X axis. For the 5x5 matrix, there are 5 levels of likelihood and 5 levels of severity, each of which has an index (from 1 to 5) as described below. The higher index represents greater likelihood or higher severity for an occurrence. Final risk rating for the specific occurrence is obtained by multiplying these two indexes. To facilitate the implementation of suitable remedial action, the risk rating is grouped into 4 categories:

- a) **Low risk (risk rating 1 – 3):** Acceptable risk; no additional control measure is needed.
- b) **Medium risk (risk rating 4 – 9):** Monitor continuously and consider any further remedial action is feasible to eliminate or reduce the risk.
- c) **High risk (risk rating 10 – 16):** Urgent remedial action is required and the work activity should be closely monitored for further safety enhancement.
- d) **Very high risk (risk rating 20 – 25):** The work activity must be suspended immediately till proper risk control measures are in place.

Risk Matrix					
Likelihood of Occurrence	Severity of Consequences				
	Insignificant [1]	Minor [2]	Moderate [3]	Major [4]	Catastrophic [5]
Rare [1]	1	2	3	4	5
Unlikely [2]	2	4	6	8	10
Possible [3]	3	6	9	12	15
Likely [4]	4	8	12	16	20
Almost certain [5]	5	10	15	20	25

Severity Table		Likelihood Table	
Severity Index (S)	Description	Likelihood Index (L)	Description
5	Catastrophic (could result in death or permanent total disability, irreversible severe environmental damage, huge financial loss)	5	Almost certain (Is expected to occur in most circumstances)
4	Major (could result in serious injury or occupational illness, significant impact to the environment, major financial loss)	4	Likely (Will probably occur in most circumstances)
3	Moderate (could result in minor to moderate injury or illness, considerable impact to the environment, medium financial loss)	3	Possible (Might occur at some time)
2	Minor (could result in minor injury or illness,	2	Unlikely (Could occur at some time)

	environmental impact, or financial loss)		
1	Insignificant (No injuries, low financial loss)	1	Rare (May occur only in exceptional circumstances)

5. Common Laboratory Hazards and their Control Measures

To facilitate HKSTP's clients in carrying out risk assessments in laboratories, many common laboratory hazards and their suggested control measures are enlisted in Annex 1. However, it is important to note that this guidance does not identify all possible hazards. Assessors should ensure that they have identified all the hazards that are associated with their particular laboratory activities and devise suitable control measures.

Annex 1. Common Laboratory Hazards and their Control Measures

1. Hazardous Chemicals and Drugs

Hazard	Suggested Control Measures (Not Exhaustive)
Fire / explosion caused by flammable or unstable chemicals	• Handle flammable chemicals in fume hoods and away from ignition sources. • Wear appropriate PPE. • Store flammable chemicals in standard flammable cabinets. Incompatible chemicals must not be kept in the same cabinets. • Label peroxide forming chemicals with the opening dates. Dispose of the chemicals in case of the presence of peroxides or upon prolonged period of storage. • Handle perchloric acid in designated fume hood with wash down system. • Follow all safety measures specific to that particular chemicals as recommended by the respective MSDSs. • Emergency facilities including firefighting equipment, emergency shower / eyewash unit, spill kit and first aid kit must be available in the vicinity.
Exposure to hazardous chemicals or drugs	• Handle hazardous chemicals in fume hoods. • Wear appropriate PPE. • Store corrosive chemicals in standard corrosive cabinets. Incompatible chemicals must be kept separately. • Highly toxic chemicals, drugs or carcinogens should be kept in appropriate lockable cabinets. • For the labs involving the use of hydrofluoric acid, relevant antidotes must be available. • Follow all safety measures specific to that particular chemicals as recommended by the respective MSDSs. • Emergency facilities including firefighting equipment, emergency shower / eyewash unit, spill kit and first aid kit must be available in the vicinity.
Exposure to nanomaterials	• Nanomaterials which may become airborne are handled in proper enclosure such as fume hood equipped with HEPA filter, biosafety cabinet, etc. • Wear proper PPE such as gloves, N95 mask, etc. whenever necessary.

2. Compressed Gas Cylinders and Cryogenics

Hazard	Suggested Control Measures (Not Exhaustive)
Fire / explosion caused by flammable gases	• Laboratory areas are well ventilated. • Gas cylinders with highly or extremely flammable gases are kept in proper gas cabinets whenever necessary. • Gas detectors are installed for gas leakage monitoring. • Flammable arrestors are installed where necessary. • Regular checking for gas leakage is in place. • Proper firefighting equipment is available in the vicinity.
Exposure to hazardous gases	• Laboratory areas are well ventilated. • Gas cylinders with toxic gases are kept in proper gas cabinets whenever necessary. • Gas detectors are installed for gas leakage monitoring whenever necessary. • Regular checking for gas leakage is in place.
Cold burn due to exposure to cryogenics such as liquid nitrogen	• Wear goggles, face shield and cryogenic gloves when handling cryogenics. • Transport cryogenics carefully in appropriate dewar flasks or containers.
Asphyxiation caused by accumulation of cryogenic gases	• Handle cryogenics in well ventilated area. • Monitor the ambient oxygen level using appropriate oxygen detector.

3. Biological Agents

Hazard	Suggested Control Measures (Not Exhaustive)
Exposure to infectious agents	• Handle potentially infectious agents in proper biosafety cabinet. • Wear proper PPE. • Have all necessary biosafety equipment in place and follow all applicable biological safety practices. • Emergency facilities including firefighting equipment, emergency shower / eyewash unit, spill kit and first aid kit must be available in the vicinity.
Injury caused by animal bites or scratches	• Wear appropriate gloves when handling animals. • Use proper animal restrainers. • Handle animals carefully following standard practices.
Needle-stick injury	• Avoid re-capping needles. • Substitute needles by other devices as far as possible.

4. Ionizing Radiation

Hazard	Suggested Control Measures (Not Exhaustive)
Exposure to X-ray	• Enclosure interlock equipped with closed beam X-ray machine functions properly. • Closed beam X-ray machine is monitored regularly for X-ray leakage. • When an open beam X-ray machine is energized, the room door should be locked (preferably controlled by door interlock) and the warning light at the entrance should be illuminated. • Wear PPE (whenever necessary) and TLD when operating open beam X-ray machine. • The indicating signal equipped with any X-ray machine should be activated whenever the machine is energized. • SOP is available for operators to follow.
Exposure to ionizing radiation emitted from radioactive substances	• Wear proper PPE and TLD. • The room is accessible to authorized users only. • Use sufficient shielding for protection. • Keep radioactive substances in proper containers with sufficient shielding. • SOP is available for operators to follow. • Check for contamination using a radiation survey meter or contamination monitor.

5. Laser Beams (Class 3B and 4 Lasers)

Hazard	Suggested Control Measures (Not Exhaustive)
Damage to eyes	• Laser equipment is not mounted at eye level or towards the room entrance. • Wear proper laser eye protectors. • The room is free from reflective surfaces. • When the laser equipment is energized, the room door should be locked (preferably controlled by door interlock) and the warning light at the entrance should be illuminated. • SOP is available for operators to follow.
Damage to skin	• Laser equipment is stably mounted and not directing towards the room entrance. • Wear proper protective clothing whenever necessary. • The room is free from reflective surfaces.

	• When the laser equipment is energized, the room door should be locked (preferably controlled by door interlock) and the warning light at the entrance should be illuminated. • SOP is available for operators to follow.

6. Magnetic Fields

Hazard	Suggested Control Measures (Not Exhaustive)
Exposure to strong magnetic fields from NMR or MRI	• The room accommodated with NMR or MRI is accessible to authorized users only. • 5 gauss line should be demarcated. • Protective shielding should be available where applicable.

7. Machinery and Pressure Vessels

Hazard	Suggested Control Measures (Not Exhaustive)
Injury caused by rotating parts of machinery	• Moving parts are totally covered. • Proper guarding is available. • Other safety devices such as two-handed operation control is in place.
Collapse or explosion caused by pressure vessels	• Pressure vessels are periodically examined by competent personnel. • Only trained users are allowed to operate the vessels following procedures laid down in the user manual.

8. Extreme Temperatures

Hazard	Suggested Control Measures (Not Exhaustive)
Burns / scalds from contact with hot surfaces, materials, equipment (e.g. oven, furnace, autoclaves, etc.)	• Heat resistant gloves are available for handling hot items. • Follow safety practices to handle hot items. • Proper enclosure or guarding is in place where necessary.
Cold burn caused by handling cryogenics.	• Cryogenic gloves are available for handling very cold items. • Follow safety practices to handle cold items.
Frostbite, low body temperature caused by working in cold rooms.	• Wear suitable clothing. • Follow safety practices and not stay for prolonged period of time.

Section C Laboratory & Research Safety Guidelines

C01 Laboratory Design Guidelines

1. INTRODUCTION

The Laboratory Design Guidelines of Hong Kong Science and Technology Parks (HKSTP) Corporation define the requirements for all laboratories and research areas and ensures all new, remodeled, or renovated laboratories at the Science Park illustrate standard health and safety elements.

Given that the research activities undertaken by the stakeholders encompass a wide range of different applications, these guidelines address the basic safety fundamentals common to the design of most laboratory premises. More specific guidelines can be obtained from the references at the end of this document.

These guidelines adopt standards and practices from local guides as well as international standards that are deemed applicable in the context of safe laboratory operation. Nevertheless, the basic emphasis for the building and its facilities shall refer to local building codes and governing statutory obligations in Hong Kong.

The ultimate purpose of these guidelines is to provide a safe environment for laboratory personnel to conduct their research works.

2. LABORATORY SPACE UTILIZATION & LAYOUT

2.1. Space Utilization and Configuration

2.1.1. In general, design of the laboratory layout and configuration must provide adequate space for safe working and appropriate separation of areas, generally including:

- a) Laboratories shall be separated from offices or other non-laboratory areas.
If it is not feasible to separate these two types of areas, offices attached to a laboratory shall be located nearby the exits of the laboratory. Laboratory activities involving the handling of hazardous materials shall be as far away from the office areas as possible.
- b) Write-up areas can be set up in the laboratories if necessary. However, they should not be used as office workstations and should be as far away from the experimental areas as possible.
- c) Support areas such as store rooms and equipment rooms should be located at convenient locations to facilitate operations and minimize influence to laboratory personnel with respect to noise, heat, and transport issues, etc.
- d) Separate pantries or rooms for food and drink consumption and/or storage should be provided if necessary to avoid eating and drinking in laboratory areas.
- e) Meeting and conference rooms, if provided, should also be separated from the laboratory areas.
- f) Provision of adequate areas for safe storage/ movement of personal protective equipment, hazardous substances, compressed gas cylinders, hazardous wastes, etc.

2.2. Floor Loading

For the installation of certain heavy equipment, consultation with the Facilities Management Office is essential to ensure the designed loading capacity of that particular floor of the building is not exceeded.

2.3. Ceiling Heights

Ceiling heights shall be sufficient to accommodate the safe installation of laboratory equipment such as shield room, fume cupboards and biological safety cabinets where applicable. Sufficient head space shall be provided to allow inspection, if required, for the equipment at high level.

2.4. Clearance for Operations

2.4.1. Sufficient floor space shall be provided for laboratory equipment to facilitate operation. Equipment such as refrigerators, freezers, incubators, autoclaves, large centrifuges shall be installed with sufficient space to cater for operators to maneuver and to allow maintenance works to be carried out as required.

2.4.2. Below is the outline for minimum separation between benches and floor-positioned equipment. Nevertheless, the actual spacing shall be determined by the requirement of the operations. The minimum separation between benches and floor-positioned equipment should meet the following clearance requirements:

- a) No operator on either side – 900mm
- b) Operators on one side of the aisle, no through traffic – 1000mm
- c) Operators on one side of the aisle, plus through traffic – 1000mm
- d) Operators on both sides of the aisle, no through traffic – 1400mm

e) Operators on both sides of the aisle, plus through traffic – 1450mm

2.4.3. Heat generating equipment, such as ovens and incubators, should be located away from corridors, aisles, passageways and frequently occupied spaces.

2.5. **Entries, Exits and Doors**

2.5.1. The laboratory and layout of equipment and laboratory furniture shall be carefully planned to maintain a free path leading from access doors to fire escape exits. The path shall be free from obstruction, such as equipment, furniture, storage boxes or any other items. Dedicated access shall be provided for the movement of compressed gas cylinders, hazardous materials and wastes, etc. The corridor width and escape distances shall meet the requirements of local legislation.

2.5.2. Emergency exits shall have appropriate exit signs. Where emergency exits are not visible, directional exit signs shall be installed. The fire escape route shall also be displayed in the laboratory to create awareness among the operators. The illuminated exit sign shall be maintained as required by local legislation.

2.5.3. Doors shall have vision panels or alternative means of viewing laboratory activities from outside. The vision panel shall offer general view of the laboratory. In order to maintain a clear path for the common corridor or service corridor, the door opening shall open into the laboratory. Doors opening into the corridor shall be recessed.

2.6. Laboratory Signage and Hazard Notices

2.6.1. All laboratories with significant hazards shall be identified clearly at each entrance including display of the name (i.e. the laboratory entity), person in-charge, emergency contact person(s), nature of hazards and protection requirements (see illustrative notice in Figure 1).

2.6.2. All containers or cabinets for hazardous materials as well as facilities or equipment associated with hazardous materials shall be labeled with the respective hazard warning signs to ensure operators are aware of the potential hazards and operate with care.

Figure 1: A Sample of Illustrative Notice for Laboratory Entrances

COMPANY:	ABC BioTech Limited.		Unit No.	399, 9W

CONTACT	NAME	POSITION	PHONE NO.
Person In Charge	HERO WONG	LAB MANAGER	+852-98765432
Emergency Contact	HERO WONG	LAB MANAGER	+852-98765432
HKSTP FMO	24 HOURS	-	+852-2639 8008
HKSTP LAB FMO	24 HOURS	-	+852-2639 8738

MAJOR HAZARDS		PROTECTION
 CORROSIVES		 ENTRY RESTRICTIONS
 BIOLOGICAL HAZARD		 PROTECTIVE CLOTHING
 RADIATION		 EYE PROTECTION
 NON-FLAMMABLE COMPRESSED GAS		

3. SURFACE FINISHES & MATERIALS

The surface finishes and materials for laboratories associated with the handling of hazardous materials should meet the following requirements.

3.1. Flooring

3.1.1. Floor finish shall be smooth, impervious, easy to clean, slip-and wear-resistant and resistant to chemicals expected to be used in the laboratory. The floor finish shall be seamless with no sharp corners. Floor surface shall be coved where it meets walls and fixed benches.

3.1.2. Vinyl sheets are normally preferred over softer environmental flooring especially where chemicals are in use. Where liquid nitrogen spills and splashes can be expected, the use of other more durable material shall be installed.

3.1.3. Flooring of the corridors next to the laboratories which are associated with the transport of hazardous materials should also be finished with the same materials as for the laboratories.

3.2. Walls

Wall surfaces shall be free from cracks and unsealed penetration. Walls shall be constructed of non-porous material and painted with a durable, impervious finish to facilitate decontamination and cleaning. Corner guards and bumper rails shall be provided to protect wall surfaces in high traffic or impact areas.

3.3. Ceilings

- 3.3.1. Washable lay-in acoustic ceiling tiles should be provided for laboratory spaces except in areas where the potential for high moisture exists like washing and autoclave rooms. Gypsum board ceilings should be finished with durable and impervious paint.

- 3.3.2. Ceiling-mounted lighting in laboratories where potentially infectious materials or unsealed radioactive substances are handled should be recessed with a cover/diffuser flush at the ceiling level.

4. LABORATORY FURNITURE

Laboratory furniture including benches, shelving, storage cabinets, stools and chairs, etc. shall be designed in accordance with safety and ergonomic principles meeting the needs of laboratory workers.

Environmentally friendly materials should also be used for laboratory furniture. Suitable color and surface texture for the furniture should be chosen to reduce glare and reflections and to enhance environmental comfort.

4.1. Benches

- 4.1.1. Benches in laboratories shall be stable and of adequate structural integrity. Bench tops shall be finished with a material that is easy to clean, smooth, impervious, resistant to chemicals, heat, and scratches. Bench tops should be free from joints as far as possible. Where unavoidable, joints shall be sealed to prevent seepage of spillages into the space below the bench tops. Where there is a wet area, ends of bench tops shall be coved to end walls.
- 4.1.2. Bench height should depend on the working position of laboratory workers. Typical bench is about 900 mm high for standing and 750 mm high for seated works. A slightly lower bench may be required for the use of tall equipment or apparatus.
- 4.1.3. Typical bench depth ranges from 600 to 900 mm for ease of access to the rear of the bench. Deeper worktop may be required for certain equipment or apparatus.

- 4.1.4. Sufficient leg or knee clearance shall be left under the bench top for laboratory workers who use the bench top as an experimental or write-up area.

4.2. Cabinetry

- 4.2.1. Cabinets in the laboratories should be finished with smooth, impervious, chemical resistant and easy to clean materials. They should also be stable and of adequate structural integrity.
- 4.2.2. Cabinets or cupboards should be such designed to reduce pinching hazard when opening or closing the drawers or cabinet doors.
- 4.2.3. Under-bench cabinets may be floor-standing or fitted with castors. The latter types allow for easy floor cleaning and decontamination.

4.3. Shelving

- 4.3.1. Shelving should be secured to prevent toppling. Adjustable height shelves should be securely retained.
- 4.3.2. Shelves, both open or closed, should be installed at a height allowing safe and ready access. Open shelves should be fitted with edge guards to prevent containers from falling. Double sided shelves should have a central partition or divider to prevent items being pushed through from one side to another.
- 4.3.3. Shelves or hanging cabinets should allow sufficient vertical clearance of at least 500 mm from sprinkler heads.

4.4. Stools and Chairs

- 4.4.1. The upholstery of chairs and stools should be vinyl or other suitable impervious material, such as acid-resistant polyurethane to prevent from absorbing the spills of hazardous substances. The surface of the upholstery should be smooth, non-porous and easy to clean. Upholstery materials shall not be ignited easily (conforming to EN1021 or other similar standards).
- 4.4.2. The chairs and stools should be ergonomically suited to the task, with adjustable height, back-rest and foot ring /rest for stools.
- 4.4.3. The chairs shall have a 5-star base with glides providing stability with wheels to facilitate movement. The wheels shall be heavy-duty polyurethane castors with stoppers and able to withstand solid load. Stools are recommended to have a stable base without castors.

5. ELECTRICAL & UTILITY ISSUES

5.1. Electrical Services

- 5.1.1. General power outlets should be elevated above bench height.
- 5.1.2. There should be sufficient power outlets for the expected number of appliances to avoid the use of extension boards or adaptors. Power outlets should be fitted with residual current protection devices.
- 5.1.3. Electrical socket outlets, outlets for telecommunication appliances and outlets for computer networks should not be positioned near water sources such as sinks, emergency showers, etc.
- 5.1.4. Electrical outlets should also be positioned away from valves for flammable gases.
- 5.1.5. Specialized facilities or equipment may require uninterrupted power supply for safety or other reasons. Such requirement should be taken into consideration during the laboratory design stage.
- 5.1.6. Emergency lighting and illuminated exit signs shall be provided to facilitate emergency evacuation in the event of power failure.
- 5.1.7. Splash-proof or water proof socket outlets should be provided for some special situations where necessary.

5.2. Sinks

- 5.2.1. Each laboratory where hazardous materials, whether chemicals, biological, or radioactive, are used, should have a sink for hand washing. A separate hand-washing basin should be provided for a biosafety level 2 laboratory.
- 5.2.2. Hand washing facilities should be installed nearby the exit of the laboratory for hand washing immediately before leaving the laboratory.
- 5.2.3. Laboratory sinks should preferably be made of epoxy, stainless steel or other chemical resistant materials.
- 5.2.4. Water taps or faucets in a biosafety level 2 laboratory and radioisotope laboratory should be of hand-free operation (e.g. elbow-, foot-, or sensor-operated) to prevent direct hand contact.

5.3. **Plumbing**

- 5.3.1. Drainage systems of the laboratory sinks should be provided with adequate seals or traps to prevent the escape of vapors or gases from the drainage systems.
- 5.3.2. Floor drains should be provided only in laboratories subject to frequent wet washing.
- 5.3.3. 5.3.3. Drainage system should be constructed of proper materials with the required chemical resistance or heat resistance. However, the construction materials should be carefully chosen to avoid any incompatibility with the

possible contaminants in the effluents.

5.4. Compressed Air and Vacuum Systems

- 5.4.1. Compressed air or vacuum system can be in form of a piped-in service from a central compressor or vacuum system or from a laboratory fitted compressor or vacuum unit.
- 5.4.2. Compressor units or associated pressure vessels must be registered and inspected in accordance with the Boilers and Pressure Vessels Ordinance of Hong Kong.
- 5.4.3. Compressors installed in laboratory premises should be separated from laboratory operations to isolate the noise and heat as far as possible. Sufficient make up air should be considered in the design to cater for air intake by the compressor units.
- 5.4.4. Vacuum systems must be fitted with in-line filters and drain traps at accessible locations, and shall be discharged outside the building at a location away from outdoor air intakes.

5.5. Laboratory Gas Delivery Systems

- 5.5.1. The laboratory gas delivery system, including pipelines, valves, regulators, alarms, monitors, supports and other accessories shall be designed, constructed and installed in compliance with local legislations, codes of practice and international standards where applicable.

- 5.5.2. Pipelines shall be constructed with materials compatible with the particular laboratory gases involved. Proprietary products from recognized manufacturers should be used.
- 5.5.3. Piping components in laboratory gas system shall have been properly cleaned by the manufacturers before installation. Great care shall be exercised during the installation to prevent oil or grease or any contaminants from being introduced into the piping.
- 5.5.4. All pipelines shall be adequately supported and protected from mechanical damage. As far as possible, pipelines should not run in the means of escape.
- 5.5.5. All piping, valves, station inlets and outlets, and alarms shall be labeled accordingly.
- 5.5.6. Manual shut-off device shall be provided in each pipeline at an easily accessible location or near its supply gas cylinder.
- 5.5.7. Over-pressure relief device shall be provided to each supply pipeline. Such device shall vent to an approved location or to a proper treatment system. The relieved gas shall be discharged to open air only when it will not jeopardize the safety of neighboring life and property.
- 5.5.8. An automatic shut-off device to be actuated by a suitable detection or

monitoring system in the event of leakage shall be provided wherever necessary.

- 5.5.9. A clearly labeled pipeline diagram showing the piping connection and gas route from a supply cylinder to a tool or workstation shall be provided in a conspicuous position near the gas supply point.
- 5.5.10. The laboratory gas delivery system shall be designed, installed, tested, inspected, commissioned and maintained by competent persons.

6. VENTILATION REQUIREMENTS

6.1. General Requirements

- 6.1.1. The general ventilation of a laboratory shall comply with relevant international standards for fresh air supply and thermal comfort. Ventilation shall be designed to provide sufficient fresh air, appropriate working temperature and relative humidity for the comfort of occupants; to provide adequate air movement to remove airborne contaminants; and to provide sufficient make up air for the operation of fume cupboards or other local exhaust equipment.
- 6.1.2. In designing ventilation for the laboratory, effective separation between potentially contaminated areas and other areas should be considered. Each area should have an independent air-circulating system or 100% fresh air delivery.
- 6.1.3. Ventilation shall be designed to maintain appropriate pressure differentials between spaces within the laboratory, and between the laboratory and the corridor to prevent cross contamination. The air flow direction should always be from clean to potentially contaminated areas.
- 6.1.4. Laboratory ventilation systems shall be totally separated from non-laboratory systems.
- 6.1.5. Air exhausted from a laboratory should not be re-circulated to other laboratories or non-laboratory areas.
- 6.1.6. Supply air system shall be designed to minimize draught and turbulence to

avoid its impacts on the performance of primary containment equipment such as fume cupboards and biological safety cabinets. Air outlets shall not discharge to the faces of fume cupboards and biological safety cabinets.

- 6.1.7. General ventilation system of a laboratory should be designed in such a way that it can be shut down or isolated to contain contaminants in case of major accidental spill.
- 6.1.8. Fume cupboards should not be used as the sole means of room air exhaust. General room exhaust should be provided to maintain minimum air change rates when the fume cupboards are turned off.
- 6.1.9. Heat generated by appliances and activities in the laboratories should be factored into the design of the air conditioning system.

6.2. Relative Room Pressure Differentials

- 6.2.1. A pressure differential system should be used to control the flow of airborne contaminants. The flow direction should always be from low hazard to high hazard areas.
- 6.2.2. Laboratories in general should be maintained at a negative pressure relative to the public corridors and non-laboratory spaces to prevent the escape of contaminants from the laboratories. A gauge displaying the differential pressure should be provided at the entrance of the laboratory.

- 6.2.3. Special laboratories including certain genome processing rooms, stem cell culture rooms, clean rooms, etc., may require positive pressure in relation to adjacent spaces. The users should be consulted at the design stage and arrange the design of air flow balancing to maintain a negative pressure to public corridor.
- 6.2.4. If an airlock/anteroom is used to facilitate pressure control, especially for high containment laboratories, the doors to the anteroom should be provided with self-closing mechanisms and interlocked so that both doors cannot be opened at the same time.

6.3. Emergency Exhaust Ventilation

- 6.3.1. An emergency exhaust system should be installed in laboratories where hazardous materials are used. The system, when activated, should allow the room exhaust to run immediately at its maximum capacity with 100% of laboratory air exhausted to outside
- 6.3.2. Emergency exhaust fan should be located and discharged at top roof to avoid contamination with any fresh air intake.
- 6.3.3. A clearly labeled emergency exhaust button should be installed near the exit of the laboratory for activating the system.
- 6.3.4. The fume cupboards and other local exhaust systems should continue to operate after activation of the button unless manually shut down.

- 6.3.5. The emergency exhaust button should also activate both an audible and a visual alarm at the entrance of the laboratory. The alarm signal should be connected to the local building management system (BMS) if possible. Where such connection is impracticable, alternative means of direct communication with the building management staff should be established.

6.4. Local Exhaust Ventilation (LEV) Systems

- 6.4.1. Certain laboratory equipment, facilities or operations may generate air contaminants in the form of fumes, vapors, particulates, steam, heat or odors. Local exhaust ventilation systems should be installed to extract these air contaminants and vented to the outside atmosphere.
- 6.4.2. Exhaust air should be properly discharged to avoid being drawn into fresh air intakes or ventilation openings, and preferably at roof top level. If this is not possible, contaminants should be removed from the exhausted air by appropriate air cleaning or treatment system to render it safe before discharge.

6.5. Air Cleaning for Laboratory Exhaust Systems

- 6.5.1. Room HVAC systems generally do not require air cleaning prior to release to the environment except for high containment laboratories. User should review with the government parties (such as the Environmental Protection Department) for any restriction for discharge.
- 6.5.2. In case where filters are installed, the flowrate through the filters shall be

maintained at design specifications and shall not exceed the rated flow capacity of the filters.

- 6.5.3. The filtration media used for the cleaning of gases and vapors shall be clearly specified for its intended use.
- 6.5.4. Main filters shall be protected by pre-filters to minimize the cost and hazards associated with frequent replacement.
- 6.5.5. Appropriate alert system should be installed to indicate when filters should be replaced. Filtering systems shall be designed in such a way that will allow filter testing and replacement in a safe manner in future.

7. EMERGENCY FACILITIES & EMERGENCY ALARM SYSTEMS

7.1. Fire Service Installations

7.1.1. HKSTP provides and maintains a fixed fire sprinkler system. Any alteration by the Laboratory Operators or its contractors is strictly prohibited without advanced written consent from the management of HKSTP.

7.1.2. Laboratory Operators are responsible to provide and maintain their own supplementary fire service installations and equipment (e.g. portable fire extinguishers, fire blankets, sand buckets, etc.) in accordance with their approved Risk Assessment.

7.2. Fire and Emergency Alarm Systems

7.2.1. HKSTP provides and maintains the statutory required fire alarm systems in the laboratories. Any alteration to these systems by the Laboratory Operators or its contractors is strictly prohibited without advanced written consent from the management of HKSTP.

7.2.2. Besides, HKSTP also provides supplementary emergency alarm systems in certain laboratories. These systems are connected to the building management system (BMS) with visual and audible alarms provided inside and outside the main entrance to each laboratory facility. Any alteration to these systems is not allowed without advanced written consent from the management of HKSTP.

7.3. Emergency Showers and Eyewash Units

- 7.3.1. Laboratories must have at least an emergency shower and eyewash unit for safe operation. Emergency shower and eyewash unit shall comply with appropriate international standards. They shall be located in unobstructed and accessible locations, preferable close to the hazard as possible and can be accessible within 10 seconds.
- 7.3.2. Emergency shower and eyewash unit should be preferably located near an emergency exit so that the victim can wash himself in an area where further contamination will not occur, and can be reached easily by any responding emergency personnel.
- 7.3.3. The clearance between the shower head and the nearest obstruction (wall, vertical supply pipe or similar) shall be a minimum radius of 0.4 m. There should also be no protrusions or sharp objects in this area.
- 7.3.4. Electrical apparatus, telephones, thermostats, electrical control panels, or power sockets should not be located within 0.5 m of the emergency shower or eyewash unit or within any area that may be considered as a splash or flood zone.
- 7.3.5. The emergency shower and eyewash unit shall be inspected and tested regularly on an annual basis. Inspection or testing records shall be affixed to the facilities for easy reference. Laboratory operators or workers should activate the eyewash units in the laboratories regularly to ensure the units are fit for use.

- 7.3.6. Emergency showers and eyewash units shall be clearly signposted for easy recognition.

8. LIGHTING, THERMAL COMFORT, NOISE & VIBRATION

8.1. Lighting

- 8.1.1. All laboratories shall be naturally or artificially illuminated to a level that is optimal for safe working. Special color-corrected lamps may be required where the correct identification of color is important.
- 8.1.2. Ceiling-mounted lighting in laboratories where potentially infectious materials or unsealed radioactive substances are handled should be recessed with a cover/diffuser flush at the ceiling level.
- 8.1.3. Bench tops shall be adequately illuminated to a level of at least 500 lux. Higher levels may be required for fine bench and machine work. Benches located near windows should be protected from direct sunlight with the use of window blinds or protective film.
- 8.1.4. Supplementary lighting should be provided for equipment or work area if the main room lighting is not sufficient. When shelf-mounted task lighting is used, they should have protective diffusive covers to prevent glare. Glare and distracting reflections should be minimized from surfaces of laboratory benches and other installations.

8.2. Temperature and Thermal Comfort

Equipment generating excessive heat or chill shall be isolated from general workspace. Ambient temperature of the laboratory shall be controlled to a level compatible with laboratory workers' comfort.

8.3. Noise and Vibration

Selection and siting of equipment shall consider noise generated by individual piece of equipment and their contribution to the cumulative noise levels in the work place. High noise-generating equipment shall be segregated from the general work area.

9. LABORATORY & RESEARCH EQUIPMENT / INSTALLATIONS

9.1. Cold Rooms and Specialty Rooms

- 9.1.1. Cold rooms used for laboratory works should be provided with sufficient ventilation and fresh air during period of occupancy.
- 9.1.2. Cold rooms must be provided with doors that are openable from inside without the use of key to allow emergency escape.
- 9.1.3. An alarm button should be installed in the cold room to allow persons entrapped to call for rescue. The alarm should be audible both inside the laboratory and in the outside corridor.
- 9.1.4. Emergency lighting should be provided in cold rooms to prevent blackout.
- 9.1.5. Doors of walk-in specialty rooms must have viewing windows and external light switches.

9.2. Fume Cupboards

- 9.2.1. Fume cupboards shall be provided where laboratory work involves the generation of hazardous vapors, gases, mists or fumes, etc. Fume cupboards shall meet recognized international standards such as BSEN 14175, AS/NZS 2243.8, ASHRAE 110, etc.
- 9.2.2. Proper operation of fume cupboards shall be tested on site by the supplier/contractor after installation according to the international standards.

- 9.2.3. Ductless fume cupboards are not to be used unless under exceptional circumstances where only small amounts of specified low-toxicity chemicals are used and there are well controlled procedures to monitor its efficiency. Ductless fume cupboards must have signage prominently posted on them informing operators and maintenance personnel about the allowed chemicals, types of filters in place, filter replacement schedule, and the potential risk of filter break-through.
- 9.2.4. Special type of fume cupboards shall be employed when handling perchloric acid or radioisotopes. Perchloric acid fume cupboard has built-in wash down system while radioisotope fume cupboard has a robust and easily cleanable workstation. Laboratory operators should select the appropriate types in the laboratory design stage.
- 9.2.5. Hood exhausts may be manifolded together when a risk assessment deems it safe for exhausts from different fume cupboards to be mixed in the ductwork. Controls shall be arranged so that shutting down one fume cupboard will not reduce or affect the exhaust capacity of other cupboards manifold to the same system.
- 9.2.6. Fume cupboards used for perchloric / hot acids, radioisotopes, carcinogens and other highly reactive, incompatible or highly toxic materials should have individual exhaust systems and fans and exhausted directly to the roof level.

9.2.7. Siting of Fume Cupboards

Fume cupboards should be located away from high traffic areas or facilities which produce air currents or turbulence such as air supply diffusers, doors, and operable windows.

Siting of fume cupboard in a laboratory should observe the followings:

- a) There should be at least 1 m between the sash and any traffic route so as to preserve an undisturbed zone in front of the fume cupboard.
- b) The distance between the sash and any bench opposite it should be at least 1.8 m.
- c) There should be no opposing wall or other large obstruction within 1.8 m of the sash.
- d) If two fume cupboards are to be installed with sash opposite to each other, they should be at a distance of 3 m apart.
- e) No fume cupboard should be positioned with either side closer than 0.3 m from a wall or similar construction.
- f) Doorways should not be within 1.5 m of the sash or within 1 m of the side of a fume cupboard.
- g) A fume cupboard should not be located adjacent to an exit, in particular if there is only one single exit in the laboratory.
- h) Fume cupboard openings should not be installed opposite a biological safety cabinet or workstations where personnel will spend much of their working day, such as desks or microscope benches.

9.2.8. Exhaust ducts and fans

- a) Basic material of exhaust ductwork should be fire and corrosion resistant

for the intended use.

- b) As far as possible, ductwork should follow the most direct route from the fume cupboard to the point of discharge.
- c) Bends should be kept to a minimum and have the largest radii practicable.
- d) Horizontal runs should be kept to a minimum.
- e) Ductwork should have no pockets where airborne gases or particles can be trapped.
- f) Automatic fire dampers shall not be used in laboratory fume exhaust systems.
- g) Treatment such as filtration and scrubbing, etc. is not generally required for fume cupboard exhaust except where risk assessment shows the need for such installation.
- h) Exhaust fans shall be powered with dual motor to provide redundancy. They should be located outside the building at the point of final discharge so that the ductwork through the building is under negative pressure. They should also be readily accessible for maintenance and inspection.
- i) The exhaust stack outlet should be at least 3.0 m above the roof. If parapet walls are present, stacks should be further extended. They should be located as far away from air intakes of buildings as possible to avoid re-entrainment of exhausted air into the building air supplies.
- j) Discharge from exhaust stacks must have an upward velocity of at least 10 m/s. Cone type reducer should not be used to achieve this velocity. Rain caps that divert the exhaust back towards the roof must not be used.
- k) Each exhaust fan and duct system should be labeled to identify the fume

cupboard in the laboratory to which they are connected.

9.3. **Biological Safety Cabinets (BSC)**

9.3.1. Biological safety cabinets shall be provided in laboratories where work involves the handling of infectious or potentially infectious biological agents. These include pathogenic microorganisms, human or animal body fluids, tissues, cell lines, etc. In addition, nanomaterials can also be handled safely in a biological safety cabinet.

9.3.2. There are three main classes of biological safety cabinets, i.e. Class I, II and III. Class II biological safety cabinets are further divided into 4 subclasses: A1, A2, B1 and B2. Laboratory operators should select the most appropriate class of biological safety cabinets for use.

9.3.3. Biological safety cabinets shall be certified to meet the specifications of recognized international standards such as NSF/ANSI 49, BS EN 12469, etc.

9.3.4. **Siting of Biological Safety Cabinets**

Biological safety cabinets should be located away from doorways, passageways, air diffusers, operable windows, fume cupboards or equipment that create air movements affecting the cabinet flows and containment.

Siting of biological safety cabinet should observe the followings:

- a) The distance from the sash to any traffic route shall be at least 1 m in order to preserve an undisturbed zone in front of the biological safety cabinet.

- b) The distance between the sash and any bench opposite it should be at least 1.5 m.
- c) There should be no opposing wall or other large obstruction within 2 m of the sash.
- d) The distance to the aperture of an opposing biological safety cabinet, fume cupboard or the edge of a local exhaust ventilation outlet should not be less than 3 m.
- e) A 0.3 m clearance should be provided on each side and at the back of the cabinet. Clearance on top of the cabinet should preferably be 0.6 m to allow free air flow and room for testing and maintenance of the HEPA filter.
- f) Doorways should not be within 1.5 m of the aperture or within 1 m of the side of a biological safety cabinet.
- g) Any room air supply diffuser should not be within 1.5 m of the front aperture.
- h) A local exhaust ventilation should be in the vicinity of a biological safety cabinet to allow proper exhaust of fumigant gases.

9.4. Controlled Atmosphere Glove Boxes

9.4.1. Controlled atmosphere glove boxes are sealed containers, commonly filled with inert gases, that are sufficiently leak-tight to protect chemicals or materials that may be sensitive to air or water vapor.

9.4.2. During the laboratory design stage, space for placement of gas cylinders and the associated gas delivery systems to be connected with the glove boxes

should be planned and allocated.

9.4.3. Sufficient exhaust ventilation systems should also be installed in the vicinity of the glove boxes to allow venting of gases from the glove boxes during operation and other processes such as purging and regeneration.

9.4.4. Exhaust ventilation systems should be connected to the rooftop by ductwork for discharge.

9.5. Gas Cabinets

9.5.1. Compressed gas cylinders containing hazardous gases (e.g. highly toxic or flammable gases) used in the laboratories shall be kept in ventilated gas storage cabinets.

9.5.2. Gas cabinets should be located in the laboratory areas that have non-recirculated exhaust ventilation and preferably operate at negative pressure in relation to the surrounding area, and shall be connected to the exhaust ventilation systems.

9.5.3. Gas cabinets shall be designed and constructed in accordance with relevant international standards or local legislations where applicable. Basic requirements for a gas cabinet include the followings:

- a) It should be constructed of non-combustible material and of robust design.
- b) It should be provided with a view panel made of transparent wired glass

for unobstructed viewing of its content and access to the cylinder valve groups.

- c) Its doors shall be closely fitted and self-closing with a self-latching device.
- d) Its interiors should be treated, coated or constructed of materials that are compatible with the hazardous gases stored.
- e) It should provide the necessary air changes for the particular hazardous gases stored, i.e. at least 10 air changes per hour for flammable and fire supporting gases, and 120 air changes per hour for highly toxic gases. The pressure drop should not exceed 150 Pa.
- f) It should be connected to non-recirculating exhaust ventilation and discharged at the rooftop.
- g) Air inside the cabinet shall be vented both at the top and bottom level to ensure adequate purging from minor gas leakage.
- h) It should be fitted with sensors connected to alarms to notify personnel in the event of a leak or exhaust system failure.
- i) It should contain no more than 3 gas cylinders.
- j) It should be constructed in such a way that cylinders can be moved in and out with minimal difficulty.
- k) Restraining devices should be installed within the cabinet for securing cylinders.

10. STORAGE OF HAZARDOUS MATERIALS

10.1. Chemicals / Dangerous Goods

10.1.1. In general, chemicals shall be stored in well ventilated, cool places and protected from direct sunlight or other direct sources of heat following recommendations from the corresponding Materials Safety Data Sheets (MSDS). They should be located away from traffic zones; not in any common passageways, stairways or doorways.

10.1.2. Hazardous chemicals (at least corrosives, flammables and highly toxics) should be stored in purpose-made storage cabinets. Incompatible classes of chemicals should be stored in separate cabinets. Excessive chemicals (exceeding the exempted quantities as specified in the Dangerous Goods (General) Regulation) should be kept in the respective dangerous goods stores. Lockable cabinets or other means of limiting access should be designed for specifically regulated materials.

10.1.3. Chemical storage cabinets should meet the following safety requirements:

- a) The design and construction of chemical storage cabinets should be in compliance with relevant international standards.
- b) The shelving inside storage cabinets shall be designed to contain spillage of the stored contents.
- c) Chemical storage cabinets should be of double wall construction with adequate fire resistance rating. Self-closing and three-point latch doors are recommended.
- d) If chemical storage cabinets are vented, they shall be connected directly

to an exterior exhaust duct with appropriate fire rating or materials compatible with the contents of the cabinets. It shall be vented outdoors to an appropriate location. If they are not vented, the vent openings should be sealed by the manufacturer.

- e) Flammable storage cabinets shall not be located near exits, doorways or at locations that would impede egress.
- f) Metal cabinets shall not be used for the storage of corrosive materials unless the materials are specifically treated to be corrosion-resistant.
- g) All chemical storage cabinets shall have appropriate hazard symbols and warning signs for the contents they are designed to store.

10.1.4. In addition, flammable liquids must not be stored in hanging cabinets. Metal storage containers for flammable liquids shall be properly earthed to avoid static charge. Flammable liquids that require refrigeration shall be stored only in “explosion-proof” or “spark-proof” refrigerators. Domestic refrigerators shall not be used for this purpose.

10.2. Compressed Gas Cylinders

10.2.1. The numbers of gas cylinders stored in any laboratory should be kept to a minimum and should not exceed the exempted quantities specified in the Dangerous Goods (General) Regulation. Enquiry with the Fire Services Department (FSD) for usage of any compressed gas cylinder without exempted quantities is necessary before works in the laboratory.

10.2.2. Gas cylinders should be stored in well ventilated and cool places and protected

from direct sunlight or other direct sources of heat.

- 10.2.3. Gas cylinders should be located away from traffic zones; not in any common passageways, stairways or doorways.
- 10.2.4. Flammable or toxic gas cylinders should be placed as close to the equipment as possible to minimize the length of connecting pipe. Piping-in of these hazardous gases from external sources or over long distance should be avoided.
- 10.2.5. Exposed pipe work for these gases should be protected from accidental damage and marked clearly. For more safety requirements about the laboratory gas delivery systems, please refer to the particular section on this topic.
- 10.2.6. Adequate space should be provided for the segregation of gases by hazard class (e.g., flammable, oxidizing, toxic or corrosive).
- 10.2.7. Enclosed storage area for gas cylinders should be ventilated to prevent the potential build-up of leaked gases.
- 10.2.8. Oxygen level detector is recommended in rooms for the storage of large amount of asphyxiant gases such as liquid nitrogen, carbon dioxide, argon and helium where ventilation to the room is limited.
- 10.2.9. Suitable gas detectors should be installed for early detection of possible leaks from the toxic or flammable gas cylinders where ventilation is limited.

- 10.2.10. Proper restraints such as chains or straps to prevent the gas cylinders from moving and toppling should be provided. They should be secured to firm fixtures, e.g. a wall bracket fixed to a solid wall or the solid frame in a plaster board partition, etc.
- 10.2.11. Gas cylinders must be individually restrained. Each individual restraint shall have two separate anchorage points to the wall, and at about 2/3 the height for each gas cylinder. Non-combustible chains or straps should be used.
- 10.2.12. Storage and use of cylinders of highly toxic or flammable gases shall be within ventilated gas cabinets. For more safety requirements about the gas cabinets, please refer to the particular section on this topic.

10.3. Liquid Nitrogen and Other Cryogenic Liquids

- 10.3.1. Areas for storage of liquid nitrogen and other cryogenic liquids shall have good and sufficient ventilation to prevent the build-up of gases. Calibrated oxygen deficiency detectors shall be installed for those storage areas.
- 10.3.2. Means of transport of liquid nitrogen tanks to and from the laboratories, e.g. service lifts and movement path for trolley, shall be carefully considered. Paths of transport of such tanks should also be separated from heavily used public thoroughfare.

10.4. Hazardous Wastes

- 10.4.1. Suitable areas shall be provided for the safe temporary storage of solid or liquid hazardous wastes (biological / clinical, chemical or radioactive) from laboratories.
- 10.4.2. Storage areas shall be designed to contain any spills that may occur during handling of the waste.
- 10.4.3. These areas shall be posted with proper warning signs / notices, and have access control but be accessible to both the laboratory personnel and approved waste collector. Alternately, the laboratory personnel can escort the waste collector during collection of waste.
- 10.4.4. Different types of hazardous wastes have different requirements. The laboratory operators shall consult the related statutory bodies, such as Environmental Protection Department (EPD), register as waste producer and engage approved waste collector. For storage and disposal of radioactive waste, requirements from the Radiation Health Unit of the Department of Health shall be strictly followed.
- 10.4.5. The concerned laboratory operator shall keep the record of registration of waste producer and engagement of waste collector. The respective certificates shall be available for checking during laboratory inspection or audit.

11.LABORATORIES OF SPECIAL FUNCTIONS

11.1. Biosafety Level 2 Laboratory

Biological agents of Risk Group 2 should be handled in a Biosafety Level 2 (BSL-2) Laboratory. In addition to the general laboratory safety features, the followings are also required in accordance with the design specifications of WHO Laboratory Biosafety Manual:

- 11.1.1. Access must be restricted to authorized persons.
- 11.1.2. Doors should have vision panels, appropriate fire ratings and be self-closing.
- 11.1.3. A biohazard warning sign shall be posted at the entrance.
- 11.1.4. Negative pressure should be maintained to allow an inward flow of air into the laboratory. Exhaust air should not be recirculated to other areas.
- 11.1.5. Hand-wash basins, preferably with elbow-operated tap, should be provided near the exit door as far as possible.
- 11.1.6. Open spaces between the under benches, cabinets and equipment should be accessible for cleaning.
- 11.1.7. Emergency shower and eyewash facilities should be available at a convenient location.
- 11.1.8. An appropriate number of biological safety cabinets should be provided.
- 11.1.9. An autoclave or other means of decontamination should be available on site or in appropriate proximity.
- 11.1.10. Essential equipment such as biological safety cabinets, freezers, etc. should be on connected to emergency power supply.

11.2. Laboratory with High Power Laser Equipment

A high power laser equipment refers to any laser equipment classified as Class 3B or 4

in accordance with international standards such as ANSI Z136.1 and BSEN 60825-1, etc. Basic design features for a laboratory with the use of high power laser equipment include the followings:

- 11.2.1. A high power laser laboratory shall be such designed that no specular reflective surfaces are present which may inadvertently reflect laser beams.
- 11.2.2. Access shall be restricted to authorized persons.
- 11.2.3. Wherever possible, adequate levels of room illumination and light-colored but diffusely reflecting walls should be used.
- 11.2.4. The door giving access into a high power laser laboratory should have an interlock connected to the high power laser equipment or the beam shutter inside the laboratory so that laser emission is terminated or laser beam is blocked when the door is opened.
- 11.2.5. The high power laser equipment should be such positioned that its laser beam is not directing towards the doorway, aisles or other areas which might be occupied with laboratory personnel. It should also be mounted at proper height level so that its laser beam is not at the eye level of a seated or standing person.
- 11.2.6. Emission indicator device such as a warning light or other means of alarm should be installed at the entrance of the laboratory when the high power laser equipment is energized.
- 11.2.7. A laser hazard warning sign shall be affixed at the entrance.
- 11.2.8. Local exhaust ventilation system should be installed wherever hazardous vapors or fumes may be generated during the high power laser operation.
- 11.2.9. Appropriate firefighting equipment should be available in the vicinity of a Class 4 laser equipment.

11.3. Radioisotope Laboratory

A radioisotope laboratory refers to any laboratory which involves in the handling of unsealed radioactive substances or radiochemicals. In addition to the general laboratory safety features, the followings should also be incorporated:

- 11.3.1. Access must be restricted to authorized persons.
- 11.3.2. A radiation warning sign shall be affixed at the entrance.
- 11.3.3. Lighting fixtures should be flush with the ceiling to eliminate dust collection.
- 11.3.4. Ceiling panels should be of metal or other suitable materials that can be cleaned easily.
- 11.3.5. Negative pressure should be maintained to allow an inward flow of air into the laboratory. Exhaust air should not be recirculated to other areas.
- 11.3.6. Hand-wash basins, preferably with elbow-operated tap, should be provided near the exit door as far as possible.
- 11.3.7. Drainage piping should be connected directly to the manhole (avoid running through other areas).
- 11.3.8. Floor drain should be avoided.
- 11.3.9. Special fume cupboard for radioisotopes should be installed if necessary.
- 11.3.10. Emergency shower and eyewash facilities should be available at a convenient location.
- 11.3.11. As the use of radioactive substances is strictly governed by law (Radiation Ordinance and Regulations; Cap 303, Laws of HKSAR), additional radiation protection features (in particular shielding) may also be required subject to recommendations by the Radiation Health Unit of the Department of Health.

11.4. Laboratory with Open-beam X-ray Machine

An open-beam X-ray machine refers to any industrial, medical or analytical X-ray machine having the X-ray tube not total enclosed in an interlocked housing or cabinet. The design for a laboratory bearing open-beam X-ray machine shall meet legislative requirements as stated in the Radiation Ordinance and Regulations; Cap 303, Laws of HKSAR). Basic radiation protection features include the followings:

- 11.4.1. Access must be restricted to authorized persons.
- 11.4.2. All the walls and the door of the room shall be embedded with lead sheets with appropriate thickness and design (for more detailed information please refer to Radiation Health Series No. 7 : “Guidance Notes on the Design of Protective Shielding for Medical, Dental and Veterinary Diagnostic X-ray Facilities” issued from the Radiation Health Unit of the Department of Health).
- 11.4.3. A red warning light shall be installed at the entrance such that it can be manually or automatically switched on whenever the X-ray machine is energized.
- 11.4.4. A radiation warning sign shall be affixed at the entrance.

11.5. Laboratory with MRI or NMR

MRI (Magnetic Resonance Imaging) or NMR (Nuclear Magnetic Resonance) are instruments capable of generating strong magnetic fields. The following safety features should be taken into consideration during planning and design of a laboratory or premises having these instruments:

- 11.5.1. 11.5.1 The location of the laboratory and the sitting of these instruments should be carefully planned in order to minimize the stray magnetic fields in the nearby areas including the upper and lower floors.
- 11.5.2. These instruments should preferably be located at the lowest or uppermost

floor (with sufficient loading capacity) of a building and should be separated from areas with high occupancies as far as possible.

- 11.5.3. They shall be such located that the 5 Gauss (or 0.5 mT) lateral region (within which the magnetic flux density caused by the MRI/NMR magnet exceeds 5 Gauss) should be within the same laboratory. The 5 Gauss region should also be clearly marked on the floor or fenced off with safety chains.
- 11.5.4. Warning signs shall be posted at the entrance of the laboratory and also nearby any 5 Gauss regions (including areas of the upper or lower floors) to alert:
 - a) individuals with medical devices (e.g., cardiac pacemakers and metal prostheses) to remain outside the 5 Gauss perimeter; and
 - b) all metal objects must be kept outside the 5 Gauss perimeter.
- 11.5.5. Access must be restricted to authorized persons.
- 11.5.6. Appropriate discharge mechanism or emergency exhaust mechanism shall be provided to exhaust cryogenic gases from quenched superconducting magnets to outside to avoid creating an oxygen deficient atmosphere.
- 11.5.7. The discharge point should have appropriate weatherhead that prevents horizontal, wind-driven precipitation from entering, collecting, or freezing in the quench exhaust pipe.
- 11.5.8. To protect persons from cryogen exposure at the point of discharge, a quench safety exclusion zone should be established and clearly marked with surface warnings, signage or alarm.
- 11.5.9. Doors of the laboratory that may be subject to the effects of gas expansion during a quench shall open outwards to ensure that they are still openable during pressurization.
- 11.5.10. An oxygen sensor should be installed in the vicinity of the instruments to

monitor the oxygen level.

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C02 General Laboratory Safety Guidelines

1. Introduction

Science laboratories of various disciplines are being operated at the Science Park either by HKSTP or its clients. Laboratory personnel shall adopt appropriate safety measures to ensure their health and safety at work in the laboratories. This document delineates the very basic safety guidelines applicable to all laboratories at the Science Park. For laboratory operations involving specific hazardous sources such as chemicals, biological agents, radioactive substances, irradiating apparatus, lasers, etc., laboratory personnel are recommended to refer to other relevant guidelines in the “SHE Handbook”.

2. Laboratory Safety Management

A framework of safety management should be established for each client’s laboratory. This includes the delegation of personnel to be responsible for different laboratory safety issues. Laboratory safety committee or group should be established to include different levels of laboratory personnel. Regular meetings should also be held to enhance communication on laboratory safety issues.

According to HKSTP’s “Laboratory and Research Safety Policy”, a Laboratory Person In-Charge must be assigned to oversee laboratory safety. S/he would be the key person to assist in managing the laboratory following the basic safety requirements laid down in this policy.

3. Laboratory Safety Orientation and Training

It is the employers’ responsibility to provide safety information, instruction, and training to their employees in the workplaces. In the laboratories at the Science Park, all new

laboratory personnel are required to attend safety orientation arranged by their corresponding Laboratory Persons In-Charge before commencement of works in the laboratories. The purpose of safety orientation is to provide new laboratory personnel with basic information about their job hazards and the corresponding safety preventative measures. The need for further safety training should also be identified in the orientation. To facilitate the implementation and recording of such orientation, Laboratory Persons In-Charge are recommended to make use of HKSTP's Safety Orientation Checklist for New Laboratory Staff.

Moreover, Laboratory Persons In-Charge should also ensure that all laboratory personnel receive the necessary safety training depending on their scope of works. Safety orientation shall not substitute training on general and specific topics regarding laboratory safety.

4. Risk Assessment

In the environment of a research laboratory, there are frequent changes in experimental works and facilities alongside with the current research fields and technologies. As new facilities, equipment and technologies may pose new health and safety hazards to laboratory personnel, it is essential for the concerned laboratory personnel to conduct risk assessment:

- a) Before using any new or modified facilities
- b) Before commencing any new or modified experimental works
- c) Whenever there are significant changes in the laboratory environment
- d) Whenever deemed necessary by the concerned laboratory personnel

A simple risk assessment method having five steps is suggested:

- i. Look for the hazards
- ii. Decide who might be harmed
- iii. Evaluate the risks
- iv. Record the findings
- v. Review the assessment

Laboratory personnel is recommended to use HKSTP's Risk Assessment Form to conduct the risk assessment and record the results. For certain laboratory activity which encompasses a series of steps or actions, the assessment can be accomplished using HKSTP's Job Hazard Analysis Form.

5. Laboratory Safety Rules and Procedures

Each laboratory is unique in its operation and has its own risk. Yet there are many safety concerns which are common to most laboratories. The followings are rules or standard procedures that are applicable to almost every laboratory.

- a) Read all fire alarms and safety signs and follow the instructions in the event of an accident or emergency.
- b) Know the laboratory's emergency escape routes and evacuation procedures.
- c) Know the locations for the laboratory's safety equipment, including firefighting equipment, emergency shower and eyewash unit, spill kit, first-aid kit, etc.
- d) Know the emergency phone numbers to use to call for help in case of an emergency.
- e) Laboratory areas containing hazardous materials such as chemicals, biological agents, lasers, radiation sources, etc. should be properly marked with appropriate warning signs or symbols.
- f) Avoid the use of open flames in the laboratory as far as possible.

- g) Always work in properly-ventilated areas. Hazardous chemicals shall be handled in fume cupboards.
- h) Never eat, drink, smoke or use make-up in the laboratories.
- i) Handle glassware with care. Check for any damaged glassware before use and dispose of them properly.
- j) Never leave any ongoing experiments unattended.
- k) Never pipette by mouth.
- l) Long hair and loose clothing should be properly confined.
- m) Wear proper personal protective equipment.
- n) Clean the laboratory benches, workstations or equipment wherever necessary after experiments.
- o) Wash hands before leaving the laboratories.

Laboratory Persons In-Charge are advised to formulate general safety rules for their laboratories and/or Standard Operating Procedures (SOP) for specific laboratory operations.

6. Personal Protective Equipment (PPE)

Personal protective equipment (PPE) refers to clothing or equipment that is designed to protect the wearer's body from injury or infection. PPE commonly used in the laboratories includes laboratory coats, gloves, safety glasses, face shields, respirators, etc.

The types and their applications are briefly described in the following table.

Type	Protection	Use
Lab coat	Serves as additional layer of protection for skin Covers the wearer to the knees	Handling chemicals, biological agents/animals, and radioactive substances, etc. Should choose the lab coats of appropriate materials (e.g. cotton for common lab works

Type	Protection	Use
		or flame resistant materials for handling pyrophoric chemicals)
Safety glasses / spectacles	Protect eyes against spills and flying objects	Handling small quantities of common chemicals, biological agents/animals or operating equipment having potential splashing hazards
Chemical goggles	Protect eyes against splashing of hazardous chemicals	Handling hazardous chemicals
Face shield	Protects the face from flying objects and splashes	Working with large amount of hazardous chemicals Face shields must be worn over safety glasses or goggles
Disposable gloves	Provide hand protection against hazardous substances	Working with apparatus or equipment potentially contaminated with hazardous substances Serve for single use only
Chemical resistant gloves	Provide hand protection against hazardous chemicals	Working with hazardous chemicals or heavily contaminated apparatus or equipment
Cryogenic gloves	Provide hand protection against cryogens or materials of very low temperature	Working with cryogens such as liquid nitrogen, or handling materials in the freezers, etc.
Heat resistant gloves	Provide hand protection against apparatus or materials of very high temperature	Retrieving items from the ovens, furnaces, autoclaves or handling very hot materials, etc.
Surgical mask	Protects against large droplets and splashes	Working with live animals
N-95 mask	Protects against dust, fumes, mists or microorganisms	Working with live animals or infectious materials Working in the environment with fine particles or nanomaterials
Respirator (half-face or full face)	Protects against a variety of particulates, vapors, dust, mists, fumes; depends on the filter cartridge used	Working in the environment with particulates, chemical vapors or infectious materials

Laboratory personnel should observe the followings before or when using PPE in the laboratories:

- a) Choose the suitable types of PPE taking into consideration of the work environment, properties of the potential hazardous sources and personal factors such as fitness, comfort, etc.
- b) Use and maintain the PPE properly in accordance with the manufacturer's instruction.
- c) Regularly inspect the PPE and replace them whenever necessary.
- d) Bear in mind that PPE should be used only as the last line of defense when engineering and administrative controls are not feasible or effective.

7. Laboratory Safety Facilities

Essential laboratory safety facilities or equipment, including but not limited to fume cupboards, biosafety cabinets, gas sensors, firefighting equipment, emergency showers and eyewash units shall be properly maintained and certified by competent parties following recognized standards or schedules recommended by the respective manufacturers.

Maintenance or certification records shall be properly displayed or kept readily available for inspection.

8. Electrical and Mechanical Safety

Laboratory equipment may pose electrical and mechanical hazards to laboratory personnel. Safety rules and procedures as delineated in relevant chapters of SHE Handbook shall be followed.

9. Pressure and Vacuum Systems

High pressure vessels and vacuum systems are frequently employed in laboratory operations. The following safety requirements shall be observed:

- a) Pressure vessels must be registered, tested and certified in accordance with local legislation.
- b) High pressure operations should be performed only in pressure vessels appropriately designed and manufactured for the operation, properly installed and protected by pressure-relief and necessary safety devices.
- c) The vessels must be strong enough to withstand the stresses encountered at the intended operating temperatures and pressures and must not corrode or otherwise react when in contact with the materials it contains.
- d) Equip systems designed for use at elevated temperatures with a positive temperature controller. Avoid using a manual temperature control. The use of a back-up temperature controller capable of shutting the system down is strongly recommended.
- e) Use personal protective equipment, such as safety glasses or chemical goggles, face shields, and/or explosion shield to protect against the hazards of vacuum procedures, and the procedures should be carried out inside a fume hood.
- f) Do not allow water, solvents and corrosive gases to be drawn into vacuum systems. Protect pumps with cold traps and vent their exhaust into an exhaust hood.
- g) Assemble vacuum apparatus in a manner that avoids strain, particularly to the neck of the flask.
- h) Avoid putting pressure on a vacuum line to prevent stopcocks from popping out or glass apparatus from exploding.

10. Glassware Handling

Glassware should be handled with care in the laboratories following the below precautions:

- a) Do not use laboratory glassware to contain foods or drinks.
- b) All glassware should be inspected for cracks and contamination before use. Avoid using cracked or contaminated glassware.
- c) To avoid accidents and injuries, broken and waste glassware should be discarded in a proper container specially marked to indicate its contents.
- d) Containers for broken glassware should be packed when they are about 80% full. Packed broken glassware containers should then be disposed of as general refuse.
- e) Glass reagent bottles should be cleaned by rinsing with water thoroughly when the reagents have been used up and then placed into proper broken glassware containers for disposal.
- f) Glass reagent bottles with safety designed plastic coating should be purchased as far as possible. In case of breakage, the content would be contained by the plastic coating.
- g) Store glassware properly when not in use. Replace caps or stoppers on reagent bottles and cover open vessels, especially when working with volatile solvents.
- h) Only round-bottomed or thick-walled (e.g. Pyrex) evacuated glass vessels specifically designed for operations at reduced pressure should be used.
- i) Pressure and vacuum operations in glass vessels should be conducted behind adequate shielding.

- j) Glassware should be vented when heating to avoid over-pressurization and possible explosion. Keep stoppers loose when autoclaving or during procedures that require heating.
- k) Wear protective gloves to wash laboratory glassware or pick up broken glass.
- l) Wear safety glasses to prevent eye damage from broken glassware.
- m) Glass-blowing operations shall only be carried out by competent personnel with proper annealing facilities.

11. Housekeeping

Good housekeeping in laboratories reduces risks and protects the integrity of laboratory operations. The following general housekeeping practices shall be adopted in the laboratory areas:

- a) Access to emergency equipment including firefighting equipment, showers, eyewash units, and exits must never be blocked;
- b) Keep all work areas clear of clutter and obstructions;
- c) Keep all aisles clear of chemicals and other obstructions, and properly store items when not use;
- d) Avoid stacking chemicals or storing chemicals on the floor;
- e) Keep cabinet doors and drawers closed;
- f) All work surfaces and floors should be cleaned regularly (cleaning shall be supervised by the Laboratory Person In-Charge or delegated persons if carried out by cleaning staff);
- g) Clean up work areas at the end of the operation or day;
- h) Sink traps and floor drain traps (if available) should be filled with water at all times to prevent the escape of sewer gases into the laboratories;

- i) Reduce the risk of slips, trips, and falls by cleaning up liquid or solid spills immediately;
- j) Keep frequently used materials and bench apparatus well away from any edges and secured whenever possible;
- k) Avoid keeping excessive combustible materials including cardboard boxes, equipment boxes, Styrofoam, etc. in the laboratories;
- l) Sharps should be properly stored or disposed of in the sharp boxes;
- m) Clothing should be hung in proper locations and not draped over equipment or the benches;
- n) Properly dispose of hazardous wastes (including chemical waste, clinical waste and radioactive waste) following statutory requirements and HKSTP's respective guidelines.

12. Working Alone

In general, working alone with hazardous materials or hazardous processes in laboratories at the Science Park is discouraged. If working alone is deemed necessary under certain conditions, laboratory personnel shall observe the following rules:

- a) The work hours must be approved by the respective supervisor or Laboratory Person In-Charge;
- b) The person working alone shall make arrangements with other persons either in the same building or in other buildings to check with each other periodically;
- c) Dangerous experiments such as, but not limited to, working with pyrophoric, explosive, or highly toxic materials shall not be allowed.

13. Unattended Operations

In general, all laboratory operations should be conducted carefully in the laboratories with constant monitoring by the operators. Occasionally, laboratory operations are carried out continuously or overnight. For these situations, laboratory personnel shall observe the following rules:

- a) Operations shall be designed to be safe in case of failure of utility services such as electricity, water, vacuum, compressed air, etc.;
- b) Water cooled operations should utilize recirculating refrigerated water baths to conserve water and protect against floods;
- c) Regulate the water pressure automatically via the installation of a water pressure regulator to avoid surges that might rupture the water lines; and monitor the water flow so that in the event of interruption, electricity and water supply can be turned off;
- d) Whenever possible, arrange periodic inspections to the operations;
- e) The laboratory lights should be left on and appropriate sign should be posted on the door.

14. Emergency Preparedness

Emergency preparedness for laboratory accidents or incidents is essential for each laboratory in response to accidents or incidents. Laboratory Person In-Charge or other responsible person shall establish an emergency response plan for the various situations and features of individual laboratory. This plan should include contact details for emergency contact persons and delineate the emergency response procedures in cases of minor and major laboratory incidents or accidents such as fire, explosion, gas leakage, hazardous substances spillage, etc.

Necessary emergency facilities and equipment shall be in provided and maintained in good conditions readily available for use. Personnel delegated to respond to laboratory emergency situations shall be properly trained. Drills for emergency situations are also highly recommended to be conducted regularly.

In addition, adequate resources shall be allocated by the management of individual laboratory to guarantee the emergency preparedness plan can be effectively executed.

15. Reporting of Laboratory Accident and Incident

In case of any laboratory related accidents or incidents, the Laboratory Person In-Charge or his/her delegates shall notify HKSTP in a timely manner following the requirements as laid down in “Accident and Incident Reporting Procedures” of the SHE Handbook. Investigation shall be carried out where appropriate and remedial measures shall be taken in order to avoid recurrence of similar cases.

C03 Laboratory Biological Safety Guidelines

1. Introduction

Biological hazards refer to any organisms or organic matters produced by these organisms that are harmful to human health. These include parasites, viruses, bacteria, fungi, toxins, etc. As laboratories involved in biomedical technology account for a majority of research laboratories at the Science Park, a great number of laboratory personnel are frequently exposing to biological hazards during their works. Biohazardous substances can enter into the human bodies via three major of routes, i.e. inhalation, ingestion and injection causing laboratory acquired infection. Laboratory personnel must exercise good biological safety practices to safeguard themselves. The laboratories shall also be equipped with proper biological safety equipment and facilities as essential biological safety measures.

2. Laboratory-Acquired Infections (LAIs)

Laboratory-acquired infections (LAIs) refer to infections acquired through laboratory or laboratory-related activities regardless of whether they are symptomatic or asymptomatic in nature. They may be resulted from occupational exposure to biohazardous substances or infectious agents via the following routes in the laboratories:

- a) Inhalation (aerosols)
- b) Percutaneous inoculation (needle and syringe, cuts or abrasions from contaminated items and animal bites)
- c) Contact between mucous membranes and contaminated material (hands or surfaces)
- d) Ingestion (aspiration through a pipette, smoking or eating)

As inhalation of contaminated aerosols accounts for a great number of LAI cases, infectious agents must be carefully handled to avoid the generation of aerosols in all

laboratory procedures including centrifugation, sonication, homogenization, pipetting, mixing, shaking, and opening containers, etc.

3. Risk Grouping of Microorganisms

Microorganisms are classified into different risk groups by numerous government agencies based on their effects on humans, taking into consideration for the transmissibility, invasiveness, virulence, lethality of the specific pathogen and the availability of vaccines or therapeutic interventions. According to the “Laboratory Biosafety Manual” issued by the World Health Organization (WHO), there are four risk groups with the following definitions:

- a) **Risk Group 1** (no or very low individual and community risk): A micro-organism that is unlikely to cause human or animal disease.
- b) **Risk Group 2** (moderate individual risk, low community risk): A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposure may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited.
- c) **Risk Group 3** (high individual risk, low community risk): A pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available.
- d) **Risk Group 4** (high individual and community risk): A pathogen that usually causes serious human or animal disease and that can be readily transmitted from one individual to another, directly or indirectly. Effective treatment and preventive measures are not usually available.

All microorganisms listed under Risk Groups 2 to 4 are known as pathogens while those classified as Group 1 are non-pathogens. Even though under the same principles of classification, different government agencies or international authorities may have developed their own list of microorganisms with different risk grouping. Research personnel shall adopt the corresponding biological safety measures for handling microorganisms in the laboratories.

Due to the health risk associated with **Risk Groups 3 and 4 organisms** and their potential health and safety impact to the community, they are currently **Not Allowed** to be handled in the laboratories at the Science Park.

4. Laboratory Biosafety Levels

In general, the biosafety level of a laboratory is the level of protection against the biohazard identified through the use of good laboratory practices, safety equipment and building facilities. Microorganisms of certain risk groups shall be handled only in laboratories of the required biosafety levels. The table below summaries the safety practices and equipment required for each biosafety level.

Risk Group	Biosafety Level	Typical Laboratory Types	Laboratory Practices	Safety Equipment
1	Basic Biosafety Level 1 (BSL1)	Basic teaching; research	Good microbiological techniques	None; open bench work
2	Basic Biosafety Level 2 (BSL2)	Primary health services; diagnostic; research	Good microbiological techniques; Protective clothing; Biohazard signs	Open bench + Biological safety cabinet for potential aerosols

3	Containment Biosafety Level 3 (BSL3) <i>(Not allowed at the Science Park)</i>	Special diagnostic; Research	As for level 2; + special clothing; controlled access, directional air flow	Biological safety cabinet for all activities
4	Maximum Containment Biosafety Level 4 (BSL4) <i>(Not allowed at the Science Park)</i>	Dangerous Pathogen Units	As for level 3; + air lock, shower exits, special waste disposal	Class III Biological safety cabinet, positive pressure suits in conjunction with Class II BSCs, double-ended autoclave (through the wall), filtered air

As Risk Group 3 and 4 organisms are restricted at the Science Park, **Biosafety Levels 3 and 4 (BSL3 and 4)** laboratories are **Not Allowed** to be built and operated at the Science Park. For animal experiments associated with microorganisms, they must be conducted in laboratories of appropriate Animal Biosafety Levels. **Animal Biosafety Levels 3 and 4 (ABSL3 and 4)** laboratories are also currently **Not Allowed** at the Science Park.

For **clinical specimens** including human blood, blood products, body fluids, tissues and cells which may contain potentially infectious agents, they must be handled in **BSL2 containment** with **BSL2 practices** as the minimum requirement unless a higher biosafety level is deemed necessary due to the presence of known microorganisms of higher risk groups.

5. Risk Assessment

Laboratory Persons In-Charge of individual clients at the Science Park are required to

conduct appropriate risk assessments before commencement of research projects involving microorganisms or other biohazardous substances. Risk assessment procedures are recommended as follows:

- a) Identify the Risk Group that has been assigned to the biohazardous agent(s) involved with reference information from local authorities or international agencies.
- b) Identify laboratory procedure hazards with particular attention to those procedures that may generate aerosols, pose hazards associated with needle-stick injury, animal bites, hazardous chemicals and radioactive substances, etc.
- c) Determine the required biosafety level and other necessary safety measures.
- d) Evaluate if existing safety measures suffice. If not, include additional measures.
- e) Review the risk assessment periodically or whenever necessary.

The purpose of this risk assessment is to ensure that appropriate equipment and facilities are available to support the work being considered. In case of any queries arising from the process of risk assessment, the concerned Laboratory Person In-Charge should contact SHE Office for consultation.

6. Safety Measures for Biosafety Levels 1 and 2 (BSL1 and 2) Laboratories

The safety guidelines described here are applicable to both Level 1 and Level 2 laboratories. They are fundamental good microbiological practices, which should be practiced in all BSL2 laboratories as a basic minimum, and as far as possible in BSL1 laboratories.

6.1. General Rules

- a) The international biohazard warning symbol and sign must be displayed on the doors of the rooms where micro-organisms of Risk Group 2 are handled.
- b) Only authorized persons are allowed to enter the laboratory working areas.

- c) Laboratory doors should be kept closed.
- d) Animals not involved in the work of the laboratory should not be permitted in the laboratory.
- e) Wear appropriate personal protective equipment such as gloves for hand protection; masks, protective eyewear or face shields for protection against splashes onto the mouth, eyes, or nose.
- f) Remove all contaminated or potentially contaminated protective equipment before leaving the laboratory areas. Never take them home or outside the laboratories (such as during lunch or personal breaks).
- g) Wash hands thoroughly before leaving the laboratories.
- h) Do not eat, drink, smoke, or apply cosmetics in the laboratory areas.
- i) Foods or drinks should not be kept in the laboratory areas except for experimental purpose.
- j) Avoid mouth pipetting, recapping needles, or leaving unprotected any skin, membranes, or open cuts.
- k) All technical procedures should be performed in a way that minimizes the formation of aerosols and droplets. Procedures which may have an increased risk of aerosolization (e.g. centrifugation, grinding, blending, vigorous shaking or mixing, sonic disruption, opening ampoules containing infectious materials, etc.) should be conducted in a biological safety cabinet.
- l) The laboratory should be kept neat, clean and free of materials that are not pertinent to the work.
- m) Work surfaces must be decontaminated using appropriate disinfectants after any spill of biohazardous substances and at the end of the working day.

- n) All contaminated materials, specimens and cultures must be decontaminated before disposal or cleaning for reuse.

6.2. Laboratory Design and Facility Requirements

- a) Walls, ceilings and floors should be smooth, easy to clean, impermeable to liquids and resistant to the chemicals and disinfectants normally used in the laboratories. Floors should be slip-resistant.
- b) Pipes and ducting should not be exposed, where possible.
- c) Bench tops should be sealed to the walls, impervious to water and resistant to disinfectants, acids, alkalis, organic solvents and moderate heat.
- d) Laboratory furniture should be sturdy. Open spaces between and under benches, cabinets and equipment should be accessible for cleaning.
- e) Facilities for storing outer garments and personal items should be provided, preferably outside the laboratory working areas.
- f) Hand washbasins, with running water if possible, should be provided in each laboratory room, preferably near the exit door.
- g) Doors should have vision panels, be self-closing. They should have appropriate fire ratings.
- h) An autoclave or other means of decontamination should be available for use at a convenient location.
- i) Emergency shower and eyewash facilities should be available at a convenient location.
- j) First-aid areas, or rooms suitably equipped and readily accessible, should be available.

- k) Individual laboratory ventilation system should be such designed that the laboratory is maintained under negative pressure and laboratory air is not recirculated to other areas.
- l) There should not be any cross connections between sources of laboratory water and drinking water supplies.
- m) An anti-backflow device should protect the public water system.
- n) There should be a reliable and adequate electricity supply and emergency lighting to permit safe exit. Back-up power is desirable for the support of essential equipment, such as incubators, biological safety cabinets, freezers, etc.

6.3. Essential Biosafety Equipment

- a) Biological safety cabinets (BSC) – BSC is an essential biosafety equipment which offers a partially or fully enclosed work space for safe handling of biohazardous substances including microbiological agents and cancer cells, etc. According to international standards, there are different types of BSC with respect to the construction design as well as types and levels of protection. Laboratory personnel should use the appropriate type of BSC for their experimental works.
- b) Pipetting aids – Use as a means to avoid mouth pipetting.
- c) Plastic disposable transfer loops – Use to substitute metal inoculation loops in preventing aerosol production.
- d) Electric transfer loop incinerators – Use to substitute gas burners in preventing aerosol production.
- e) Screw-capped tubes and bottles – Avoid splashing of infectious materials in the tubes or bottles.
- f) Autoclaves: Use for decontaminating infectious materials.

- g) Plastic disposable Pasteur pipettes – Use whenever available to substitute glass pipettes.

Equipment such as autoclaves and biological safety cabinets must be validated with appropriate methods (preferably by a certified examiner) before being used. Re-certification should take place at regular intervals according to the manufacturer's instructions.

7. Handling, Storage and Disposal of Biological / Clinical Wastes

Biological or clinical waste is potentially dangerous because it can cause cuts and needle-stick injuries or transmit disease. According to the Waste Disposal (Clinical Waste)(General) Regulation (Cap. 354O, Laws of HKSAR), clinical waste means waste consisting of any substance, matter or thing generated in connection with:

- a) A dental, medical, nursing or veterinary practice;
- b) Any other practice, or establishment (howsoever described), that provides medical care and services for the sick, injured, infirm or those who require medical treatment;
- c) Dental, medical, nursing, veterinary, pathological or pharmaceutical research; or
- d) A dental, medical, veterinary or pathological laboratory practice.

Each laboratory operator at the Science Park that may generate clinical waste (as a clinical waste producer) shall obtain a premises code from the Environmental Protection Department (EPD) and follow all respective legal requirements in segregation, packaging, labelling, handling, storage, collection, transportation and disposal of clinical waste.

7.1. Segregation

Clinical waste must be segregated from municipal waste or general refuse and divided

into six groups as described below which will be handled or treated differently.

- a) Group 1 - Contaminated Sharps: Contaminated syringes, needles, cartridges, contaminated broken glass and other sharp instruments.
- b) Group 2 - Laboratory Waste: Unsterilized laboratory stocks and cultures of infectious agents.
- c) Group 3 - Human and Animal Tissue: All human tissue and animal carcasses from medical practices or research laboratories, whether infected or not, and items heavily contaminated with blood or blood products.
- d) Group 4 - Infectious Material: Infectious material from patients under strict isolation.
- e) Group 5 - Soiled Dressings: Soiled surgical dressings, swabs and all other contaminated waste from treatment areas and isolation rooms, assessed to be of significant risk by health care personnel.
- f) Group 6 - Other Wastes: Other wastes that are likely to be contaminated with infectious materials or clinical waste and may pose significant health risk.

It should be noted that pharmaceutical waste and chemical waste which are potentially contaminated with infectious materials or clinical waste are classified as a special type of chemical waste and should be disposed of in accordance with chemical waste arrangements.

7.2. Packaging and Labelling

All clinical waste must be placed in a container or combination of containers that are leak resistant, impervious to moisture, strong enough to prevent tearing or bursting under normal handling, and can be sealed securely. Containers shall be of one-trip type and under no circumstances should they be reused or recycled.

Bags and sacks should be colored RED and of high density polyethylene of a minimum gauge of 100 microns or equivalent strength. Group 1 waste should be disposed of in boxes or drums, which after sealing should be subsequently placed in plastic bags of the above specifications. Other groups of waste should be disposed of in plastic bags or plastic drums prior to dispatch for disposal.

Bags or sacks can be sealed by a "goose neck tie", and tied at the neck with adhesive tape. Bags or sacks should be sealed when they are no more than three-quarters full. Boxes and drums when closed must be further sealed with adhesive tape to ensure complete security of the aperture cover or lid prior to placing the container into a bag or sack, or prior to transportation in its original form, to storage and/or disposal. Sufficient space should be left in boxes or drums to ensure that they can be sealed securely. All containers should be conspicuously marked with the "Biohazard" symbol and labeled as "Clinical Waste" in both Chinese and English.

7.3. Handling

Personnel who may be required to handle or move bags of clinical waste by hand within a particular location should:

- a) Check that storage bags, boxes and drums are effectively sealed;
- b) Wear proper gloves and handle bags by the neck only;
- c) Handle sharps containers and plastic drums safely;
- d) Avoid damaging packaging by throwing, dropping, dragging it on ground or stepping on it;
- e) Know the procedure in the event of accidental spillage and how to report accidents;

- f) Check that the seal of any storage container is unbroken when movement is complete;
- g) Understand the special problems related to special types of clinical waste, e.g. sharps, cytotoxic waste etc.

In the event of spillage of clinical waste, the clean-up operation should be conducted by workers trained for the purpose. The workers should be provided with absorbent materials, disinfectants, appropriate protective clothing, masks, eye protectors, gloves etc.

7.4. Storage

Clinical waste producers should provide suitable and adequate area for temporary onsite storage of clinical waste. The storage area should be located close to the sources of waste generation so as to minimize waste handling and to facilitate management control.

The storage area should be enclosed on at least three sides by wall, partition or fence. As the quantity of clinical waste generated by most of the laboratories at the Science Park is not large, a small lockable cupboard with ventilation openings and proper signage can serve this purpose. For Group 3 clinical waste which contains human tissues or animal carcasses, they should be kept in dedicated lockable refrigerators or freezers to prevent obnoxious odor. Proper signage should also be displayed on the refrigerators or freezers.

7.5. Collection, Transportation and Disposal

Clinical waste producers must appoint a licensed clinical waste collector (list of licensed clinical waste collectors is retrievable from EPD's website) to collect the waste.

Licensed clinical waste collectors are required to use appropriate transit skips for

collection and transportation of waste from the collection points to the dedicated vehicles for subsequent delivery to the licensed disposal facility.

In order to keep track of the waste movement in a waste consignment, EPD employs a “Trip Ticket” system to record and certify the quantity of clinical waste collected and delivered to the final destination. For each waste consignment, the licensed waste collector is required to provide a trip ticket copy to both the waste producer and the operator of the licensed disposal facility for checking and recording. Waste producers must keep such records for 12 months from the date of consignment / delivery for inspection by EPD.

8. Spillage and Decontamination

In the event of spillage of biohazardous or infectious agents, an assessment should be made so that suitable actions can be adopted for treating the spillage inside or outside of a biological safety cabinet.

8.1. Spillage inside a Biological Safety Cabinet

A spillage of infectious agents that is confined to the interior of a functioning biological safety cabinet should pose minimal risk to personnel in the area. However, the personnel involved should:

- a) Stop any experimental works immediately;
- b) Alert any nearby workers and notify the supervisor or Laboratory Person In-Charge;
- c) Initiate decontamination procedures while the cabinet ventilation system continues to operate to prevent escape of contaminants from the cabinet;
- d) Wear appropriate personal protective equipment including gloves, lab coat, goggles, and have the spill kit ready;

- e) Cover the spill with paper towels or other absorbent materials and let the spill soak in;
- f) Apply appropriate disinfectant such as 10% bleach from the outside to the inside of the spill;
- g) Allow at least 20 minutes for disinfectant contact time;
- h) Discard the paper towels into a clinical waste bag inside the cabinet;
- i) Wipe up the spill area with clean paper towels and disinfectant for one or two more times;
- j) Clean the area again using paper towels soaked with sterile water to remove any residual disinfectant;
- k) Transfer all contaminated items into the clinical waste bag for disposal as clinical waste;
- l) Upon completion of decontamination, report to the supervisor or Laboratory Person In-Charge for following up assessment if decontamination of the whole biological safety cabinet by fumigation is necessary.

8.2. Spillage outside a Biological Safety Cabinet

When there is an accidental spillage of infectious agents outside a biological safety cabinet, personnel involved should take the following emergency response procedures:

- a) Alert all workers in the laboratory;
- b) Hold the breath and evacuate the laboratory immediately followed by closing the door;
- c) In case any body parts or clothing are contaminated, remove the contaminated clothing and flush the body parts with water using the nearby emergency shower;

- d) Report the incident to the supervisor / Laboratory Person In-Charge as well as HKSTP by telephone following the general laboratory emergency procedures;
- e) Proceed with decontamination procedures if considered manageable. Otherwise, stay in a nearby safe place and wait for assistance;
- f) Before re-entering the laboratory to carry out decontamination, stay outside for at least 30 minutes to allow droplets or aerosols to settle. Meanwhile, prepare for the spill kit and personal protective equipment;
- g) Put on appropriate personal protective equipment such as gloves, lab coat, goggles, respirator and shoe covers;
- h) Always work in a team by assigning personnel to control access to the site and personnel to do the cleanup.
- i) Cover the spill with paper towels or other absorbent materials and let the spill soak in;
- j) Apply appropriate disinfectant such as 10% bleach from the outside to the inside of the spill;
- k) Allow at least 20 minutes for disinfectant contact time;
- l) Discard the paper towels into a clinical waste bag;
- m) Wipe up the spill area with clean paper towels and disinfectant for one or two more times;
- n) Clean the area again using paper towels soaked with sterile water to remove any residual disinfectant;
- o) Transfer all contaminated items including gloves, shoe covers and other protective clothing into the clinical waste bag for disposal as clinical waste;
- p) Upon completion of decontamination, report to the supervisor / Laboratory Person In-Charge and HKSTP for following up assessment if the laboratory can be re-

opened or further decontamination of the whole laboratory area by fumigation is necessary.

C04 Guidelines For Handling Laboratory Animals

1. Introduction

Animal experiments are frequently involved in a variety of scientific researches in the laboratories. Those who work with animals are exposed to a range of different hazards depending on the type of works undertaken. The objective of this safety guide is to protect laboratory personnel at the Science Park against possible hazards arising from the handling of laboratory animals, which are classified as vertebrates. Relevant legal requirements and ethical issues are also highlighted.

2. Hazards Associated with Animal Workers

The general hazards associated with the care and use of laboratory animals include:

- a) Physical harm – It includes bites, scratches and kicks associated with research animal contact.
- b) Needle-stick and sharps injuries – These are also common injuries arising from animal experimental procedures like injection using hypodermic needles, feeding, etc.
- c) Experimentally-induced infection – Laboratory animals may be deliberately inoculated with microorganisms for experimental works in the laboratory facilities. Animal workers might contract experimentally-induced infections via infectious materials during the course of handling or holding of the infected animals if protective measures such as the use of proper containment or personal protective equipment are not strictly followed.
- d) Zoonotic infections – Zoonotic diseases are infectious diseases that can be transmitted from animals to humans. Laboratory animal species potentially harbor a variety of zoonotic agents including viruses, bacteria, fungi, protozoa and

parasites. Individuals with animal contact should be aware of these diseases and take appropriate precautionary measures to prevent infections.

- e) Allergens – Laboratory workers may show signs of allergies such as animal-induced asthma due to exposure to animals during their works with animals. Animal-induced asthma is the immune system's response to allergens including animal dander, scales, fur, body wastes and saliva, etc.
- f) Other hazards:
 - i. Ergonomic hazards caused by tasks that require repetitive motion, lifting, or awkward body postures.
 - ii. Slip, trip and fall hazards caused by various work processes, lighting requirements, housekeeping practices.
 - iii. Pressure vessel hazards related to compressed gas cylinders, autoclaves, high pressure washing equipment, etc.
 - iv. Electrical hazards related to the use of various electrical equipment.
 - v. Machinery hazards include pinch, nip or crush points related to moving parts.
 - vi. Noise hazards can result from animals, especially pigs and dogs, and from equipment such as cage washers.
 - vii. Radiation hazards include ionizing and non-ionizing radiation sources such as radioactive substances, X-ray devices, MRI, laser equipment, ultra-violet germicidal lamps, etc.
 - viii. Chemical hazards related to the use of disinfectant, anesthetic gases, pesticides, tissue preservatives and protocol-related use of chemicals.

3. Health and Safety Requirements

To assure the health and safety of laboratory animal workers and the compliance of

relevant local legislations, the management of each concerned laboratory shall observe the following health and safety requirements:

3.1. Licensing and Ethics Approval

The use of living vertebrate animals for experiments in Hong Kong is regulated by the Animals (Control of Experiments) Ordinance (Cap 340, Laws of Hong Kong SAR). Animal workers must have valid licenses issued by the Department of Health for handling animals. They shall treat animals humanely in compliance with the Prevention of Cruelty to Animals Ordinance (Cap 169, Laws of Hong Kong SAR) and relevant code of practice. Respect the animals. Kill the animal with appropriate method such as carbon dioxide asphyxiation, cervical dislocation or induction of overdosed anesthesia. Ensure the animal has been sufficiently anesthetized or dead before carrying dissection.

In addition, clients intending to carry out experiments involving living vertebrate animals shall obtain approvals from relevant parties including individual client's Animal Ethics Committee.

3.2. Training of Personnel

All animal workers shall be trained and provided with information regarding standard work practices, potential hazards and their control measures as well as emergency procedures. Standard work practices shall include proper animal handling techniques, precautions for using hazardous substances, proper use of personal protective equipment and other safety devices for safeguarding animal workers.

3.3. Personal Hygiene and Health Assessment

Personal hygiene is an important factor in protecting the health of personnel engaged in

animal care or research. They need to understand and follow the hygiene practices that are to be taken routinely to protect them against zoonotic agents found naturally in experimental animals as well as the hazardous materials involved. These include:

- a) Wear proper personal protective equipment and clothing during work with animals. Dedicated clothing shall be either laundered by husbandry staff using in-house facilities or by professional laundry services. Dedicated clothing must not be taken home.
- b) No eating, drinking, smoking and application of cosmetics in the animal facilities or laboratories.
- c) Wash hands after handling animals, non-sterilized tissues or body fluids.
- d) Avoid working with animals if you are ill.
- e) Take additional precautions if you have open wounds by bandaging the area and wearing double gloves.

In addition, animal workers are recommended to have pre-employment and periodic health assessment or medical examination to determine if they are physically fit to work with specific animals and detect early signs of any diseases associated with that particular animal works. They should also maintain appropriate vaccination status depending on the animal species they are working with and upon physician's advice.

3.4. Facilities and Building Services Requirements

Animal facilities at the Science Park shall meet the following facilities and building services requirements in order to ensure a safe and suitable environment for animal care and use as well as necessary containment of the premises:

- a) The floors, ceilings, walls, benches and equipment in animal laboratories shall be designed to be easily cleaned and decontaminated.

- b) Proper ventilation shall be provided to ensure a suitable environment for the keeping of animals as well as to protect workers from airborne contaminants or odors arising from the handling of animals and operation of the facilities. In general, laboratories or areas for holding and handling animals should be maintained under negative pressure relative to the corridors or neighboring areas. 10 to 15 air changes per hour should also be provided to these areas.
- c) If animals are to be inoculated with microorganisms for experiments, all works associated with the infected animals as well as post-mortem examinations shall be carried out in special containment laboratories of suitable animal biosafety levels matching the corresponding risk groups of the microorganisms involved. For more details on risk grouping of microorganisms, biosafety level classification for laboratories and the necessary biosafety equipment, please refer to the section “Laboratory Biological Safety Guidelines” of SHE Handbook.
- d) Essential facilities for animal holding including cage washer or other appropriate washing facilities, cage changing station or animal bedding disposal station, etc. shall be available in the premises.
- e) In general, living animals are not allowed to be housed overnight in the laboratories unless the abovementioned facilities are in place. Exemption would be granted for the situation that animal experiments are in progress without washing or changing of cages.
- f) Suitable area shall be provided for the temporary storage of clinical waste including animal carcasses, animal tissues, and animal-related waste materials (which may be contaminated with infectious agents). Relevant legal requirements shall be observed for their storage and final disposal.

- g) Essential safety facilities including emergency shower, eyewash station, firefighting equipment, spill kit, and first-aid kit shall be available at appropriate locations. Autoclave, biosafety cabinets and other biosafety equipment should also be available depending on the biosafety level of the laboratories.

3.5. Safe Work Practices

Animal workers shall adopt the following health and safety practices for caring and handling of animals:

- a) Wear proper personal protective clothing and equipment (including spectacles / goggles, face shield, hair cover, gloves, respirator, mask, lab coat, coverall, shoe covers, etc.) and remove after animal contact or other operations.
- b) Exercise good personal hygiene practices.
- c) Use appropriate methods and equipment to restrain animals and prevent escape of animals.
- d) Perform animal manipulations within ventilated hoods or safety cabinets if necessary.
- e) Animal areas and cages should be cleaned and disinfected regularly.
- f) Use absorbent pads for bedding. If these are not available, use corncob bedding instead of sawdust bedding.
- g) Use ventilated enclosure such as cage changing station or animal bedding disposal station as far as possible for changing animal bedding.
- h) All sharp items including needles, scalpels, capillary tubes, etc. must be handled safely and placed in designated sharps containers for disposal.
- i) Do not recap needles.

- j) All animal carcasses, tissues or organs, shall be packaged in proper containers or bags and kept temporarily in deep freezers till picked up by licensed clinical waste collectors for final disposal. Animal-related waste materials possibly contaminated with infectious agents must also be disposed of as clinical waste. Packaging, storage and disposal of all the above-mentioned clinical waste shall follow the Waste Disposal (Clinical Waste)(General) Regulation (Cap 354, Laws of HKSAR).
- k) All post-mortems on infected animals shall be carried out under the physical containment conditions equivalent to the risk group of the microorganism present.
- l) Handle hazardous chemicals and drugs carefully following precautions recommended by the respective Material Safety Data Sheet (MSDS).
- m) Use anesthetic gases in ventilated enclosures or under well ventilated conditions. Suitable scavenging systems shall also be employed to remove the excessive or waste gases.
- n) Operations involving the use of radiochemicals shall be carried out in designated areas or proper ventilated enclosures in compliance with legal requirements.
- o) Adopt necessary engineering control measures and exercise safety precautions when operating machinery or equipment associated with mechanical, electrical, radiation, high pressure and noise hazards.

3.6. Precautions for transportation of animals

If it is necessary to transport animals from the animal holding facilities or from one laboratory to the others within Science Park for experimental purposes, the following precautions must be observed:

- a) Only healthy animals are allowed to be transported within the Science Park area. Sick animals or animals treated with hazardous substances such as pathogens or radiochemicals should never be transported.
- b) Animals should be transported in covered or opaque cages, carriers, or container that are escape-proof, adequate in size, and made of materials that can be readily sanitized.
- c) These cages or transport devices should have solid bottoms or placed in secondary container to contain animal waste.
- d) Transportation of animals should be done in a direct and timely manner, avoiding public areas as much as possible.
- e) Use cargo lifts for transporting animals. If there is not any cargo lift in the building, use the passenger lift only when there are no other passengers.
- f) Clean and disinfect immediately any contamination of public areas with animal materials.
- g) People who are involved in transporting animals should have appropriate personal protective equipment readily available for use.
- h) Wash hands thoroughly with soaps after each transportation.
- i) All devices for transporting animals should be sanitized between uses.

4. Security Issue

Research using animals is sensitive, and the design of these facilities requires a heightened awareness to the issues of security control to maintain confidentiality and to prevent unauthorized intrusions. Access control to animal facilities and use authorization for animal workers should be carefully considered.

C05 Laboratory Chemical Safety Guidelines

1. Introduction

Nowadays, the operation of a research laboratory usually involves the use of a variety of chemicals of different hazardous properties. Laboratory personnel must be knowledgeable to identify the hazardous natures of the chemicals they are working with and exercise appropriate precautionary measures to protect themselves as well as their co-workers, and avoid any accidents happened in the laboratories. The purpose of this document is to provide laboratory personnel at the Science Park with general guidelines on chemical safety in compliance with corporate and statutory requirements.

2. Types of Hazardous Chemicals

Chemical hazard is anything with the potential to cause harm to a person and damage to property. It is vital to understand the different types of hazardous chemicals commonly used in the laboratories to avoid unexpected consequences including fire, explosion, intoxication, other adverse health effects or even death.

2.1. Corrosive Chemicals

Corrosive chemicals refer to those chemicals which may cause serious injuries on prolonged contact with skin. Examples include ammonia, hydrochloric acid, nitric acid, sodium hydroxide, phosphoric acid and sulphuric acid, etc. Corrosive chemicals should always be handled by wearing chemical resistance gloves.

2.2. Flammable Chemicals

Flammable chemicals refer to those gases, liquids and solids that will ignite and continue to burn in air if exposed to a source of ignition. Flammability depends on the flash point which is defined as the lowest temperature at which the chemical will give off sufficient

amount of vapor to form a mixture with air that can be ignited. The lower the flash point, the higher the fire risk associated with the chemical.

Organic solvents are common flammable chemicals used in the laboratories. Those with a flash point below ambient temperature require more attention. Examples include methanol, ethanol, acetone, and diethyl ether, etc. Flammable chemicals should be carefully handled in the fume cupboards and away from any ignition sources. They should never be stored with oxidizing agents, highly reactive metals and highly toxic or corrosive chemicals.

2.3. Irritant Chemicals

Irritant chemicals refer to those chemicals which can cause reversible inflammation or irritation to a body surface including eyes, respiratory system and skin. Examples include ammonia, sulfur dioxide, halogens and nitrogen dioxide. Protective gloves should be worn and good ventilation should be ensured when handling these chemicals.

2.4. Toxic Chemicals

Toxic chemicals refer to those chemicals which can pose significant adverse health effect to people upon immediate or short-terms exposure via inhalation, absorption (through eye, skin or mucous membranes) or ingestion. Examples include sodium cyanide, dimethyl mercury, hydrogen fluoride, phosphine.

2.5. Harmful Chemicals

Harmful chemicals are those substances which if inhaled, ingested or absorbed through skin, may involve limited health risk. Examples include citric acid, sodium oxalate and acetonitrile.

2.6. Oxidizing Chemicals

Oxidizing chemicals are those chemicals which may give rise to highly exothermic reactions when in contact with other substances, particularly flammable and organic substances. Examples include hydrogen peroxide, potassium permanganate, sodium chlorite, concentrated nitric acid and sodium perchlorate.

2.7. Explosive Chemicals

Explosive chemicals are those chemicals which may start reactions spontaneously upon sudden change in temperature and pressure or under mechanical friction and vibration. The reactions are usually violent and explosion often results. Examples include benzoyl peroxide, azide compounds, picric acid and ammonium nitrate. Explosive chemicals must be stored in lockable storage chemical cabinets at minimum quantities.

3. Chemicals of Specific Hazards

Some specific groups of chemicals used in the laboratories possess significant or unique hazardous properties which demand greater attention and special precautionary measures:

3.1. Hydrofluoric Acid

Hydrofluoric acid is a weak acid, but strongly corrosive. It is widely used in the semiconductor processing for etching silicon dioxide and stripping the native oxide prior to further processing. It is a highly hazardous chemical which can attack our bone, tissue and goes into the blood stream. Exposure to hydrofluoric acid without adequate follow-up treatment may result in death due to systemic poisoning.

Laboratory personnel must wear appropriate chemical resistant gloves and handle hydrofluoric acid in a fume cupboard preferably equipped with wash down facilities.

Plastic containers are required for keeping hydrofluoric acid as it can etch glass. Upon exposure to hydrofluoric acid, laboratory personnel must flush that body parts using an emergency shower or eyewash unit for at least 15 minutes followed by the application of calcium gluconate gel which serves as an antidote. Personnel should seek medical consultation afterwards.

3.2. Peroxide Forming Chemicals

Peroxide forming chemicals refer to those chemicals that are susceptible to peroxide formation in their normal storage condition. Peroxides are highly reactive and can explode upon shock or spark. Diethyl ether, tetrahydrofuran, dioxin, alkali metals, olefins and vinyl monomer are some examples of peroxide forming chemicals. The date of opening should be marked on the container and stored in cabinet for flammable chemical.

3.3. Highly Reactive and Unstable Chemicals

Highly reactive and unstable chemicals refer to those chemicals which can liberate a large amount of heat or even an explosion when contact with other chemicals or exposed to moisture or air. Examples includes:

- a) Metal alkyls such as triethylaluminium – Burst into flames on exposure to air. Procedures to minimize contact with air and moisture must be followed.
- b) Alkali metals such as sodium and lithium – React vigorously with water. Procedures to minimize contact with air and moisture must be followed. They must also be stored in closed containers under mineral oil.
- c) Powerful oxidizing agents such as perchloric acid, nitric acid or chlorine – React violently with easily oxidizable chemical such as hydrocarbons. Perchloric acid should be handled in designated fume cupboard equipped with wash down facility

to avoid the accumulation perchlorate salts on the surfaces of the fume cupboard exhaust system.

- d) Metal acetylides, azides, azo and diazo compounds, chlorates and perchlorates, highly nitrated organic compounds, nitrogen halides, organic peroxides and organic salts of per-acids – Can explode if heated or subjected to mechanical shock. They should be handled with great care.
- e) 2,4-6-Trinitrobenzenesulphonic acid, 4-Fluoro-3-Nitrophenylhydrazine, Dinitrophenols, Picric acid, Pecryl chloride, 2,4-Dinitrophenylhydrazine, Hexanitrodiphenylamine – Have explosives properties when dry. They need to be kept wet or moist for safe storage. The containers should be regularly inspected and add water as necessary.

4. Chemical Safety Information

4.1. Labels

Labels on chemical container provide initial information of the hazardous properties and the required safety precautions for the chemicals. Chemicals purchased from reputable manufacturers usually have labels providing the following basic information:

- a) Chemical name of the substances
- b) The classification of the substance as being explosive, flammable, corrosive, oxidizing, toxic, harmful, irritant, etc.
- c) The symbol(s) indicating the hazards of the substance
- d) Wording indicating the type of risks associated with the substances
- e) Wording indicating the type of safety precautions required

Laboratory personnel need to read the label of chemicals for understanding the hazards and their associated precautions before handling and using them in the experiment.

4.2. Material Safety Data Sheets (MSDSs)

Material Safety Data Sheets (MSDSs) provide essential hazardous information about the chemicals, including the hazardous properties, reactivity, safe handling procedure, first-aid measures and emergency procedures, etc. for laboratory personnel's reference at any instance. MSDSs are usually provided by the chemical suppliers or retrievable from the Internet. They should be readily available in each laboratory either in hard copies or through any web-based electronic databases. Laboratory personnel should read the MSDSs and take note of the necessary safety measures before handling any chemicals that they are not familiar with.

5. Safety Measures

5.1. Planning

Before commencement of a new research project involving the use of hazardous chemicals, the Laboratory Person In-Charge together with the concerned laboratory personnel should carry out a risk assessment and carefully plan for the necessary safety measures in order to minimize the risk. The following aspects should be taken into consideration for such planning:

- a) Legal compliance – The purchase, use, storage, transport and disposal of chemicals at the Science Park must comply with all applicable local legislations. Before proceeding a procurement, laboratory personnel must check and verify if the chemicals or drugs concerned require any licensing or permits for import, possession, transport or use, etc. The quantities of the items to be purchased shall also be considered to avoid the exceedance of any applicable legal limits. Examples of some local legislations associated with hazardous chemicals are listed below for

laboratory personnel's reference:

- i. Dangerous Goods Ordinance (Cap. 295)
 - ii. Control of Chemicals Ordinance (Cap. 145)
 - iii. Hazardous Chemicals Control Ordinance (Cap. 595)
 - iv. Dangerous Drugs Ordinance (Cap. 134)
 - v. Waste Disposal Ordinance (Cap. 354)
 - vi. Water Pollution Control Ordinance (Cap. 358)
- b) Compliance with HKSTP's safety requirements – Apart from legal compliance, laboratory personnel at the Science Park shall also observe all applicable laboratory safety requirements and guidelines promulgated by HKSTP. For examples:
- i. Laboratory personnel are not allowed to handle hazardous chemicals in those laboratories not maintained under negative pressure or not equipped with appropriate fume cupboards;
 - ii. Quantities of Dangerous Goods exceeding the limit granted to individual tenants by HKSTP are not allowed to be kept in the respective Dangerous Goods Stores at the Science Park.
- c) Risk associated with laboratory personnel – Laboratory Persons In-Charge should carry out appropriate risk assessments to identify all potential hazards that may pose a risk to personnel in the laboratories. Special occasions such as working alone, unattended operations and overnight experiments, etc. should be taken into consideration.
- d) Implementation of safety measures – To reduce or mitigate the associated risks,

suitable safety measures should be devised and implemented to safeguard all laboratory personnel. These include engineering controls (safety facilities such as fume cupboards), administrative controls (safety procedures or standard operating procedures) and personal protective equipment (PPE).

5.2. Safety Facilities

Adequate safety facilities must be provided and kept in good conditions at all times. All personnel in the laboratory should be familiar with the use of these facilities.

a) Fume Cupboard / Hood

Fume cupboard is an essential safety equipment for handling hazardous chemicals in the laboratories. It can capture emissions generated by hazardous chemicals or arising from chemical reactions and expel them to the outdoor environment.

Laboratory operators at the Science Park are required to select appropriate types of fume cupboards meeting their functions, and with constructions as well as performance in conformance with relevant international standards. Installation and maintenance of fume cupboards and their associated exhaust ventilation systems shall also follow the respective international standards.

Laboratory personnel should observe the following safety practices associated with the use of fume cupboards:

- i. Experimental items inside a fume hood should be placed at least 15 cm from the front opening of the hood because placing items close to the front opening may interfere with the airflow, and thus reducing the level of protection.
- ii. The sash should be kept at the lowest possible position during operation to enhance containment of chemical vapors.
- iii. Never place your face or head inside the fume cupboard.

- iv. Close the sash door when the hood is not being used.
- v. The working area of fume hood should be kept clean and clear when not in use.
- vi. Fume hood should not be used for long term storage of chemicals, apparatus and glassware.

b) Emergency Shower and Eyewash Station

Emergency shower and eyewash station are required to be installed in the vicinity of laboratory areas with the use of hazardous chemicals for emergency use. Their installation and performance should meet relevant international standards. Basically, an emergency shower and eyewash station must be available within a walking distance of 100 feet from an area with hazardous operation. Laboratory personnel can access to these safety facilities without obstructions.

In the case that hazardous chemicals splash onto laboratory personnel's bodies or into their eyes, they should go to the nearby shower or station, and flush the affected body parts with water for at least 15 minutes.

Individual Laboratory Persons In-Charge should arrange regular check on the facilities to ensure their performance.

c) Firefighting Equipment

Laboratories involving the use of chemicals must be equipped with at least one appropriate fire extinguisher. Fire extinguisher should be inspected annually by registered contractor. They should be easily accessible and not be obstructed. All laboratory personnel should be familiar with the operation and handling of fire extinguisher.

For certain laboratories having the use of alkali metals or related chemicals, they should be equipped with special type of fire extinguishers for treating metal fires (Class D fires).

d) Spill Control Kit

Spill control kit is essential for cleaning up chemical spillage. It should be available in each laboratory involving the use of chemicals. Laboratory personnel should wear suitable personal protective equipment when using the kit. The waste materials after usage should be properly disposed of as chemical waste.

Items in a spill control kit should contain the followings:

- i. Personal protective equipment (e.g., goggles, gloves, overalls, overshoes)
- ii. Absorbent materials (e.g. paper towels, spill pads, spill socks)
- iii. Waste bags or containers
- iv. Dustpan and scoop, or tongs
- v. Chemical neutralizers (optional)

e) First Aid Box

Each laboratory should be equipped with a first aid box marked clearly with “FIRST AID” and “急救”. The names and contact number of two persons responsible for the first aid box need to be displayed on the box. The information can be referred to Occupational Safety and Health Ordinance (Cap. 509A) regarding first aid box requirements. The laboratory first aid boxes should be installed in prominent and easily accessible positions. Their content should be regularly checked to ensure that all the recommended materials and equipment are kept in sufficient quantity as well as maintained in good condition.

5.3. Personal Protective Equipment

All laboratory personnel should wear suitable personal protective equipment (PPE) in all circumstances when working in the laboratories. Information on the types and applications of various PPE can be found in the General Laboratory Safety Guidelines. All PPE should be kept clean and properly maintained in a serviceable condition. Defective PPE should be replaced immediately.

5.4. Safety Procedures / Standard Operating Procedures

Laboratory Person in-Charge needs to formulate safety procedures or Standard Operating Procedures (SOPs) for potentially hazardous laboratory operations including the handling of hazardous chemicals. The guidelines enlisted in the next section serve as reference information. The SOP should clearly delineate the safety procedures as well as the safety equipment and/or personal protective equipment required for that specific operation. Laboratory personnel should attend the corresponding training or briefing arranged by the Laboratory Person In-Charge before commencement of works. The SOPs should also be regularly reviewed by the Laboratory Person In-Charge.

6. Guidelines on Handling, Transport and Storage of Chemicals

6.1. General Precautions:

- a) Before acquiring a chemical, its hazard nature should be assessed by going through the relevant chemical safety information such as MSDS. Safer alternatives to hazardous chemical, if available, should be used instead.
- b) Chemicals should be kept to minimum quantities in the laboratories as far as possible.

- c) All chemicals must be kept in proper containers clearly labelled with their chemical names. For peroxide forming chemicals, the dates when they were opened shall be clearly marked.
- d) A clear inventory of chemical stocks should be maintained and updated regularly.

6.2. Handling of Chemicals:

- a) Wear appropriate personal protective equipment such as lab coat, chemical resistant gloves, goggles, etc. when handling hazardous chemicals.
- b) Flammable, corrosive, toxic and other hazardous chemicals shall be handled in the fume cupboards.
- c) No naked flames are allowed to heat flammable chemicals.
- d) Handle highly reactive and unstable chemicals using safety shields and away from ignition sources.
- e) Handle water-sensitive chemicals such as alkali metals away from water sources.
- f) Peroxide forming chemicals should be checked for the presence of peroxide before use. Should there be the presence of peroxide, do not use the chemicals and seek professional consultant's assistance for treatment and disposal.
- g) Pour more concentrated solution into less concentrated solution to avoid violent reactions (e.g. acid to water, not water to acid).
- h) Never grind explosive substance as it can cause explosion under friction or shock.
- i) Unwanted or waste chemicals must not be disposed of down the laboratory sinks.
- j) Clean up the glassware after use to avoid incompatible reaction occur when use for next experiment.

6.3. Transport of Chemicals:

- a) Tighten container caps before moving any chemicals.
- b) Use suitable secondary containers such as chemical resistant bottle carriers, chemical buckets, etc. to transport chemicals between laboratories.

6.4. Storage of Chemicals:

- a) Flammable and corrosive chemicals should be stored separately in their respective fireproof metal cabinets with proper receptacles as secondary containment.
- b) Incompatible chemicals should not be stored together, such as oxidizing agents with flammables, acids with bases, and nitric acid with organic chemicals, etc. Laboratory personnel should check the compatibilities of individual chemicals with reference to the MSDSs before making storage arrangement.
- c) Only the spark-proof refrigerators are suitable for storage of flammable liquids.
- d) Store light sensitive chemicals in light-tight containers.
- e) Liquid chemicals should not be kept on the shelves above eye level or placed on the floor. If they are required to be put on the floor for temporary use, proper secondary containment must be provided.
- f) The storage area should be properly labelled and the chemicals should be placed back to original storage area after usage.
- g) Chemicals in containers should be regularly checked to spot any signs of change, leakage and spillage. Corrective actions should be taken for any defects observed. Blurred and detached label should be replaced immediately.
- h) Chemicals which are categorized as dangerous goods shall not be stored in the laboratories exceeding their respective exempt quantities or the aggregated quantities specified in the Dangerous Goods Regulation (Cap. 295B). The excess

amount of chemicals should be stored in HKSTP's Central Dangerous Goods Stores in accordance with the respective licensing conditions.

7. Chemical Waste Management

Chemical wastes are liquid, semi-solid and solid wastes which are hazardous in nature or constitute a risk of pollution to the environment. The Waste Disposal (Chemical Waste)(General) Regulation (Cap. 354C) enlists those substances in respect of their forms, quantities or concentrations which are referred as chemical waste. Laboratory operators at the Science Park are required to follow through all legislative requirements in managing chemical waste.

7.1. Registration

Laboratory operators intending to generate chemical waste during their operations are required to register with the Environmental Protection Department (EPD) as chemical waste producers. The respective Laboratory Persons In-Charge should identify the types and quantities of chemical waste to be generated in various laboratory activities.

7.2. Packaging and Labelling

Chemical waste should be packed and held in containers of suitable design and construction as to prevent leakage of the contents. Each container should be labelled with the allowed waste type (chemical name), hazard symbol and other necessary information on risks and safety precautions. Different types of waste may include acids, alkali, halogenated organic materials, non-halogenated materials, heavy metals, mineral oils, etc. There should be no mixing of incompatible wastes in a container. Sufficient air space should also be left in containers to avoid leakage of waste due to liquid expansion resulting from changes of temperature or other physical conditions.

7.3. Storage

Small quantities of chemical waste (not exceeding 50 litres in total) are allowed to be stored temporarily in suitable areas in the laboratories before collection. A cupboard or cabinet having ventilation openings and displayed with proper signage may serve such purpose. Chemical waste containers shall also be placed in suitable receptacles as secondary containment during storage.

7.4. Collection, Transportation and Disposal

Registered chemical waste producers must appoint a licensed chemical waste collector (list of licensed chemical waste collectors is retrievable from EPD's website) to collect the waste.

In order to keep track of the waste movement in a waste consignment, EPD employs a "Trip Ticket" system to record and certify the quantity of chemical waste collected and delivered to the final destination. For each waste consignment, the licensed waste collector is required to provide a trip ticket copy to both the waste producer and the operator of the licensed disposal facility for checking and recording. Waste producers must keep such records for 12 months from the date of consignment / delivery for inspection by EPD.

8. Chemical Spill Handling

Each laboratory involving the use of hazardous chemicals should have emergency response plan for handling chemical spill. It is good practice for laboratory personnel to have well preparation to handle minor chemical spill. Methods of safe handling and spillage treatment for particular chemical are usually provided in the respective Material

Safety Data Sheet. The followings serve as general guidelines for handling chemical spill:

- a) Stay away from the area of spill.
- b) Alert other laboratory personnel to leave.
- c) In case any body parts or clothing are contaminated, remove the contaminated clothing and flush the body parts with water using the nearby emergency shower or eyewash station.
- d) Notify the supervisor or Laboratory Person In-Charge.
- e) If the spilt chemical is flammable, do not turn on or off any electrical switches or use telephone in the area. Remove all nearby sources of ignition if possible.
- f) Open the window, turn on the fume cupboard or local exhaust ventilation system to ventilate the area.
- g) Put on suitable personal protective equipment such as gloves, laboratory coat, goggles and respirator.
- h) At least two people should work together to handle the spill. Treatment work should be started from the side closest to the exit.
- i) Clean up the spill by chemical absorbents provided in spill control kit.
- j) Dispose of all contaminated materials including absorbents and protective clothing into a polythene bag provided in spill control kit for collection as chemical waste.

For major chemical spill involving highly dangerous chemicals or large quantities of chemicals, alert all nearby laboratory personnel and evacuate the area immediately.

Report the incident to the supervisor / Laboratory Person In-Charge as well as HKSTP by telephone following the general laboratory emergency procedures. Stay in a nearby safe place and wait for assistance. Meanwhile, restrict other people from entering the area. Cordon off the area with warning sign if possible.

C06 Safe Handling Of Compressed Gas Cylinders

1. Introduction

The use of compressed gas cylinders in the laboratories is very common. Compressed gas cylinders supply laboratory gases for different purposes such as controlling experimental conditions or operating laboratory equipment. Gas cylinders should be handled with great care as a number of potential dangers are associated with the use and storage of compressed gas cylinders. The purpose of this document is to provide laboratory personnel at the Science Park with general guidelines for safe handling, use and storage of compressed gas cylinder in compliance with corporate and statutory requirements.

2. Definition

A compressed gas is a material which is a gas at normal room temperature and pressure, but is packaged as a pressurized gas, pressurized liquid or refrigerated liquid and is contained usually in a cylinder. The compressed gases may be inert, toxic, flammable or explosive. The hazards associated with compressed gas cylinders arise from their pressure and contents. They must be stored and handled very carefully.

3. Type of Compressed Gases

There are three main types of compressed gases stored in cylinders:

3.1. Non-liquefied Gas

Non-liquefied gases are gases that remain gases at room temperature even at high pressure. Examples include oxygen, nitrogen, argon, air, methane and hydrogen.

3.2. Liquefied Gas

Liquefied gases are gases that become liquid at room temperature when compressed at high pressure in a cylinder. Examples include carbon dioxide, nitrogen, chlorine and ammonia.

3.3. Dissolved Gas

Dissolved gases are gases that are dissolved in a volatile solvent for stabilizing. Example include acetylene.

4. Gas Cylinder Information

Color coding is the common practice for gas cylinder manufacturer to verify the type of compressed gas in the container. However, this color coding system is not standardized. Instead, it is required to label the cylinder to identify the gases contained. Cylinders are made in a wide variety of sizes and shapes. They range from small lecture bottles to large cylinders over 3 meters long. The materials made for the cylinder can be steel and aluminium.

5. Hazards Associated with Compressed Gas Cylinder

The hazards associated with handling, use and storage of compressed gases are summarized as follows:

5.1. Asphyxiation

Asphyxiation is the main hazard associated with inert gases such as helium, nitrogen and argon. If gas leakage happens, it will reduce the atmosphere oxygen concentration below concentration necessary to support consciousness and life.

5.2. Physical

Compressed gas cylinders are usually large, heavy and awkward to handle. Improper handling or not properly securing can cause cylinders falling which results in injury to workers.

5.3. Fire and Explosion

Flammable gases such as acetylene and hydrogen can burn and explode if leakage occurred under certain conditions.

5.4. Health

Some compressed gases are toxic which cause serious health problems depending on the specific gas, its concentration and length of exposure.

5.5. Chemical Burn

Some compressed gases are corrosive which cause skin burn or damage when contact, eyes or lung burn when inhaled.

5.6. Pressure

All compressed gases are hazardous due to the high pressure inside the cylinder. Damage to the cylinder valve or container can result in rapid release of high pressure gas causing personal injury and damage to property.

6. Use, Handling and Storage of Gas Cylinders

Laboratory operators at the Science Park are required to comply with the Dangerous Goods Ordinance (CAP. 295) on handling and storage of gas cylinders. Compressed gas are classified as Category 2 in the Ordinance. Compressed gas suppliers are responsible

for ensuring the safety of the container by performing the pressure tests on the container for every five years as required by the Ordinance. Appropriate gas detectors should be installed in the laboratory areas where necessary for monitoring gas leakage.

6.1. Use of Gas Cylinder

Some general practices of using gas cylinders are described below:

- a) Laboratory personnel working with gas cylinders are well trained.
- b) Regulator installation with leakage test must be done by trained personnel.
- c) Ensure equipment is compatible with the cylinder pressure and contents.
- d) Identify the chemical hazards of the particular gas in cylinder and wear appropriate personal protective equipment accordingly.
- e) Ensure adequate regulator and fittings are used for the particular gas in the cylinder.
Each cylinder and regular fitting has connection fitting that is designated by a Compressed Gas Association (CGA) number.
- f) Visual inspect on regulator and connection for any damage or disrepair each time before using.
- g) Gas cylinders should always be used in a vertical and secured position.
- h) Open the main valve with an adequate sized wrench if required and slowly adjust the regulator control to the desired pressure on the regulator delivery gauge.
- i) Always use gas cylinders in a well-ventilated area to prevent asphyxia.
- j) Prevent sparks and flames from contacting gas cylinders.
- k) Release the pressure from regulators and close all the valves after using.
- l) Use a flashback arrestor for flammable and oxidizing gases. It will stop gas flow in the event of a reverse flow or flash back.
- m) Discontinue use and contact the supplier if a cylinder valve is difficult to operate.

- n) Never use copper fitting or tubing on acetylene gas cylinder as an explosion may result.

6.2. Transport of Gas Cylinder

Some general practices for transport of gas cylinder are described below:

- a) Cylinders must not be transported with regulator attached.
- b) Close the main valve with valve cap protection during transportation.
- c) Use cylinder trolley when moving gas cylinders. Ensure the cylinder is secured to the cart during transport with a chain. Cylinder should not be dragged, rolled or manually carried.
- d) Never drop cylinders or allow them to strike each other violently.
- e) Use the proper personal protective equipment for cylinder handling.
- f) Never attempt to catch a falling cylinder.
- g) Move cylinder trolley on clean, smooth and level surface to the greatest extent.

6.3. Storage of Gas Cylinder

Gas cylinders shall not be stored in the laboratories in excess of their respective exempt quantities or the aggregated quantities specified in the Ordinance. Laboratory Person In-Charge should apply to store those excessive quantity of gas cylinders in the Central Dangerous Goods Stores of HKSTP wherever necessary. The following safety measures should be adhered to regarding storage of gas cylinders:

- a) Store gas cylinders in cool and well ventilated designated areas, away from incompatible materials and ignition sources.
- b) Gas cylinders with toxic or highly flammable gases should be kept in proper gas cabinets whenever necessary.

- c) Cylinders shall not be stored at temperature above 52°C or in direct sunlight or outside of the temperature range specified by the supplier.
- d) Cylinders shall be secured by chains or straps at a point approximately 2/3 of the height of the cylinder to a wall or bench in an upright position.
- e) Cylinders shall be protected against tampering and damage.
- f) Cylinders containing oxygen should be kept away from flammable gases or large quantities of flammable liquid.
- g) Flammable gases shall be separated from nonflammable gases.
- h) Dirt, oil or water should be prevented from entering cylinder valves.
- i) Empty cylinder should be separated from full cylinder within storage area and returned to supplier as soon as possible.
- j) Provide adequate access for cylinder handling.
- k) Visually inspect stored cylinders on a routine basis for any indication of leakage or damage.

7. Commonly Used Gases

Additional precautionary measures for some commonly used gases in the laboratories are described as follows:

7.1. Acetylene

Acetylene is an extremely flammable gas usually dissolved in acetone in the cylinder. Mixture of acetylene and oxygen or air will explode in a confined area in the presence of spark. Appropriate regulator for acetylene cylinder (CGA connection: 510) should be used and a flashback arrestor should be connected to the pipe line. Acetylene can form explosive compounds with copper, silver and mercury under certain conditions. Copper fittings are not allowed to connect with acetylene gas cylinder.

7.2. Hydrogen

Hydrogen is a flammable gas and is lighter than air. A mixture of hydrogen and oxygen or air will explode in the presence of spark. Appropriate regulator for hydrogen cylinder (CGA connection: 350) should be used and a flashback arrestor should be connected to the pipe line. Personnel should take every precaution against hydrogen leakage which cannot be detected by sight, smell or taste. Leaked hydrogen may accumulate at the ceilings of the premises. The installation of detectors or carrying personal sensing devices for leak detection is strongly recommended.

7.3. Nitrogen, Argon and Helium

These inert gases can cause asphyxiation in release of large quantities in confined area. Liquefied gases may cause frostbite to eyes or skin. Do not touch the frosted pipes or valves. The regulator of CGA connection number is 580.

7.4. Oxygen

Oxygen can support and accelerate combustion of flammable materials. Segregate the storage of oxygen cylinder with flammable gas cylinder. Never use oil or grease on oxygen cylinders and their valves, fittings or regulators as it may cause fire or explosion. The regulator of CGA connection number is 540.

8. Emergency

Laboratory Persons In-Charge should address the potential hazards of individual gases and their corresponding safety measures to all concerned laboratory personnel. Suitable preparedness and arrangements should be in place to ensure that all laboratory personnel take appropriate actions in case of emergency. In the event of uncontrolled gas leaking

from cylinder:

- a) Alert other people and evacuate the area immediately.
- b) Ventilate the area by opening the windows or activate the emergency ventilation system. If the leaked gas is flammable, do not switch on or off any electrical appliances including the mobile phone.
- c) Leave the laboratory and close the door.
- d) Report the incident to HKSTP following the “General Laboratory Emergency Procedures” in the SHE Handbook.
- e) Stay away from the laboratory and wait for assistance. Do not allow people to enter the laboratory or go to the nearby areas.

C07 Safe Handling Of Cryogenics

1. Introduction

Cryogenics (Cryogenic liquids) are frequently used in the laboratories for operation of specific equipment, freezing of foods and preservation of biological samples. Cryogenics should be handled with extreme care as they are extremely cold and can be converted into gases at very high rate posing various hazards. The purpose of this document is to provide laboratory personnel at the Science Park with general guidelines on safe handling, transport and storage of cryogenics in the laboratories.

2. Definition

Cryogenics are liquefied gases that are kept in their liquid state at very low temperature. These liquids typically have boiling points below -150°C and are gases at normal room temperature and atmosphere pressure. Most cryogenic liquids are odorless, colorless (except for liquid oxygen which is light blue) and tasteless when vaporized into the gaseous state. Cryogenics must be stored, shipped and handled in special designed containers. The hazards associated with cryogenics arise from their extremely low temperature, pressure building up in the containers and high expansion rate to gases when discharging.

3. Types of Cryogenics

Cryogenics can be classified into the following three groups. Each has its own unique properties.

3.1. Inert Gases

These gases do not react chemically to any great extent, nor burn and support combustion. Examples of this group include nitrogen, argon, helium and neon.

3.2. Flammable Gases

Some cryogens when vaporized can burn in air. The most common examples are hydrogen, methane and liquefied natural gas.

3.3. Oxygen

Liquefied oxygen is a very powerful oxidizing agent and can burn rapidly or react explosively with organic materials. Many materials considered as non-combustible can also burn in the presence of oxygen.

4. Cryogen Containers

A cryogenic liquid cannot be indefinitely maintained as a liquid, even in a well-insulated container. Vapor generated produces enormous pressure that could rupture the container. Thus, cryogen containers are normally equipped with pressure relief valve for primary protection and rupture disc for secondary protection. The types of containers for cryogen include dewar, cryogenic liquid cylinder and cryogenic storage tank. All containers should be clearly labeled and operated in accordance with manufacturer's instructions.

4.1. Dewar

Dewar flasks are non-pressurized, vacuum jacketed vessels, somewhat like a “Thermos bottle”. They should have a loose fitting cap or plug that prevents air and moisture from entering and allows excessive pressure to vent. The capacity of a dewar flask ranges from 5 to 200 liters.

4.2. Cryogenic Liquid Cylinder

Cryogenic liquid cylinders are insulated, vacuum jacketed and pressurized vessels. They

have valves for filling and dispensing the cryogenic liquid, and a pressure control valve with a rupture disk to protect the cylinders from excessive pressure buildup. These containers operate at pressure up to 350 psi and have capacities between 80 and 450 liters of liquid.

4.3. Cryogenic Storage Tank

A cryogenic storage tank is usually mounted in fixed location as stationary vessel or on truck for easy transportation. It contains a tank, vaporizer and pressure control manifold. Tanks are equipped with various circuits to control product fill, pressure buildup, pressure relief, product withdrawal and tank vacuum. The size of the tanks ranges from 500 to 420000 gallon.

5. Hazards Associated with Cryogens

Cryogens can be hazardous to laboratory personnel or cause damage to properties if they are not handled properly.

5.1. Skin and Eye Hazard

The high expansion ratio property makes cryogen more prone to splash, and therefore may damage skin and eye. Cryogens are extremely cold which cause instant and severe frostbite. Direct contact with cryogenic liquids, uninsulated cryogenic pipes or equipment can cause freeze burns and tissue damage.

5.2. Cold Embrittlement

At cryogenic temperature many materials such as rubber, plastic and carbon steel can become so brittle that very little stress can break the materials. Avoid using these materials for handling of cryogens. Do not dispose cryogenic liquids down the drain as

polyvinyl chloride (PVC) piping in laboratory sinks may not be able to resist cryogenic temperature.

5.3. Asphyxiation

The accidental release of inert cryogenic liquids will quickly transfer to gaseous phase and displace the oxygen content of the surrounding area. This will cause asphyxiation hazard to personnel working in the area. Oxygen detectors are recommended in some confined and poorly ventilated areas. Personnel should not be permitted in atmospheres containing less than 19.5% oxygen without supplied air.

5.4. Explosion due to Rapid Expansion

Without adequate venting or pressure relief devices on the containers, enormous pressure can build up. The pressure can cause an explosion called a “boiling liquid expanding vapour explosion” (BLEVE). Accidental conditions such as an external fire, or a break in the vacuum which provides thermal insulation, may cause a very rapid pressure rise. The pressure relief valve are unable to handle this increased pressure, thus, rupture disc is installed for secondary protection.

5.5. Fire

Flammable gases such as hydrogen, methane, carbon monoxide and liquefied natural gas can burn and explode. It should be kept away from any ignition source. Hydrogen is particularly hazardous which can form flammable mixtures with air over a wide range of concentration (4-75% v/v) and very easily ignited.

5.6. Toxic

The toxic hazard of a particular cryogen should be identified by referring to the Material Safety Data Sheet. For example, the release of large quantities of carbon monoxide can cause death almost immediately.

5.7. Oxygen Enrichment

When transferring liquid nitrogen through uninsulated metal pipes, the air surrounding a cryogen containment system can condense. Nitrogen evaporates more rapidly than oxygen. This can leave an oxygen-enriched condensate on the surface that can increase the combustibility of materials near the system. Equipment containing cryogens must be kept clear of combustible materials in order to minimize the fire hazard potential.

6. Personal Protective Equipment

6.1. Eye and Face Protection

Full face shield and splash resistance goggles provide the best protection for the eyes and face. Safety glasses cannot protect the face entirely and contact lens should not be worn.

6.2. Hand Protection (Gloves)

Always wear appropriate cryogenic gloves, such as loose-fitting thermal insulated or leather gloves. Gloves should be loose-fitting so they are able to be quickly removed if cryogenic liquid is spilled on them. Rubber gloves should not be used because they could harden instantly.

6.3. Proper Clothing and Shoes

Wear closed-toe shoes or safety shoes, along with lab coat or long sleeve shirt and trousers without cuffs, when handling cryogens.

7. Handling, Transfer and Storage of Cryogenics

All laboratory operators at the Science Park are required to comply with the Dangerous Goods Ordinance (CAP. 295) on handling and storage of cryogenics. Cryogen (Liquefied gases) are classified as Category 2, Class 2 in the Ordinance.

7.1. Handling of Cryogenics

Some general practices are described below:

- a) Standard operating procedures are developed for specific operations on different cryogenics.
- b) Laboratory personnel working with the cryogenics are well trained and familiar with the standard operating procedures.
- c) For particular hazardous operation, a work permit system should be put into place. A competent person should examine all the equipment and review the proposed procedures before the work begins.
- d) Identify the hazard potential of the cryogen and wear appropriate personal protective equipment accordingly.
- e) Advise to remove all the metal watches, rings, bracelets before working with cryogenics. If exposed to cryogenics or boil-off gases, they can freeze to the skin.
- f) Ensure all equipment and containers are free of oil, grease, dirt or other materials which may lead to fire hazard.
- g) Do not allow water to contaminate the equipment as freezing water will expand and may cause equipment cracking.
- h) Conduct operations in well ventilated areas or with local exhaust ventilation to prevent possible gas or vapor accumulation.

- i) Never allow any unprotected part of body to contact with uninsulated pipes or vessels which contain cryogenics.
- j) When using cryogenic liquid to cool an object, insert the object slowly using tongs.
- k) Ensure containers are properly labeled with the identity of the cryogen. Do not mix different cryogenics into the same containers.
- l) Never pour cryogenic liquids into any drain.

7.2. Transfer of Cryogenics

Some general practices are described below:

- a) Transfer or pour cryogenics slowly to minimize boiling and splashing. Use a special filling funnel (the top of the funnel should be partly covered). If the liquid cannot be poured, use a cryogenic liquid withdrawal device for transfer.
- b) When transfer to secondary container, slowly fill the container not more than 80% of its capacity.
- c) Never roll, drag or drop containers or permit them to strike each other.
- d) Use suitable hand truck or cart for cryogenic liquid container movement. Use a strap to secure the container to the hand truck or cart.
- e) If cryogenics must be transported by elevator, ensure that no passengers get on the elevator while the cryogen is being transported.

7.3. Storage of Cryogenics

Cryogenics shall not be stored in the laboratories in excess of their respective exempt quantities or the aggregated quantities specified in the Ordinance. The excessive cryogenics should be stored in HKSTP's Central Dangerous Goods Stores. The following safety measures should be adhered to regarding storage of cryogenics:

- a) Keep cryogen containers upright in cool and well ventilated areas, away from incompatible materials and ignition sources.
- b) As far as reasonably practicable, install oxygen or flammable gas monitor systems in appropriate areas for continuous monitoring.
- c) Use only approved storage containers equipped with protection devices.
- d) Avoid the contact of moisture with storage containers to prevent ice plugs in relief devices.
- e) Do not store cryogen containers on hand carts as they could fall or get knocked over.
- f) Provide adequate access for handling cryogen containers.
- g) Visually inspect stored cryogen containers on a routine basis for any indication of leakage or damage.

8. Emergency

Laboratory Persons In-Charge should address the potential hazards of cryogenics and the corresponding safety measures to all concerned laboratory personnel. In the event of skin contact, eye exposure or cryogenics leakage, follow the emergency procedures listed below:

8.1. Skin Contact

- a) Remove any clothing that may restrict blood circulation to frozen area.
- b) Do not rub the affected part of the body. Rubbing may further damage the tissue.
- c) Rinse the affected area with warm water (<40°C) for 15 minutes to gradually warm up the affected area.
- d) Seek medical attention immediately.

8.2. Eye Exposure

- a) Flush the eyes with warm water ($<40^{\circ}\text{C}$) for 15 minutes.
- b) Seek medical attention immediately.

8.3. Cryogenics leakage

- a) Alert other people and evacuate the area immediately.
- b) Ventilate the area by opening the windows or activate the emergency ventilation or any forced ventilation to allow any split liquid to evaporate and the resultant gas to disperse.
- c) Report the incident to HKSTP following the “General Laboratory Emergency Procedures” in the SHE Handbook.
- d) The laboratory should be cordoned off and warning signs should be posted on the exits. Do not re-enter the area until it is clear of cryogenics.

C08 Safe Handling Of Engineered Nanomaterials

1. Introduction

The term ‘nanomaterial’ is used generally to describe a material that has at least one dimension smaller than 100 nanometers (nm). Nanomaterials may be naturally occurring (such as in volcanic ash), produced as unintentional by products (such as in auto emissions) or intentionally created or engineered. The latter groups comprises the so called engineered (or manufactured) nanomaterials which may in turn to be used to produce ‘nano-enabled products’ showing enhanced functionality.

These very small particles often possess different properties than larger particles of the same composition, making them of interest to researchers and of potential benefit to society. Because of these differences, nanomaterials offer new and exciting opportunities in industry such as agriculture, electronics, medicine and pharmaceuticals technology, food processing, construction, automotive industry, textiles, health care and cosmetics. A growing number of innovators are harnessing the unique properties of nanomaterials into their research.

Nanomaterials can be spheres, rods, tubes, and other geometric shapes. The small particles may be bound to surfaces or substrates, put into solution or suspension, attached to a polymer, or in a few cases handled as a dry powder. Various nanomaterials can be created in the laboratory under experimental procedures, and some can be purchased from commercial vendors. In most research, the amount of material used is small, generally less than one gram.

Although nanomaterials have many beneficial properties, there are limited information

about their associated health hazards. Particular care regarding the management of these materials must therefore be taken while research continues.

The purpose of this document is to provide personnel at the Science Park with general guidelines for safe handling of engineered nanomaterials in the laboratories.

2. Potential Health, Safety and Environmental Hazards

2.1. Health Hazards

Health concerns regarding the use of nanomaterials originate from the recognition of several unique attributes of them. The ultra-small particle size permits the particles to be carried deeply into tissues. The particles may be deeply respired into the lungs; may pass through the blood-brain barrier; or translocate between organs. The molecular structure of nanomaterials and the relatively greater surface area confer on these particles different chemical reactivities than for larger structures made from the same elements or molecules. Some evidence suggests that nanoparticles may be more toxic to tissues than larger molecular structures. Examples include the followings:

- a) Carbon nanotubes and nanofibers may be capable of causing pulmonary inflammation and fibrosis by depositing in the respiratory tract.
- b) The nanoscale TiO₂ particles, used in many commercial application such as paint, paper, cosmetics and food, have higher mass-based potency than larger particles. The occupational exposure (by inhalation) to nanoscale TiO₂ particles should be considered a potential occupational carcinogen.

There are four possible routes of workplace exposure to nanomaterials including **inhalation, ingestion, skin absorption and injection**. The physiological effects and

potential hazard due to exposure will depends on size, dose, reactivity and structure of the nanomaterials.

2.2. Fire and Explosion Hazards

Because of the surface-to-volume ratio increases as a particle becomes smaller, nanomaterials may be more prone to explosion than an equivalent mass concentration of larger particles. Both carbon-containing and metal nanopowders can explode if they are aerosolized at a high enough concentration and if oxygen and an ignition source are present. Researchers should avoid creating concentrated aerosols of combustible nanoparticles. Decreasing the particle size of combustible materials can increase combustion potential and combustion rate, leading to the possibility of relatively inert materials becoming highly reactive in the nanometer size range. Some nanomaterials are designed to generate heat through the progression of reactions at the nanoscale. Such materials may present a fire hazard that is unique to engineered nanomaterials. One example is aluminum powder; particles bigger than 80 nm are known to be inert when exposed to air. On the opposite, particles less than 80 nm are known to be very reactive and can cause explosion. Another example is nanoscale Al/MoO₃ particles that can ignite more than 300 times faster than corresponding micrometer-scale material.

2.3. Environmental Hazards

There are limited publications on the effects of engineered nanomaterials on animal and plants in the environment. However, nanomaterials entering the environment resulting from accidental release from production facilities, landfills or wastewater treatment plants may become toxic to microorganisms in the soil and groundwater. This may in term affect other plants and animals following the food chains.

3. Nanomaterials Hazard Control Measures

To ensure the health and safety of laboratory users, the management of each concerned laboratory shall observe the following hazard control measure requirements:

3.1. Risk assessment - Though some nanomaterials have been used safely for decades, other manufactured forms are new and have characteristics that are not yet fully defined. Laboratory Person In-Charge should identify the risk and the corresponding control measures needed by:

- a) Identifying and describing processes and job tasks where workers may be exposed to nanomaterials.
- b) Determining the physical state of the nanomaterials such as dust, powder, spray, or droplet.
- c) Determining routes of exposure (e.g., inhalation, skin contact or ingestion) of particulates, slurries, suspensions or solutions of nanomaterials.
- d) Identifying the most appropriate sampling method to determine the quantities, airborne concentration, duration, and frequencies of lab personnel exposures to nanomaterials as far as possible.

3.2. Facility and Building Services Requirements - The following requirements should be met for providing adequate environment or facility for laboratory users working inside:

- a) General exhaust - Laboratory should be maintained under negative pressure relative to the corridor so that airborne nanomaterials, if any, will not spread to the outside.
- b) Local exhaust - The small size and low inertia of particulate means they can move in the air more like a gas than normal particles. Therefore, correctly designed and

well maintained local exhaust ventilation with a filtration mechanism for nanomaterials should be available. This includes biological safety cabinet (BSC), fume hood and glove box equipped with high efficiency particulate air (HEPA) filters. Because air is recirculated in Class II type A and BI biological safety cabinets, tasks involving volatile materials should not be performed in these cabinets.

- c) Laboratory design - Set up a designated area for work with nanomaterials and suspensions away from entrances and high traffic areas. A designated area may be an entire laboratory, a section of a laboratory, or a containment device such as fume hood or BSC. Work surfaces where nanomaterials are handled should be smooth, impermeable and free of joints and cracks for easy cleaning.
- d) Signage - Post signs indicating hazards and personal protective equipment requirements at entry points to the laboratory or areas where nanomaterials are handled.
- e) Waste storage – Waste nanomaterials should be treated as chemical waste. A designated area and labeled container for waste should be assigned following the requirements for storing chemical waste.
- f) Emergency facilities - Emergency shower, eyewash station, firefighting equipment, spill kit and first-aid kit shall be available at appropriate location in the laboratory.

3.3. Training of Personnel - All personnel working with engineered nanomaterials should receive training before working with nanomaterials. The training should address the hazards associated with nanomaterials and procedures to prevent exposure, appropriate nanomaterials handling and storage procedures, proper use of personal protective

equipment (PPE), cleaning of contaminated surfaces or clothing, and proper disposal of nanomaterials.

3.4. Good Work Practice - A list of good work practice should be developed for the laboratory include:

- a) **Purchase and Use** - Purchase and use the lowest concentration or quantity that meet your research needs. Use nanomaterials in solution or suspension if possible, to reduce the risk of dispersing dry nanomaterials during handling.
- b) **Labeling and Storage** - Nanomaterials should be stored in labeled containers that indicate their chemical content and form (include the term 'nano' in the descriptor). Liquid or dry particles should always be stored in unbreakable, tightly sealed containers. Secondary containment should be used when appropriate. Cover all containers when not in use. Nanomaterials must not be stored with incompatible chemicals.
- c) **Transport** - Transport of dry nanomaterials should be in closed container. Handling solutions containing nanomaterials over disposable covers.
- d) **Cleaning Process** - Clean bench tops using a cleaning solution after each work activity. Spill of dry nanoparticles must be cleared up using HEPA vacuum cleaner or by wet-wiping. Dry sweeping must not be used.
- e) **Personal Hygiene** - Wear proper PPE during work with nanomaterials. The minimum requirement includes safety glass, lab coat, nitrile or other compatible gloves and closed toed shoes. Dedicated clothing shall be either laundered by husbandry staff using in-house facilities or by professional laundry services. Dedicated clothing must not be taken home. Wash hands before leaving the work

area and after removing gloves. Do not eat or drink in the areas where nanomaterials are handled.

4. General Safety Practices for Handling Nanomaterials

Laboratory personnel shall adopt the following health and safety practices when handling nanomaterials in the laboratories:

- a) Wear proper PPE and clothing. Avoid getting nanomaterials in eye, mucous membranes, on skin or in respiratory tract. Do not handle nanomaterials with your bare skin. Wash your hands before leaving the laboratory.
- b) Ensure you well understand and strictly follow the safety procedures of specific task or experiment. Only trained personnel are permitted to work in these areas while nanomaterials are being used.
- c) Make yourselves familiar with the hazards of nanomaterials and other precursor materials involved by reading the Material Safety Data Sheet (MSDS).
- d) Perform works in HEPA-filtered fume hood or BSC. If neither is available, laboratory personnel should wear appropriate respirator or N95 mask. The use of respirator requires proper training and fitting test.
- e) If weighing dry powders is necessary and the weighing balance cannot be located in fume hood or BSC, take a container then add the material to the container in a hood. Seal the container before returning to the balance to weigh the powder.
- f) Aerosol producing activities such as sonication, vortexing and centrifugation should not be conducted on the open bench.
- g) Keep nanomaterials which may become dispersed in air away from ignition sources to avoid fire or explosion.

- h) If other hazardous chemicals are involved in the experiments associated with nanomaterials, work carefully in compliance with all necessary chemical safety requirements.
- i) If heating in a closed vessel (e.g. hydrothermal or solvothermal reactor) is not avoidable, use vessel and other associated equipment designed and certified for that purpose and built-in with the necessary safety devices such as pressure relief valve or rupture disc.
- j) All waste nanomaterials should be kept in proper waste containers with labels for pickup by a licensed chemical waste collector following the requirements of the Waste Disposal (Chemical Waste)(General) Regulation (Cap. 354C). Waste should never be poured down the drain or placed in trash bins.
- k) Equipment used to create or handle nanomaterials should be cleaned or evaluated for potential contamination prior to disposal or reuse.
- l) Regular cleaning of bench tops, floors and other surface should be implemented. Cleaning solution should be compatible with the vehicle in which the nanomaterials are suspended.

5. Emergency

Laboratory Persons In-Charge should address the potential hazards of the engineered nanomaterials involved and the necessary safety measures to all concerned laboratory personnel. Suitable preparedness and arrangements should be in place to ensure that all laboratory personnel take appropriate actions in case of emergency.

In the event of minor spillage of nanomaterials, it is important that nearby personnel are alerted so that exposure to airborne nanoparticles is minimized. Window and doors

should be kept closed. Always wear appropriate PPE when cleaning up a spill. For spills that might result in airborne nanomaterials, proper respiratory protection should be worn. Cleaning up powder spills should use HEPA vacuum cleaner or wet wipe the area with towels. Liquid spills can typically be cleaned by applying absorbent in the spill kit.

In case of larger scale of spillage:

- a) Alert other people and evacuate the area immediately.
- b) Leave the laboratory and close the door.
- c) Report the incident to HKSTP following the “General Laboratory Emergency Procedures” in the SHE Handbook.
- d) Stay away from the laboratory and wait for assistance. Do not allow people to enter the laboratory or go to the nearby areas.

C09 Ionizing Radiation Safety Guidelines

1. Introduction

Ionizing radiation sources, including radioactive substances and irradiating apparatus, are regulated by the Radiation Ordinance and its subsidiary regulations (Cap. 303, Laws of Hong Kong SAR) in Hong Kong. Valid license must be obtained from the Radiation Board for the following categories:

- a) To possess and use radioactive substances; and
- b) To possess and use irradiating apparatus

According to the legislation, owners and users of ionizing radiation sources must fulfill stringent radiation safety requirements. This document serves as guidelines for all concerned laboratories at the Science Park to meet legal requirements as well as to adopt good practices on radiation protection.

2. Ionizing Radiation Sources

Radiation, in the form of electromagnetic waves or particles, with energy high enough to remove electrons from an atom to create an electrically charged ion is called ionizing radiation. This ionizing process often results in chemical changes in living tissue, which may result in injury to the organism. Sources of ionizing radiation include both radioactive substances and irradiating apparatus, such as X-ray machine, with the following definitions under the legislation:

Radioactive substance – any substance which consists of or contains any radioactive chemical element whether natural or artificial and whose specific activity exceeds 75 bequerels of parent radioactive chemical element per gram of substance.

Irradiating apparatus – any apparatus which is (i) intended to produce or emit ionizing

radiation; or (ii) capable of producing or emitting ionizing radiation at a dose rate exceeding 5 μSv per hour at a distance of 5 cm from any accessible point of the surface of the apparatus.

3. Responsibilities

3.1. Management of the Client: The Management of a Client whose laboratory possesses and uses ionizing radiation source(s) must:

- a) Ensure that relevant and valid license(s) is/are available and all aspects of radiation safety as indicated in the legislation are complied with;
- b) Delegate a responsible person with sufficient and proper training to oversee radiation safety.

3.2. Responsible Person: The Responsible Person shall:

- a) Manage the procurement, licensing, delivery, storage, handling and disposal of ionizing radiation sources in accordance with legal requirements and HKSTP's guidelines;
- b) Ensure that all radiation workers in the laboratory are properly trained, licensed, physically fit (passed medical examination), and provided with personal monitoring device where applicable;
- c) Monitor radiation safety in the laboratory;
- d) Provide safety instructions to users on specific work procedures;
- e) Advise on radiation protection where necessary; and
- f) Report to the management or the authority in case of any radiation incident or emergency situation.

3.3. Radiation Worker: A radiation worker shall:

- a) Be licensed with the Radiation Board where applicable;
- b) Be trained in radiation safety;
- c) Be physically fit to carry out the radiation work by passing the annual medical examination where necessary;
- d) Wear the personal monitoring device if necessary;
- e) Follow all applicable radiation safety practices when working with ionizing radiation source.

4. Safety Requirements Associated with Radioactive Substances

4.1. Sealed and Unsealed Radioactive Substances – Radioactive substances can be in form of “sealed” or “unsealed” with the following definitions delineated in the Radiation (Control of Radioactive Substances) Regulations:

- a) Sealed radioactive substance – a radioactive substance which is permanently enclosed in a container but in such a manner as to permit the emission of radiation. However, the substance cannot be separated from the container unless the container is damaged. Examples of commonly used sealed sources include standard solid radiation sources, analytical equipment embedded with radioactive substances such as electron capture detector, particulate analyzer, etc.
- b) Unsealed radioactive substance – any radioactive which is not sealed. Liquid radiochemicals are commonly used unsealed sources in the laboratory.

While both sealed and unsealed radiation sources are regulated by law, more stringent safety control measures are imposed on the use of unsealed sources due to the higher risk of spillage and contamination. The Management of a Client should avoid or minimize the use of unsealed sources in the research works as far as possible.

4.2. Purchase – Before the purchase for any radioactive substances, the responsible person shall ensure if relevant license has been obtained from the Radiation Board. For unsealed radioactive substances, if the radioactivity of individual radionuclide to be purchased exceeds the maximum allowed radioactivity covered by existing license, amendment of the license must be completed before purchasing. Always check the existing license for details about the licensing conditions before any plan for new or modified experiment involving the use of additional radionuclides or increased radioactivity.

4.3. Personnel – All radioactive substance users must be trained in radiation safety. Users of unsealed radioactive substances and high radioactivity sealed radioactive substances must also be physically fit for the radiation work by passing a medical examination and have their radiation exposure personally monitored using the thermoluminescent dosimeters (TLDs).

4.4. Laboratory Area – Radioactive substances must only be used or stored at designated laboratory areas covered by the corresponding licenses. A copy of each license shall be displayed or available at convenient location in the laboratory. A radiation hazard warning sign shall be posted at the entrance of the laboratory. The area should also be accessible to authorized users only. Other laboratory requirements regarding sealed and unsealed radioactive substances are listed separately below.

- a) Areas with Sealed radioactive substances:
 - i. The sealed sources shall be kept in suitable containers with sufficient shielding;
 - ii. The area should be ventilated efficiently if gases radioactive substances may be generated due to decay of the radioactive sources;

- iii. Proper personal protective equipment, if necessary, should be available for use.
- b) Areas with Unsealed radioactive substances:
 - i. The floor should be covered with monolithic materials such as seamless vinyl or epoxy;
 - ii. The walls should be coved to the floor for ease of cleaning;
 - iii. The bench surfaces should also be impervious and easy to clean;
 - iv. The lighting fixtures should be flush with the ceiling to eliminate dust collection;
 - v. There should be independent laboratory ventilation system;
 - vi. Special radioisotope fume hood should be available for use if radioactive aerosols are likely to be generated during radiation work;
 - vii. Sufficient and appropriate shielding materials should be provided;
 - viii. Wash basin, preferably made of stainless steel and equipped with hands free faucet, should be available;
 - ix. Emergency shower and eyewash unit should be available in the vicinity;
 - x. Necessary personal protective equipment such as gloves, lab coats, eye protectors should be provided;
 - xi. A calibrated radiation survey meter should be available;
 - xii. Sufficient and appropriate radioactive waste containers should be available;
and
 - xiii. Spill control kit for radioactive substances should be available.

4.5. Handling and Operation – Local rules for the radiation laboratory and standard operating procedures (SOP) for specific radiation work should be established and

displayed at a conspicuous area in the laboratory for all users to follow. These rules and procedures should also be revised whenever necessary. For laboratories where unsealed radioactive substances are used, relevant safety information such as Nuclide Safety Data Sheets (NSDS) should also be available for reference.

- a) Precautions for handling sealed radioactive substances:
 - i. No eating, drinking, smoking, application of cosmetics, or storage of foods or drinks should occur in the laboratory;
 - ii. Wear protective equipment such as gloves, protective clothing, eye protectors, etc. whenever necessary;
 - iii. Use appropriate shielding, forceps or tongs to handle sealed radioactive substances whenever necessary.
- b) Precautions for handling unsealed radioactive substances:
 - i. No eating, drinking, smoking, application of cosmetics, or storage of foods or drinks should occur in the laboratory;
 - ii. No mouth pipetting;
 - iii. Wear personal protective equipment consisting of at least a laboratory coat, appropriate gloves and eye protectors;
 - iv. Wear personal monitoring device, i.e. TLD badge, during work for monitoring personal exposure to radiation;
 - v. All works should be conducted in secondary containment facilities such as a spill tray lined with absorbent materials;
 - vi. Suitable shielding materials should be used in all experimental situations and when storing radioactive substances or wastes;

- vii. All radioactive substances should be stored in a suitable cabinet, container or refrigerator according to the storage requirements as given by the manufacturer;
- viii. All operations that may produce a vapor, gas, spray or dust should be carried out in the radioisotope fume hood;
- ix. Each radioactive preparation should be properly clearly marked with details of the chemical compound, radionuclide, activity, date and name of user;
- x. Use of any radioactive substances should be properly recorded;
- xi. A calibrated radiation survey meter should be available and used throughout all radiation works;
- xii. Equipment to be used in active working areas should be retained only for that purpose and be labelled accordingly;
- xiii. Possibly contaminated gloves, absorbent materials, cleaning equipment and disposable laboratory equipment should be disposed of as radioactive waste in suitable, adequately labelled containers;
- xiv. Clean-up of the active working area and checking for any contamination should be conducted after each experiment and at the end of each day.
- xv. Radiation working areas should be cleaned by laboratory staff. Cleaning staff should not service these areas;
- xvi. Before leaving the laboratory, wash hands thoroughly. Monitor hands, clothing and shoes to ensure no contamination is present.

4.6. Waste Disposal – Radioactive substances and materials contaminated with radioactive substances must be disposed of as radioactive waste.

- a) Waste with sealed radioactive substances:

Unwanted sealed radioactive substances are usually collected and shipped back to the manufacturers for final disposal.

- b) Waste with unsealed radioactive substances:
 - i. Radioactive waste should be segregated and stored according to different radionuclides and properties of chemicals in suitable and adequately labelled containers;
 - ii. The storage area should be provided with proper and sufficient shielding;
 - iii. Follow the respective licensing conditions for final disposal of the radioactive waste.

5. Safety Requirements Associated with Irradiating Apparatus

5.1. Types of irradiating apparatus – The most commonly used irradiating apparatus at the Science Park is X-ray machine. Other irradiating apparatus include any high voltage (20 kV or above) vacuum devices that may have potential for generating X-ray. X-ray machines can be further categorized into the following three types according to the design and purpose of use:

- a) Closed-beam X-ray machine (e.g. X-ray diffractometer, etc.)
- b) Open-beam X-ray machine for purposes affecting the human body (e.g. diagnostic X-ray devices)
- c) Open-beam X-ray machine for purposes other than x-raying human bodies (e.g. industrial X-ray machines for non-destructive testing)

A closed-beam X-ray machine has the X-ray beam, the target materials and the detector enclosed in an interlocked cabinet while an open-beam X-ray machine does not have a cabinet or enclosure and therefore requires more safety control measures.

5.2. Purchase and installation – The possession and use of any type of irradiating apparatus requires a valid license from the Radiation Board. The owner of an irradiating apparatus must apply for such license before purchasing to facilitate the import, delivery and installation of the apparatus. Upon completion of installation, the Radiation Board should be notified in order to obtain the valid license for operation.

5.3. Personnel – All irradiating apparatus users must be trained in radiation safety. Users of open-beam X-ray machines or other irradiating apparatus as required by the Radiation Board must obtain valid user licenses for operating the apparatus. They must also be physically fit by passing a medical examination and have their radiation exposure personally monitored using the thermoluminescent dosimeters (TLDs).

5.4. Laboratory Area – Irradiating apparatus must only be installed and used at designated location specified by the corresponding license. The entrance to this area shall be posted with a radiation hazard sign and a copy of the irradiating apparatus license shall be displayed in the vicinity of that particular apparatus. The area shall also be restricted to authorized users only.

Moreover, the laboratory area where open-beam X-ray machines or other irradiating apparatus specified by the Radiation Board shall have additional safety features as follows:

- a) It shall be designated only for operation of the specified open-beam X-ray machine or other irradiating apparatus;
- b) It shall be built-in with sufficient shielding for protection against the radiation meeting Radiation Board's requirements; and
- c) A warning light shall be installed at the entrance in such a way that it must be turned

on whenever the irradiating apparatus is energized.

5.5. Operation – Local rules for the laboratory and Standard Operating Procedures (SOP) for the irradiating apparatus must be established and displayed at a conspicuous area in the laboratory for all users to follow. SOP should include basic requirements for users, normal operating procedures, safety precautions and emergency response in particular to that apparatus. It should be revised whenever there are any modifications to the apparatus or any changes in its application.

- a) Precautions for operating closed-beam X-ray machines:
 - i. Only authorized and trained personnel are allowed to operate the machines.
 - ii. Flammable chemicals should not be kept in the vicinity of the machines.
 - iii. No alternation should be made to the machine unless the X-ray tube is de-energized.
 - iv. Alignments or adjustments shall not be carried out visually while the X-ray tube is energized, unless a viewing system is used to avoid direct exposure to the radiation. Proper protective equipment should also be used whenever necessary to protect the body parts which might be exposed to the radiation.
 - v. Safety devices (such as enclosure interlocks) of the machines must be regularly checked for normal functions.
 - vi. Repair and maintenance of the machines shall be carried out by qualified personnel on a regular basis.
- b) Precautions for operating open-beam X-ray machines:
 - i. Only authorized personnel who are trained, physically fit and licensed are allowed to operate the machines. They must also wear their TLDs for

personal monitoring during operation.

- ii. Useful X-ray beam must be directed away from room entrance or adjacent occupied areas.
- iii. Flammable chemicals must not be kept in the room where the machine is installed and used. Ignitable gas or vapor must be free from this area.
- iv. When the machine is used inside a demarcated area, all persons should be excluded from the area during irradiation.
- v. Where it is necessary for any person to enter or remain in demarcated area while the machine is irradiating, the shielding and operating conditions should be such that the radiation doses received by such persons are not in excess of the dose limits.
- vi. Arrangements must be made (e.g. emergency stop in the vicinity) to ensure that the persons within the demarcated area can switch off quickly all sources of ionizing radiation from within the area, can leave the area without delay and can, if necessary, obtain immediate help from outside the area.
- vii. No alternation should be made to the machine unless the X-ray tube is de-energized.
- viii. Alignments or adjustments shall not be carried out visually while the X-ray tube is energized, unless a viewing system is used to avoid direct exposure to the radiation. Proper protective equipment should also be used whenever necessary to protect the body parts which might be exposed to the radiation.
- ix. Safety devices (such as room door interlock, if there is any) of the machines must be regularly checked for normal functions.
- x. Repair and maintenance of the machines shall be carried out by qualified personnel on a regular basis.

5.6. Disposal – The licensee of an irradiating apparatus must notify the Radiation Board and follow the Board's recommendations for disposal of the irradiating apparatus and cancellation of the license.

6. Accidents / Incidents and Emergency Responses

6.1. Leakage of radiation – In case radiation leakage is detected from an operating irradiating apparatus, the apparatus must be switched off immediately. The user should report the incident to the Responsible Person, who should in turn seek assistance from the manufacturer's request servicing personnel for checking and maintenance.

6.2. Accidental exposure to radiation – If any person is suspected to have been accidentally exposed to high energy radiation, S/he must report the case to the Responsible Person and seek medical assistance as soon as possible.

6.3. Spillage and decontamination – In an incident involving spillage of radioactive substances, an assessment should be made so that suitable measures can be taken for minor and major spillage accordingly.

- a) Minor spillage which may involve only a low radioactivity level ($< 4 \text{ MBq}$ or 0.1 mCi):
 - i. Report the incident to the Responsible Person and notify HKSTP by telephone following HKSTP's general laboratory emergency procedures;
 - ii. Demarcate the contaminated area with a warning notice;
 - iii. Wear gloves, protective clothing, shoe covers and respirator where appropriate;
 - iv. Drop appropriate absorbent around the spill to avoid its spreading;

- v. Cover the spill with absorbent and allow it to absorb the radioactive substances;
 - vi. Starting decontamination by moving the surrounding absorbents slowly towards the spill;
 - vii. Clean the area with water or appropriate detergent;
 - viii. Monitor the decontamination process continuously with a proper radiation survey meter;
 - ix. All materials used in the decontamination process (including protective clothing, gloves, shoe covers, absorbent materials, etc.) must be treated and disposed of as radioactive waste.
- b) Major spillage which may involve a higher radioactivity level (≥ 4 MBq or 0.1 mCi):
- i. Alert other nearby personnel and evacuate the laboratory immediately;
 - ii. Under safe condition, shut off the laboratory ventilation system and close the laboratory door;
 - iii. Stay in a nearby safe area. Report the incident to the Responsible Person and notify HKSTP by telephone following HKSTP's general laboratory emergency procedures;
 - iv. Call the local emergency hotline (999) and wait for assistance;
 - v. Warn other persons to keep clear of the contaminated area;
 - vi. Injured or possibly contaminated persons should not proceed far away from the contaminated area until they have been monitored;
 - vii. When emergency personnel arrive, provide them with necessary information about the incident;
 - viii. Emergency personnel will treat any injured first, then minimize the spread of

contamination from the spill and start decontamination procedures.

6.4. Reporting of accidents / incidents to the Authority – All accident and incident cases involving major spillage of radioactive substances, personal exposure to high energy radiation, and loss of ionizing radiation sources, etc. shall be reported to the Radiation Board as soon as possible within 48 hours.

C10 Laser Safety Guidelines

1. Introduction

Laser equipment are widely used in a variety of research activities in the laboratories. The fields of use include biotechnology, photochemistry, material processing, applied physics, optometry, medical equipment, etc. Laser equipment can emit intense, monochromatic and coherent radiation of an intensity that may impose hazards to personnel within and around the laser. Amongst the various potential hazards, eye and skin exposure to the laser operators requires particular attention. The purpose of this document is to provide the laboratory personnel at the Science Park with basic information and general guidelines on safe operation of laser equipment.

2. Types of Laser

The word “Laser” is actually an acronym for Light Amplification by Stimulated Emission of Radiation. In simple term, laser is a device that produces an intense, coherent and monochromatic beam of light by stimulating electronic or molecular transitions. It produces electromagnetic radiation at wavelengths extending from 100 nm in the ultra-violet, through the visible (400-700 nm), and the near infrared (700-1100 nm), to the far infrared (1400 nm-1mm). Thus, the light emitted can be either visible or invisible.

Lasers can be operated in different modes either in the form of a continuous beam (CW) or as a single pulse or a series of pulses. The power output of CW and pulsed lasers are usually expressed in terms of watts (W) and Joules (J) respectively. Various lasers with different types of lasing media are available for different applications. Some examples are indicated in the table below.

Type	Example
Gas	Argon (Ar), Carbon Dioxide (CO ₂), Helium Neon (He-Ne), Krypton (Kr),

	Excimer
Liquid	Dye
Solid-State	Neodymium-YAG (Nd-YAG), Ruby
Semi-conductor (Diode)	Gallium Arsenide (GaAs), Indium Phosphorous (InP)

3. Laser Classification

Laser equipment is classified by evaluating its potential to cause harm. Referring to the International Electrotechnical Commission Standard (IEC 60825-1) and American National Standard (ANSI Z136.1), laser classification is based on the ability of the primary beam to cause biological damage to eye or skin during intended use. The maximum accessible emission limit (AEL) permitted for a particular class of laser is defined.

It is a requirement of the laser manufacturer to provide the correct classification of a laser product. This classification is made on the basis of a combination of output power (s) and wavelength (s) of the accessible laser radiation over the full range of capability during operation at any time after manufacture. An instrument label is needed to affix to the laser by the manufacture which indicates the hazard class. A brief description of each class is given below:

a) Class 1

Lasers that are safe under reasonably foreseeable conditions of operation, either because of the inherently low emission of the laser itself, or because of its engineering design such that it is totally enclosed and human access to higher levels is not possible under normal operation.

b) Class 1M

Laser products emitting in the wavelength range of 302.5 to 4000 nm, whose total output is larger than that of Class 1 permitted laser. The very low power density of lasers do not pose a hazard in normal use. However, they may be hazardous to eyes if gathering optics are used with them.

c) Class 1C

Any laser product which is designed explicitly for contact application to the skin or tissue.

d) Class 2

Laser products limit to a maximum output power of 1 mW (Continuous Wave) and operate in the visible wavelength region (400-700 nm). This type of laser is relatively safe as natural aversion response (blink response) can protect from eye injury.

e) Class 2M

Laser products that only emit visible radiation in the wavelength ranging from 400 to 700 nm, whose total output is larger than that of Class 2 permitted laser. Their diverging beams or very low power density are safe for accidental viewing during normal use. However, they may be hazardous to eyes if gathering optics are used with them.

f) Class 3R

Laser product that emit in the wavelength ranging from 302.5 nm to 1 mm with maximum output power of 5 mW (Continuous Wave). This is considered safe with restricted beam viewing.

g) Class 3B

Laser products that have an output power of continuous wave not exceeding 0.5W.

Lasers are hazardous when direct viewing of laser beams. Viewing diffuse

reflections is normally safe.

h) Class 4

Laser products that have output power greater than 0.5W for continuous wave.

Class 4 lasers are the most dangerous class of laser. Such lasers are capable of burning the skin, and can cause ruinous damage to the eyes as the results of direct, indirect or diffuse beam viewing. It can also constitute fire, chemical or electrical hazards. **The most stringent control measures need to be established for Class 4 laser.**

4. Laser Hazards

Hazards associated with laser can be divided into two main categories, beam hazards and non-beam hazards. Beam hazards are of course dangers arising from the laser light directly and their concern on exposed tissues, skin or eyes when not protected properly. Non-beam hazards include the danger of exposure to toxic and cryogenic materials, electrical shock and ionizing radiation, etc.

4.1. Eye and Skin Hazard

The hazard depends on a number of factors, including the wavelength of light it emits, the intensity of the beam and the exposure duration. The eye is more susceptible to injury due to the focusing capability on the retina. If a visible or near infra-red beam enters the eye, it may be focused on the retina to a minute spot with intensity raising by a factor up to 200000 times. The worst case of incident may cause blindness. The pigmentation, ulceration and scarring of the skin and damage of underlying organs may occur from extremely high power irradiation. Certain wavelengths of laser light in the ultra-violet region may cause adverse effects similarly produced by over-exposure to sunlight.

4.2. Electrical

Most high power laser systems require high voltage and current. The use of laser systems can present an electric shock hazard. This may occur from contact with exposed utility power utilization, device control or power supply conductors.

4.3. Physical

Cryogenic fluids such as liquid nitrogen are often used for cooling of lasers and detectors. These fluids can produce severe skin burns and should wear appropriate PPE such as face shield and thermal insulated gloves during handling (for details please refer to “Safe Handling of Cryogenics” from HKSTP’s SHE Handbook). Adequate ventilation should be provided for reducing the risk of asphyxiation.

4.4. Chemical

Dye lasers use an organic dye as their lasing medium. These dyes can be toxic, carcinogenic or flammable. Adequate ventilation and suitable PPE should be available for handling.

Hazardous compressed gases such as fluorine, hydrogen chloride are often used in laser system. The gas cylinders should be stored in exhausted area secured to the wall and piped to the laser system using the appropriate regulators and fittings (for details please refer to “Safe Handling of Compressed Gas Cylinders” from HKSTP’s SHE Handbook).

Air contaminants may be generated when certain laser beams interact with matter. Laser generated air contaminants (LGAC) include metallic fumes and dust, metallic oxide fumes, chemical and gaseous vapors and biological fragments from human and animal

tissues. Various measures should be performed such as exhaust ventilation, respiratory protection and isolation.

4.5. Fire and Explosion

Class 4 lasers pose a fire hazard especially if focusing optics are used. Wherever a component of a laser facility has the potential to be exposed to an incident beam, it should be made of flame retardant material. These include beam stops and enclosure. Operation of Class 4 lasers should be aware of the ability of unprotected wire insulation and plastic tube to catch on fire from intense reflected or scattered beams, particularly from lasers operating at invisible wavelengths.

5. Laser Hazard Control Measures

Control measures are devised to reduce the possibility of exposure of the eye and skin to hazardous levels of laser radiation and to other associated hazards during operation and maintenance of laser equipment. Hazard control measures can be grouped into three general categories: Engineering, Administrative and Personal Protective Equipment. Maximum emphasis should be placed on engineering control and, Class 3B and Class 4 lasers.

5.1. Engineering Controls

The controls include built-in safety features supplied by the manufacturers as well as the enclosure design and laboratory layout for accommodation of laser equipment.

- a) Protective Housing – Required for all classes of lasers to limit access to associated laser beam and to electrical hazards associated with components and terminals. Interlock is required to install for Class 3B and Class 4 lasers to protect personnel from accidental exposure to the beam while the protective housing is opened.

- b) Key Control – Class 3B and 4 laser systems should be provided with a master switch operated by a key, or by coded access (such as computer code). The authority for access to the master switch shall be vested.
- c) Beam stop or Attenuator – The inadvertent exposure shall be prevented by the use of permanently attached beam attenuator, filter or beam stop on viewing portals and display screen. A beam attenuator can reduce the output of a laser beam to a level at or less than maximum permitted exposure levels (MPE). Consideration must be given to the material selection of the beam stop to reduce the risk of fire or burn.
- d) Remote Interlock Connector – A remote interlock connector allows connection to an emergency master disconnect interlock or to a room, entrance, floor or area interlock. Safety latches or interlocks are used to deactivate the laser in the event of an unexpected entry into laser controlled areas. The design of interlocks must allow both rapid egress and admittance by personnel in emergency situation.
- e) Activation Warning System – It consists of audible sound, warning lights or verbal “countdown” which notifies personnel that the laser is being activated. A red light is usually connected to the interlock system and typically mounted near the entry points to the controlled area.
- f) Beam Paths – The beam path consideration is given to direct, reflected and scattered radiation in the establishment of boundaries of the laser controlled area (Nominal Hazard Zone) as furnished by the manufacturer. The direct beam path should be kept above or below eye level.
- g) Laboratory Design – A laser laboratory, in particular with the operation of Class 3B or 4 lasers, should be isolated from all other activities not directly related to laser works. Windows should be kept to a minimum and need to be covered by

laser curtain with fire retardant material capable of withstanding a direct continuous hit from high power laser beams. Walls, ceilings and fitting should be painted with a light colored matt paint to enhance illumination and minimize specular reflection. There should be adequate ventilation especially if cryogens are used for cooling detectors or if toxic fumes are produced.

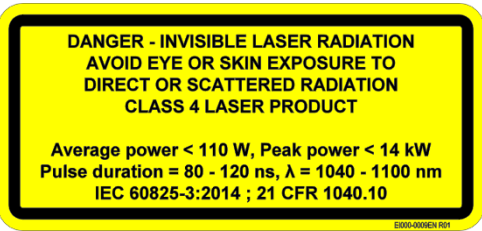
5.2. Administrative Controls

Administrative control covers comprehensive laser safety program including writing up procedures for beam alignment and operation, stipulating training to laser operators, providing adequate label and warning signs on laser equipment and designated laser area, setting up policy for access control on laser laboratory and developing an emergency plan.

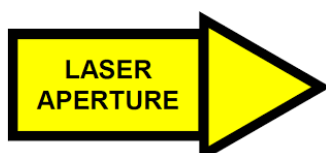
- a) Standard Operating Procedures (SOP) – SOP shall be written and approved for Class 3B and 4 lasers. SOP is usually a concise document that provides general safety guidelines and control measures, hazard information, training requirements and emergency procedures, etc. Laser operators must be familiar with the procedures prior to laser operation and beam alignment. A copy of the procedure should be posted on the laser laboratory.
- b) Training – Training must be provided to personnel who operates Class 3B or 4 laser system. The purpose is to let laser operators get familiar with the hazards, control methods for the whole system, PPE requirement, signage meaning and safety procedures.
- c) Laser Equipment Label – All lasers require labeling except class one which are deemed safe within normal operation conditions. Labels should comply with international standards such as IEC 60825-1, BS EN 60825-1, and ANSI Z136.1. The labels shall be permanently fixed, legible and clearly visible during operation,

maintenance or service. The labeling system should contain hazard label and explanatory label showing the laser class, safety instruction, maximum output, pulse duration (if appropriate), emitted wavelength, name and publication date of standard.

Examples of labeling are shown as follows:

Hazard Label	Explanatory Label
	

For Class 3R, Class 3B and Class 4 laser products, labels bearing the wording ‘LASER APERTURE’ or ‘AVOID EXPOSURE – LASER RADIATION IS EMITTED FROM THIS APERTURE’ shall be displayed close to where the beams are emitted. Example of this aperture label is shown as follows:



- d) Warning Label on Designated Area – The points of access to areas in which Class 3B, Class 4 laser and open beam work with modified Class 1M, Class 2M or Class 3R are used should be marked with appropriate warning labels. Appropriate label should contain cautionary or danger statement or protective actions. Some examples are shown as follows:



- e) Control of Access – Lasers of Class 3B and 4 must be operated and maintained by

authorized personnel. A list of operating personnel must be maintained and is highly recommended to be posted on the area. Access to the area should be restricted to only personnel working with the laser systems. All other personnel must not be allowed to enter the area while the lasers are switch on. The entry point must be well marked with appropriate signage with examples shown below:



- f) Emergency Plan – An emergency plan should be written down for any incidents which may occur such as laser eye strike, skin injury, critical equipment breakdown or chemical exposure. The emergency procedures and contact details must be provided and posted on the laser laboratory.

5.3. Personal Protective Equipment

a) Eye Protection

Safety eyewear is the most common and certainly the most important aspects of personal laser protection. It should be regarded as a last line of defense against exposure to laser radiation but not a convenient alternative to avoiding any engineering and administrative controls.

Laser safety eyewear is afforded by incorporating optical filter to reduce light transmission of a specific wavelength, or range of wavelengths, to a safe level while maintaining adequate light transmission at all other wavelengths. The Optical Density (OD) of a filter is a measure of this attenuation. The required OD, which

is the logarithm of the ratio of maximum reasonably foreseeable exposure to Maximum Permissible Exposure (MPE), needs to be determined. Eyewear providing a smaller level of OD than required will not offer sufficient protection.

All eyewear supplied must provide adequate attenuation at the appropriate wavelength and comply with the international standards such as BS EN 207 (for full protection – 180 nm to 1 mm) and BS EN 208 (for alignment work – 400 nm to 700 nm). Eyewear must be clearly labeled with the OD, wavelength and laser emission type so that the user can identify the protection level for the laser they intend to use.

Appropriate safety eyewear must be worn for each particular laser operation. The supplier of eyewear can assist the users to choose appropriate eyewear when they know the laser model. The most important information for supplier's consideration include laser wavelength, maximum average power, smallest beam diameter and divergence, repetition rate for pulsed laser, maximum pulse energy and pulse duration.

The eyewear should be stored in designated, clean drawers or containers, in an area outside the hazard zone close to the entry point of laser laboratory. Periodic inspections must be made of safety eyewear to ensure there is no scratches, cracking or bleaching found.

b) Skin Protection

Skin protection may be required for laser operated in ultraviolet region such as excimer laser application. Leather gloves, leather aprons and jackets are generally

considered the most desirable in protection against UV exposure.

6. General Safety Practices

Laboratory personnel shall adopt the following safety practices during operation of laser in the laboratories:

- a) Ensure you well understand and strictly follow the SOP of the laser equipment to be operated.
- b) Wear appropriate laser safety eyewear and other PPE as required. Inspect for any damage and wear of eyewear before use.
- c) The activation warning light must be switched on to remind other personnel that laser is in operation.
- d) Restrict unauthorized personnel to enter the laser laboratory.
- e) Remove all watches, rings, bracelets, earrings and ID badges. These items can reflect light which can be hazardous.
- f) Activate the local exhaust ventilation system if the laser operation is liable to generate air contaminants.
- g) Verify that all safety devices are in place before energizing a laser.
- h) Work with sufficient levels of room illumination.
- i) Confine the beam within a well-defined area such as an optical table.
- j) Keep the laser beam path as short as possible and enclose it as much as possible.
- k) Never view the source of laser beam directly and no part of skin should be exposed to the direct beam.
- l) Collimating instrument such as telescope or microscope should not be used to view the beam directly.
- m) The laser should not be fired unless it is correctly aimed at the target area.

- n) The laser should be switch off immediately and be kept under lock after use.
- o) Maintenance and repair work on laser systems should be performed only by certified personnel.
- p) The use and storage of flammable chemicals should be avoided in the designated areas with Class 3B and 4 lasers. Appropriate firefighting equipment should also be available in the vicinity.

7. Emergency

Laboratory Persons In-Charge should address the potential hazards of individual laser equipment and corresponding safety measures to all concerned laboratory personnel. Suitable preparedness and arrangements should be in place to ensure that all laboratory personnel take appropriate actions in case of emergency.

In the event of an accident or incident involving suspected injury to the eye or skin, stop the experiment and turn off the laser equipment immediately. Report the accident or incident to the supervisor / Laboratory Person In-Charge and HKSTP following the “General Laboratory Emergency Procedures” in HKSTP’s SHE Handbook. Seek medical assistance as soon as possible.

C11 Safety Guidelines For MRI And NMR Equipment

1. Introduction

In the laboratory environment, the most commonly used equipment capable of generating strong magnetic fields are Magnetic Resonance Imaging (MRI) and Nuclear Magnetic Resonance (NMR) systems. The primary hazard associated with magnet field is its attraction of magnetic objects. Secondary hazards associated are cryogenic and electrical hazards. The purpose of this document is to provide laboratory personnel at the Science Park with basic information on safety requirements for installation and operation of these equipment.

2. Definition

2.1. Static Magnetic Field

A magnetic field is a force field created by a magnet or charges that move in a steady flow as in direct current (DC). Static magnetic fields exert an attracting force on metallic objects containing for example, iron, nickel or cobalt. The quantity of ferrite (a form of iron) or martensitic steel (specific type of stainless steel alloy) in an object will affect its magnetic ability: the greater the quantity of these components, the greater the ferromagnetism. Static magnetic fields can erase data stored on magnetic media or on the strips of credit cards and badges.

The unit of magnetic field is usually expressed either as Gauss (G) or Tesla (T) which is the CGS-derived and SI unit of magnetic field strength per unit area respectively. One T equal 10000 G ($1\text{T} = 10000\text{G}$ or $1\text{mT} = 10\text{G}$).

2.2. Time-Varying Magnetic Fields

Time-varying magnetic fields are magnetic fields that reverse their direction at a regular frequency. They can induce an electric current in a conductor present in this field as well as in a human body. Time-varying magnetic fields are produced by devices using AC such as cellular telephone antennas, microwaves, etc. A general rule of thumb is that 1 T/sec can induce about 1 microampere per square centimeter ($\mu\text{A}/\text{cm}^2$) in the body. At 10-100 $\mu\text{A}/\text{cm}^2$ changes in the threshold for nerve and muscle action occur, with a potential health hazard. However, the magnetic field necessary to generate 10 $\mu\text{A}/\text{cm}^2$ is very large.

2.3. Superconducting Magnet

A superconducting magnet is an electromagnet made from coils of superconducting wire. It must be cooled to cryogenic temperatures during operation. In its superconducting state, the wire can conduct much larger electric currents than ordinary wire, creating intense magnetic fields. Superconducting magnets are used in MRI scanners in hospitals/ research laboratories and in scientific equipment such as NMR spectrometers.

MRI or NMR equipment can generate maximum magnetic field strength ranging from 5 to 20T. The earth's magnetic field is around 1×10^{-4} T. Equipment generating static or time-varying magnetic fields greater than 0.5 mT (5G) entail appropriate safety control measures.

3. Hazards Associated with MRI and NMR Equipment

3.1. Magnetic Field Hazard

Ferromagnetic and metallic objects (Steel or iron) are strongly attracted to the magnet, and can become potentially lethal projectiles. Personnel can be severely injured and/or equipment can be damaged if hit by objects that are attracted to the magnet at high speed. Therefore, no ferromagnetic and metallic objects are allowed inside a magnet room or within the pre-determined radius of the magnetic field ($> 5G$). Credit cards, cell phones, camera and magnetic storage media can be damaged or destroyed by the magnetic field and therefore should be stored outside the predetermined magnetic field lines.

3.2. Cryogen Hazard

The superconducting magnet is kept in a cryostat containing both liquid helium and liquid nitrogen for maintaining the extremely low temperature. Both liquids are extremely cold (liquid helium $-452^{\circ}F$, liquid nitrogen $-320^{\circ}F$), colorless, and odorless. Magnet quenching takes place when a magnet suddenly loses its superconductivity. Due to failure of the superconducting coil or the coil in the cryogenic system becomes resistive and generates heat which leads to explosive expansion of helium gas from the cryostat. The rapid escape of helium displaces the room air and this may lead to asphyxiation if personnel are working in the laboratory with limited space. Depletion of oxygen levels below 18% in the environment starts showing oxygen deficiency effects. When oxygen levels falls below 6% can result in sudden death.

Moreover, contact with liquid or cold vapor can cause severe frostbite. Personnel should wear appropriate personal protective equipment (PPE) when handling cryogenics.

3.3. Electrical Hazard

Superconducting magnets require a large amount of electrical power for operation. This power is proportional to the voltage utilized by the equipment. Proper electrical safety measures must be in place for the installation and use of the equipment.

3.4. Fire Hazard

The cryogenic gases are not flammable; however, the extreme cold condition that exists during and immediately after a quench may cause air to condense and create liquefied oxygen on surfaces. Violent reactions such as rapid combustion or explosion may occur if accumulated oxygen were to come in contact with combustible materials.

3.5. Other Hazard

NMR tubes have thin walls and get broken easily. Majority of accidents take place during the process of capping and insertion of tubes into the magnet. Broken samples can result in injuries or lead to dangerous spills of toxic chemicals.

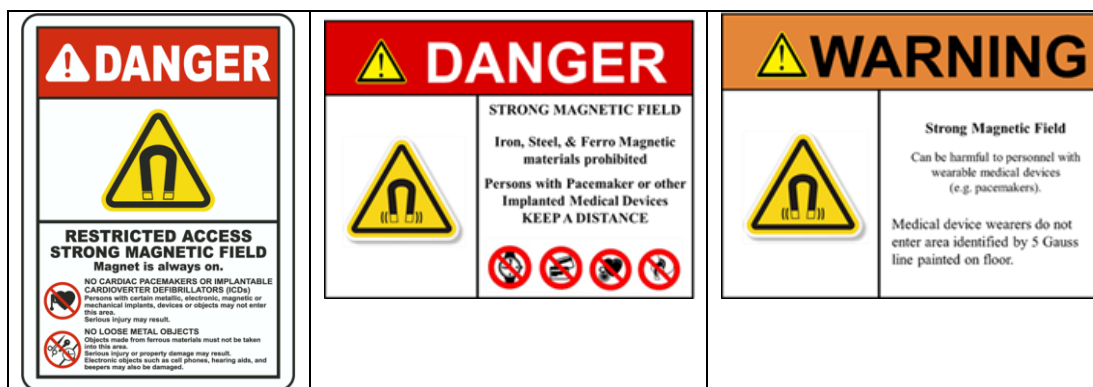
4. Safety Requirements

To ensure the safety of laboratory personnel, the management of each concerned laboratory shall observe the following safety requirements:

4.1. Facility and Building Services Requirements

- a) Magnet Room – MRI or NMR equipment must be located in restricted areas accessible to authorized personnel only. Persons with metallic implants and prostheses such as aneurysm clips, implanted pins, shrapnel, insulin pumps, prosthetic limbs, cochlear implants, pacemakers, and cardiac or neural defibrillators must not be allowed to the room. They should be reminded of the potential hazard.

- b) **Forbidden Objects** – Tools and magnetizable objects must be kept out of places where elevated static magnetic fields are present ($>5G$). Examples of such objects or tools include work station, fire extinguishers, compressed gas cylinders, screw drivers, tweezers, chairs, flashlights, keys, jewelry, hearing aids, magnetic stirring bars, batteries, watches, scissors and badges, etc.
- c) **Area Designation** – A 5G line must be used to designate the area where the magnetic field strength is larger than 5G. The 5G line is a demarcation between uncontrolled and controlled areas. This line can be denoted with a barrier, such as non-metallic stanchions or plastic chains or a visible warning, such as tape on the floor around the magnet. Whatever method is used, egress from the area in the event of emergency shall not be blocked or prevented. Individuals should be able to enter or exit the room without passing strong magnetic field. To highlight the designated area within a workplace, it is advised to create a floor plan highlighting the location of the MRI or NMR equipment and the 5G lines covering areas. This floor plan should be displayed at the entrance of that area.
- d) **Signage** – Hazard warning signs are required to be posted at all access points to the magnet room and other areas probably affected by magnetic fields. Examples of such signage are shown below.



e) Magnetic Field Shielding – The static magnetic fields in the facility must be identified by measurement or calculations to determine the installation of magnetic field shielding in order to reduce the magnetic field to less than 0.1 mT (1G) in adjoining rooms and public corridors.

f) Exhaust – Laboratory should be maintained under negative pressure relative to the corridor so that the quenching gases will not spread to the outside corridor so quickly if quenching occurs.

A quench pipe should be installed to allow the quenching gases to escape and discharge to an unoccupied area outside the building. This area is taken as the quench safety exclusion zone and should be clearly marked with warnings and signage. It should be devoid of any serviceable equipment, air intakes, operable windows or unsecured doors that either require servicing or offer a pathway for the gases to re-enter the building.

g) Sensor device – It is advised to install oxygen level sensor in the magnet room with audible alarms when oxygen concentration reaches unsafe levels (<19.5%). To avoid a quench situation, use a cryogen level sensor system to detect the quench and trigger a lowering of the current and stored magnetic energy to prevent burnout of the conductor. Always refill or de-energize the magnet if low cryogen levels are indicated on the sensors.

h) Emergency facilities – Emergency shower, eyewash station and fire extinguisher must be installed outside the magnet room. Spill kit and first-aid kit shall be available at nearby convenient locations.

4.2. Training of Personnel – All personnel working with MRI or NMR equipment should receive training before commencement of work. Training content should include basic

information regarding hazard identification, standard operating procedures (SOPs) and emergency response.

5. General Safety Practices

As superconducting magnets or permanent magnets do not require power to sustain their magnetic fields, personnel must be aware that the magnetic fields generated from the equipment cannot be simply “switched off” but always remain on. Laboratory personnel shall adopt the following safety practices during operation with MRI or NMR equipment in the laboratories:

- a) Personnel using pacemakers or medical implants should not access to the region of 5G zone.
- b) Wear appropriate PPE as required. Safety goggles and thermal insulated gloves must be worn if handling of cryogen is needed.
- c) Objects should be tested for magnetic properties, if necessary, by a small hand-held magnets before being brought into a magnet room.
- d) Remove all the metallic or ferromagnetic materials (coins, cell phones, watches, credit card, spatulas, stirring bar, hair accessories etc.) and stored in the designated plastic cabinet or box outside the 5G zone or outside the magnet room.
- e) Switch on the ventilation system before operating the equipment to reduce the risk of asphyxiation.
- f) Ensure warning signs are displayed at entrances to prevent entry by unauthorized personnel.
- g) Ensure there is no metallic or ferrous tools such as screwdrivers, wrenches, tweezers stored in the magnet room.
- h) Remember to use non-magnetic stainless dewars when transferring cryogens to

the equipment.

- i) Check the cryogen level and replenish if necessary to avoid magnet quenching. It is best practice to maintain a schedule for replenishment of cryogens.
- j) Avoid positioning your head over the helium and nitrogen exit tubes.
- k) Maintenance and repair work on equipment should be performed only by certified personnel.

In case of planned quenching for the reason of maintenance or repairing of equipment, the Laboratory Person In-Charge concerned should notify HKSTP in advance for necessary arrangement to prevent accidents or other adverse consequences.

6. Emergency

Laboratory Persons In-Charge should address the potential hazards of MRI and NMR equipment and their corresponding safety measures to all concerned laboratory personnel. Suitable preparedness and arrangements should be in place to ensure that all laboratory personnel take appropriate actions in case of emergency.

- a) In the event of quenching:
 - i. Alert other personnel to evacuate the room.
 - ii. Activate the emergency alarm and emergency ventilation system (buttons located near the entrance).
 - iii. Leave the room immediately.
 - iv. Report the incident to HKSTP for assistance following the “General Laboratory Emergency Procedures” in the SHE Handbook of HKSTP.
 - v. Do not re-enter the room until the purge is complete and fresh air has been provided.
- b) In the event of skin contact and eye exposure to cryogens:

Follow the procedures laid down in the “Safe Handling of Cryogenics” in HKSTP’s SHE Handbook.

- c) In case of any metallic objects strike the magnet:

Notify the Laboratory Person In-Charge immediately. Do not attempt to pull the object off yourself which may cause damage to the magnet and induce danger to yourself.

C12 Safety Guidelines For Fume Cupboards

1. Introduction

Fume cupboards (hoods) are installed in most of the research laboratories where toxic or volatile chemical operations are involved. They are a type of safety device specifically designed to carry chemical fumes, vapors, mist and aerosol, generated during a laboratory procedure, away from the laboratory personnel and out of the building. They also serve as physical barrier between users and hazardous sources offering a measure of protection against inhalation, chemical spills and run-away reactions. The purpose of this document is to provide laboratory personnel at the Science Park with basic information on safety requirements for design, installation, testing, operation and maintenance of laboratory fume cupboards.

2. Standards and Recommended Practices

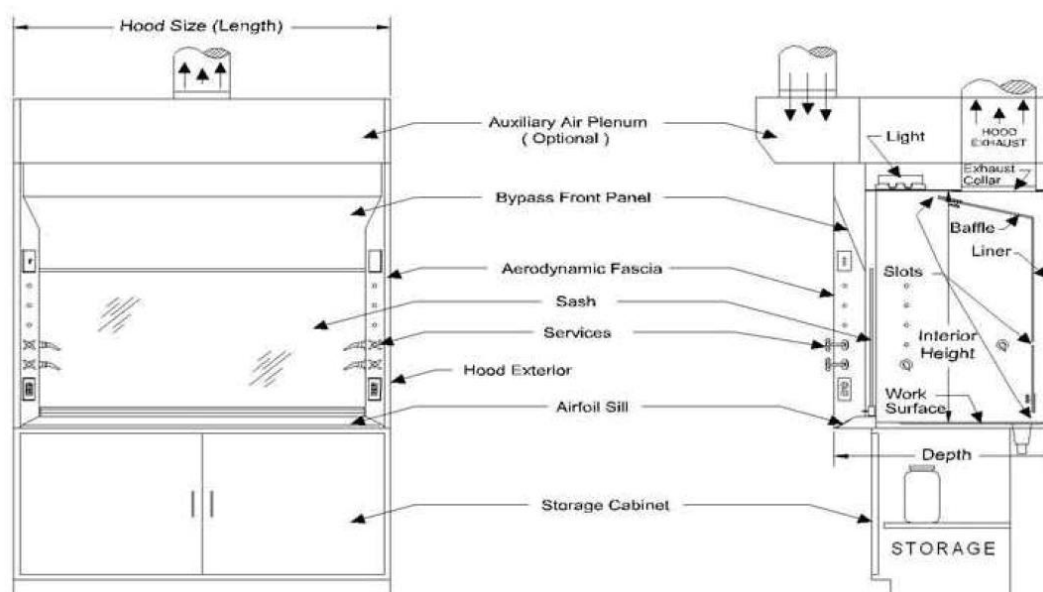
The efficiency and safety performance of a fume cupboard depends on many factors including its design and construction, location in laboratory, as well as rapport with the whole laboratory ventilation and exhaust system. Regular testing and inspections are needed for ensuring its performance and make necessary correction when needed. A variety of standards and recommended practices regarding fume cupboards are useful reference for laboratory personnel. Some of them are listed below:

- a) ANSI/ASHRAE 110: Methods of Testing Performance of Laboratory Fume Hoods – This standard is published by the American National Standards Institute and the American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. It covers the most widely accepted methods of testing the performance of laboratory fume hoods. Three useful test procedures including face velocity grid test, flow visualization or smoke test, and tracer gas

containment test are described in this standard.

- b) ANSI/AIHA Z9.5: Laboratory Ventilation – This standard is published by ANSI and American Industrial Hygiene Association. It covers a variety of laboratory ventilation requirements including hood monitoring, face velocities and exhaust.
- c) NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals – This standard is issued by the National Fire Protection Association. It provides recommendations on hood construction, location, fire protection, inspection, testing, maintenance and exhaust as well as use of specialty hoods in the laboratories.
- d) SEFA 1: Laboratory Fume Hoods Recommended Practices – Published by the Scientific Equipment & Furniture Association, this document covers useful information such as fume hood design requirements, face velocities and testing methods, etc.
- e) AS/NZS 2243.8: Safety in Laboratories, Part 8: Fume Cupboards – It is the Australian/New Zealand Standard specifies requirements for fume cupboards relating to their safety performance, along with recommendations and procedures for their selection, installation, testing and use.
- f) BS EN 14175: Fume Cupboards – It is the British Standard published by British Standards Institution which consists of several parts covering fume cupboard's type test, safety performance requirements and on-site test methods.

3. Components of a Fume Cupboard



A fume cupboard consists of several components tied together for providing effective function to capture and remove contaminants from the work area. The typical components of a conventional fume cupboard are shown in the above diagram.

3.1. Exterior

The exterior of a fume cupboard is usually made of painted steel.

3.2. Interior

The interior lining material shall be chemical resistant (in particular to the chemicals to be handled), corrosion resistant and flame retardant. Typical materials are epoxy, polyester, phenolic resin, stainless steel 304, stainless steel 316 and polypropylene.

3.3. Baffle

Baffle is a moveable partition with slot opening in the rear of the fume cupboard to

control the airflow distribution within the hood and through the face opening.

3.4. Sash

The sash is a moveable panel or panels to restrict the opening and provide a protective barrier between the operator and the experiment. By using the sash to adjust the front opening, airflow across the fume cupboard can be adjusted to the point where capture of contaminant is maximized. Each cupboard has its optimum sash configuration called “operating sash opening” or “design sash opening”. Sash is available in three configurations including vertical, horizontal; and combination of vertical and horizontal.

3.5. Airfoil

Airfoil is located along the bottom and side edges of the fume cupboard. The airfoil streamlines the airflow into the fume cupboard preventing the creation of turbulent eddies that can carry vapors out of it.

3.6. Work Surface

Work surfaces are typically made of a material that provides good heat and corrosion resistance and is easily clean and decontaminated. The work surface should have a recessed area for providing containment of small spill.

3.7. Exhaust Collar

The exhaust collar that connects the fume cupboard to the exhaust duct is located behind the baffle at the top of the interior liner. The design of exhaust collar can affect the hood static pressure drop and noise level.

3.8. Bypass

Bypass is used to divert air from the face opening when the sash is lowered. It is designed to limit the increase in face velocity.

3.9. Auxiliary Air Plenum

Auxiliary air plenum is installed in some fume cupboards designed to reduce the amount of room air exhausted by the fume cupboard by introducing a source of supply air into the cupboard. The consumption of conditioned room air is reduced and hence the energy is saved.

3.10. Lighting

Lighting can be either housed inside the chamber and separated by a vapor resistance glass panel at the top of the interior wall or mounted inside hood liner with flameproof and corrosion-proof properties. The adequate illumination at the work surface should be provided.

3.11. Service Fixtures

A fume cupboard is usually equipped with a variety of amenities or services. It includes electrical outlet, sinks, fixtures and plumbing for gas, vacuum, air and water. All fixture controls should be external to the fume cupboard, clearly identified and within easy reach. All internal service fixture outlets shall be corrosion resistant or have a corrosion resistance finish.

3.12. Air Flow Monitor

The newly installed fume cupboards at the Science Park are incorporated with air flow

monitor tied to alarm system for indicating the instant face velocity and giving audible alarm when the air flow deviates from the set point.

4. Types of Fume Cupboards

There are different types of fume cupboards available for different operations. Laboratory Person In-Charge should purchase/select appropriate types and models of fume cupboards to meet their own research purposes.

4.1. Conventional Fume Cupboard (Bench-Top Fume Cupboard)

Conventional fume cupboard is the most common type of fume cupboard that is generally placed on a bench-top or above a storage cabinet. It can be used for a variety of chemical operations involving small to moderate quantities of materials having low to highly hazardous properties. Constant air volume (CAV) and variable air volume (VAV) are two different operation modes for fume cupboards.

- a) CAV – this type of fume cupboard operates with a face velocity that varies with the sash opening. It is usually incorporated with bypass opening to reduce the turbulence inside the cupboard and prevent excessive face velocity.
- b) VAV – this type of fume cupboard operates with a face velocity that maintains within a preset range across the sash opening. It is capable of varying the exhaust air volume in proportion to the sash opening by either changing the speed of the exhaust blower or by adjusting the damper in the exhaust duct.

4.2. Floor Mounted Fume Cupboard (Walk-in Fume Cupboard)

Floor Mounted fume cupboards are used for applications which require large apparatus. They are floor mounted without any work surface. This facilitates the transfer of equipment and materials into, and out from the hood.

This type of fume cupboard is particularly susceptible to variations in face velocity across the opening and room air disturbance due to the large opening area afforded by the hood design. Thus, it is prudent not to use a floor mounted fume cupboard for work with highly toxic materials.

4.3. Ductless Fume Cupboard (Re-circulatory Fume Cupboard)

Ductless fume cupboard does not require any exhaust ducting and relies on filtration system to retain the airborne contaminants before the air is recirculated to the laboratory. As filter effectiveness changes across the lifetime and difficult to guarantee, this type of fume cupboard is only suitable for small-scale and low toxicity chemical operations. Ductless fume cupboards must have signage prominently posted on them informing operators and maintenance personnel about allowed chemicals, types of filters in place, filter replacement schedule, and the potential risk of filter break-through.

4.4. Other Fume Cupboards

There are other types of fume cupboards that are designed for specific operations. All these special purpose fume cupboards bare the general characteristics of a conventional fume cupboard with some modifications on the design or material used.

- a) Perchloric acid fume cupboard – perchloric acid reacts violently with organic materials. Dried perchloric acid is also highly explosive. Therefore, it requires built-in water wash down systems on entire duct work and the area behind the baffle to prevent perchlorate salt deposits. The interior lining must be coved and welded seamless stainless steel or other non-reactive material such as chlorinated

polyvinyl chloride or polypropylene. Non-reactive and corrosion resistance material should extend all the way through the exhaust system.

- b) Radioisotope fume cupboard – it is constructed specifically to protect users from radioactive materials. The work surface shall be dished to contain spills and be properly reinforced to support lead shielding and shield containers. Interiors are made of 304 stainless steel with coved corners to aid in decontamination. Horizontal sash panels are not appropriate for this hood type.
- c) Distillation fume cupboard – it is characterized by a low work surface height which results in a large working height for the operator. This allows tall distillation equipment to be installed and mounted in the work chamber.

5. Installation of Fume Cupboards

The performance of a fume cupboard in a laboratory is affected by the room layout and supply air distribution. The overall exhaust system performance depends on the fan and duct layout as well as fan type and discharge conditions. The installer must carry out on-site commissioning tests after installation to ensure that the performance of the fume cupboard meets with relevant international standards.

5.1. Location

Fume cupboards shall be installed at appropriate locations of the laboratories according to the manufacturer's instructions and in compliance with relevant international standards. In general:

- a) They should be located away from high traffic lanes, cross-draughts, air inlets and other sources of disturbance;
- b) There should be at least 1 m between the sash and any traffic route so as to preserve an undisturbed zone in front of the fume cupboard;

- c) They should not be located directly opposite a biological safety cabinet or another fume cupboard unless the distance between them is at least 3 m;
- d) They should not be sited in a position where a person requires to pass in front of them when leaving a laboratory;
- e) They should be located at a distance of least 1.8 m from an opposite bench, opposing wall or other large obstruction;
- f) The distance between the side of a fume cupboard and a wall or architectural column protecting beyond the plane of sash should be at least 0.3 m;
- g) The distance between the sash of a fume cupboard and a doorway should be at least 1.5 m; and
- h) The distance between the side of a fume cupboard and a doorway should be at least 1 m.

5.2. Supply Air

Before a new fume cupboard is put into operation, adequate supply of make-up air must be provided to the laboratory. A fume cupboard exhausts a substantial amount of air, additional make-up air must be brought into the laboratory to maintain a proper air balance.

- a) Supply and exhaust volume should be such that the laboratory is slightly negative pressure in relative to corridors and outside.
- b) The air exhausted shall not be recirculated to other laboratory areas.
- c) The make-up air distribution system should be designed and installed such that the supply air diffusion devices are properly located to avoid air currents that would adversely affect the performance of the fume cupboards.
- e) Supply air intake location should be chosen so as to avoid drawing in chemicals

or products of combustion coming either from the laboratory building itself or from other structures and devices.

5.3. Exhaust System

The whole exhaust system including ductwork, exhaust fan and exhaust stack must be properly selected and installed.

- a) Each fume cupboard should be separately ducted to the roof of the building preventing from any possible compatibility issues.
- b) As far as possible, ductwork should follow the most direct route from the fume cupboard to the point of discharge.
- c) Exhaust ducts should be maintained under negative pressure to reduce the possibility of contaminants leaking into the building.
- d) Fire dampers are not allowed in fume cupboard exhaust ducts.
- e) Damper for adjusting the fume cupboard air velocity may be incorporated into the ductwork.
- f) Ductwork should have no pockets where airborne gases or particles can be trapped.
- g) Elbows, bends and offsets within a duct system should be kept to a minimum for reducing static pressure losses.
- h) Exhaust fans must be located at the point of final discharge. They should be readily accessible for maintenance and inspection.
- i) Ductwork and fans shall be constructed of materials compatible with the chemicals being transported.
- j) Fans shall be sized to provide adequate exhaust air flow. The static pressure losses of fume cupboard and associated ductwork shall be included in the determination of fan size.

- k) Fans of centrifugal type should be considered as they are more efficient and generate less noise than other types.
- l) A permanently plumbed-in drain should be connected to the lowest point of each fan casing to permit disposal of condensate, rainwater and liquid used for cleaning the exhaust system.
- m) Exhaust stack shall be located so as to ensure acceptable dilution and dispersion of exhaust air and to preclude exhaust re-entry through air intakes and building openings. This represents a minimum exhaust stack height of 3 m above the exhausting unit or any roof lines and will be as far away from supply air intakes as possible.
- n) Exhaust stack must be directed vertically upward and the discharge should have a minimum exit velocity of 10 m/s. Cone type reducer should not be used to achieve this velocity. Rain caps that divert the exhaust back towards the roof must not be used.
- o) Each exhaust fan and duct system should be labeled to identify the fume cupboard in the laboratory to which they are connected.

6. Performance Tests on Fume Cupboards

Testing of a fume cupboard should be performed after the installation is complete, the building ventilation and control system has been balanced and all connections are made. Performance test for a fume cupboard should be conducted at least annually, or whenever a significant change in the fume cupboard system is made. Tests shall be carried out by qualified personnel. Any unsafe conditions disclosed by these tests should be corrected before using the fume cupboard.

ANSI/ASHRAE 110 provides thorough protocols for fume cupboard performance test including face velocity measurements, airflow visualization (smoke test) and tracer gas containment. It also defined three modes, i.e. As Manufactured (AM), As Installed (AI) and As Used (AU). For the AI test, a fume cupboard is installed in the laboratory and tested empty. For the AU test, the assessment is conducted with equipment and tools remaining in the fume cupboard and used by the laboratory users. Many regulatory organizations use face velocity as the only performance standard for fume hood testing. But by all means, this does not guarantee that the fume cupboard's performance is optimal when it meets face velocity standards.

6.1. Face Velocity

Face velocity is a measurement of the speed at which air enters a fume cupboard face opening. The recommended average face velocity usually ranging from 0.3 to 0.9 m/s depending on manufacture's specification. The testing should be done at "design sash opening" position. During the measurement, the doors to the laboratory should be closed. The anemometer used should be calibrated and the measurement should be done along the plane of sash with equally spaced grid points. Each individual readings must be within $\pm 20\%$ of the average face velocity.

6.2. Smoke Test

The purpose of the smoke test is to provide visual evidence of fume containment within the fume cupboard. A smoke stream is created at various points in the fume cupboard area such as around the entire perimeter of face opening, around any equipment or apparatus and along the internal walls. The direction of smoke flow is then carefully observed. The performance is acceptable when the smoke travels straight to exhaust without reverse flow or eddies and no escape from the confines of fume cupboard.

6.3. Tracer Gas Containment

The tracer gas containment test involves the release of gas (sulfur hexafluoride) inside the fume cupboard while a gas monitoring device is placed in the estimated breathing zone of a laboratory user positioned in front of the fume cupboard. The device measures the presence of the tracer gas at user's breathing zone outside the fume cupboard.

7. General Safe Work Practices for Fume Cupboards

The level of protection provided by a fume cupboard is affected by the manner in which it is used. No fume cupboard, however well designed, can provide adequate containment unless safe work practices are followed. Laboratory personnel shall adopt the following safety practices during the operation of fume cupboards:

- a) Ensure the fume cupboard exhaust is switched on before commencement of works.

If the fume cupboard is fitted with an airflow monitor, verify whether adequate face velocity is attained or not. If there is no airflow monitor installed, check the fume cupboard inspection records to ensure that it has been tested and operation performance was satisfactory at the time of the tests.
- b) Clear all unnecessary chemicals and apparatus inside the fume cupboard. Do not use the fume cupboard as storage area. Excessive storage of materials or equipment can cause eddy currents or reverse flow resulting in contaminants escaping from the fume cupboard.
- c) Elevate the equipment 5 to 10 cm above the work surface to provide flow beneath and around the equipment. Ensure the elevated equipment is stable.
- d) Do not place electrical receptacles or other spark sources inside the fume cupboard when flammable liquids or gases are present.

- e) Wear appropriate personal protective equipment and work at least 15 cm beyond the plane of sash.
- f) Keep your face outside the plane of the fume cupboard during operation. Use the sash for partial protection when working with hazardous materials. The sash height should be kept as low as possible.
- g) Care should be taken with the use of paper products, aluminum foil and other lightweight materials within the fume cupboard. It has potential risk for those materials entering the exhaust duct and affecting the fume cupboard's performance.
- h) Do not use the fume cupboard as a waste disposal mechanism.
- i) Limit pedestrian traffic past the fume cupboard, particularly during hazardous experiments. Inform other laboratory personnel about the work conducted in the fume cupboard.
- j) Always attempt to slowly approach and withdraw from the fume cupboard. Open and close the sash slowly.
- k) Clean the work surface and remove all unnecessary items from the hood after work.
- l) Keep the sash closed when not in use. Fume cupboard can be turned off if adequate laboratory ventilation can be maintained when the fan is not running.
- m) Report any defects or problems regarding a fume cupboard to the Laboratory Person In-Charge and stop using it until the problem is fixed. Post a notice "DO NOT USE" on the sash to remind other laboratory personnel.

8. Regular Maintenance and Testing of Fume Cupboards

The maintenance and testing of fume cupboards should be carried out at least annually to ensure they are operating safely. Where extremely hazardous or corrosive conditions exist, the inspection frequency should be increased appropriately. For those fume cupboards and associated exhaust systems that are purchased and installed by individual laboratory tenants, schedules for annual inspection, maintenance and testing shall be developed and maintained by the respective Laboratory Persons In-Charge. For those that are owned by HKSTP, Lab FMO of the Science Park will be responsible for the maintenance services. Regular inspection, maintenance and testing of fume cupboards should include the following items:

- a) Periodically clean the sash, exterior and interior surfaces, and light panel.
- b) Inspection procedures should consists of a physical examination of liner condition and cleanliness, baffle and sash operation and condition, light operation and condition, and service fixture function.
- c) Measure the face velocity and compare the result to the specifications of individual fume cupboard.
- d) Low flow alarm should be tested for correct operation.
- e) The emergency isolator (if any) should be tested.
- f) Lubrication of sash guides, cables, pulley wheels and other working parts should be accomplished as required or in accordance with manufacturer's recommendations.
- g) Replacement of worn, damaged or nonfunctioning parts as necessary.
- h) The inspection results should be recorded and a label should be attached to each fume cupboard showing its unit number, inspection dates, average face velocities and the names of inspectors.

C13 Safety Guidelines For Biological Safety Cabinets

1. Background

As laboratories involved in biomedical technology account for a majority of research laboratories at the Science Park, a great number of laboratory personnel are frequently exposing to biological hazards during their works especially when procedures and equipment promoting aerosol formation are involved. The microbiological safety cabinet had its inception in 1909, when the W. K. Mulford Pharmaceutical Co. in Glenolden (PA, USA) designed a ventilated hood to prevent infection with *Mycobacterium tuberculosis* during the preparation of tuberculin.

Aerosol particles are created by any activity that imparts energy into a liquid or semi liquid material, such as shaking, pouring, stirring or dropping liquid on to a surface or into another liquid. Laboratory activities including streaking agar plates, inoculating cell culture flasks with a pipette, using a multichannel pipette to dispense liquid suspensions of infectious agents into microculture plates, homogenizing and vortexing infectious materials, and centrifugation of infectious liquids, or working with animals, can generate infectious aerosols.

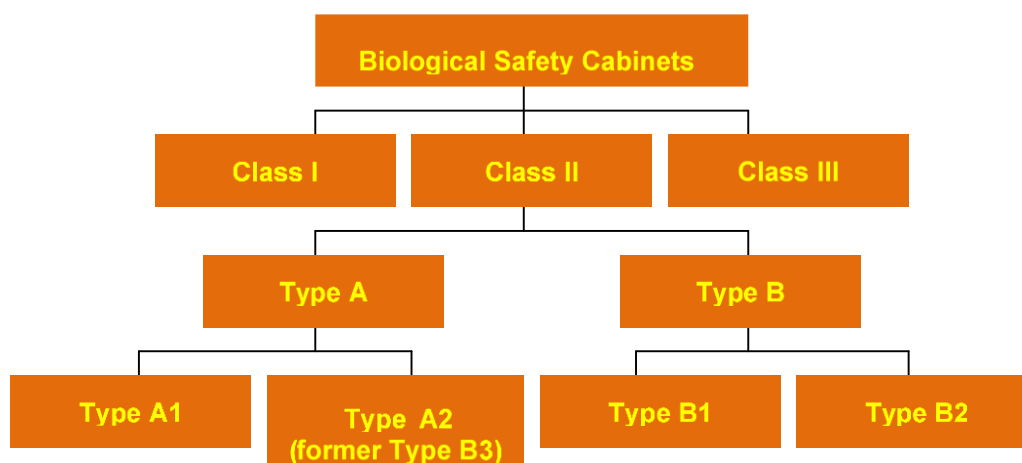
Aerosol particles of less than 5 μm in diameter and small droplets of 5 – 100 μm in diameter are not visible to the naked eye. The laboratory worker is generally not aware that such particles are being generated and may be inhaled or may cross-contaminate work surface materials. Biological safety cabinets (BSCs), when properly used, have been shown to be highly effective in reducing laboratory-acquired infections and cross-contaminations of cultures due to aerosol exposures.

2. Introduction

Over the years the basic design of BSCs has undergone several design modifications. A major change was the addition of a high-efficiency particulate air (HEPA) filter to the exhaust system. The HEPA filter traps 99.97% of particles of 0.3 μm in diameter and 99.99% of particles of greater or smaller size. This enables the HEPA filter to effectively trap all known infectious agents and ensure that only microbe-free exhaust air is discharged from the cabinet. A second design modification was to direct HEPA-filtered air over the work surface, providing protection of work surface materials from contamination. This feature is often referred to as product protection. These basic design concepts have led to the evolution of three classes of BSCs as described in details in the next section.

3. Classification of Biological Safety Cabinets (BSCs)

According to international standards (please refer to Section 11 for details), BSCs are categorized into 3 classes, i.e. Class I, II and III as indicated below. Class II BSCs are further grouped into 4 types.

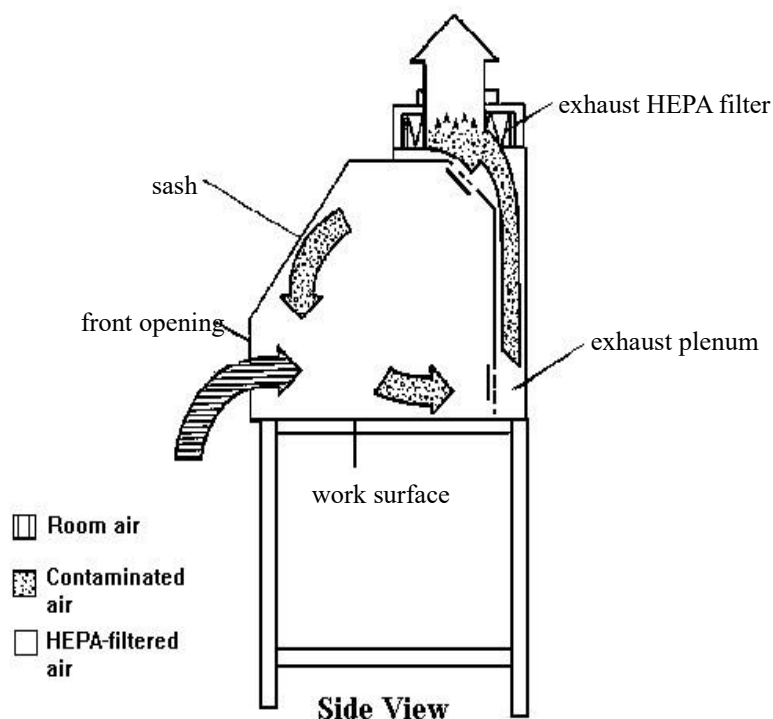


Major differences between these BSCs are listed in the table below.

BSC	Face velocity (m/s)	% of air flow		Exhaust system
		Recirculated	Exhausted	
Class I	0.36	0	100	Hard duct Exhaust to room
Class IIA1	0.35-0.51	70	30	or thimble connection Exhaust to room
Class IIA2	0.51	70	30	or thimble connection
Class IIB1	0.51	30	70	Hard duct
Class IIB2	0.51	0	100	Hard duct
Class III	N/A	0	100	Hard duct

3.1. Class I BSC

Class I BSC was the first recognized BSC and, because of its simple design, it is still in wide use throughout the world.



Adopted from WHO Laboratory biosafety manual, 2nd ed.

Class I BSC provides protection to the operator and environment only. It provides no reliable protection to the product (i.e. work inside the cabinet) from contamination because unsterilized room air is drawn over the work surface through the front opening. It is suitable for work with low to moderate risk biological agents (i.e. Risk Groups 1, 2 & 3). It can be used for work with radionuclides and volatile toxic chemicals.

Class I BSC is a partially enclosed ventilated cabinet. An air barrier of downward airflow through the front working opening, across the work space of the cabinet, and out through a HEPA filter, minimizes the escape of airborne aerosols generated within the cabinet.

Room air is drawn in through the front opening at a minimum velocity of 0.38 m/s, passes over the work surface and is discharged from the cabinet through the exhaust duct. The directional flow of air whisks aerosol particles that may be generated on the work surface away from the laboratory worker and into the exhaust duct. The front opening allows the operator's arms to reach the work surface inside the cabinet while he or she observes the work surface through a glass window. The window can also be fully raised to provide access to the work surface for cleaning or other purposes.

The air from the cabinet is exhausted through a HEPA filter:

- a) into the laboratory and then to the outside of the building through the building exhaust;
- b) to the outside through the building exhaust; or
- c) directly to the outside. The HEPA filter may be located in the exhaust plenum of the BSC or in the building exhaust. Some Class I BSCs are equipped with an

integral exhaust fan, whereas others rely on the exhaust fan in the building exhaust system.

Operator protection can be affected by any disturbance to the air barrier such as aerosols releasing from high-energy operations like centrifuges, human activity near the cabinet, closing and opening of a nearby room door or air discharges from a ventilation supply grille located near the cabinet.

Class I BSCs are commonly used in laboratories for handling clinical specimens or to enclose equipment (e.g., centrifuges, harvesting equipment, fermenters, etc.) or procedures (e.g. aerating cultures or homogenizing tissues, etc.) with a potential to generate aerosols.

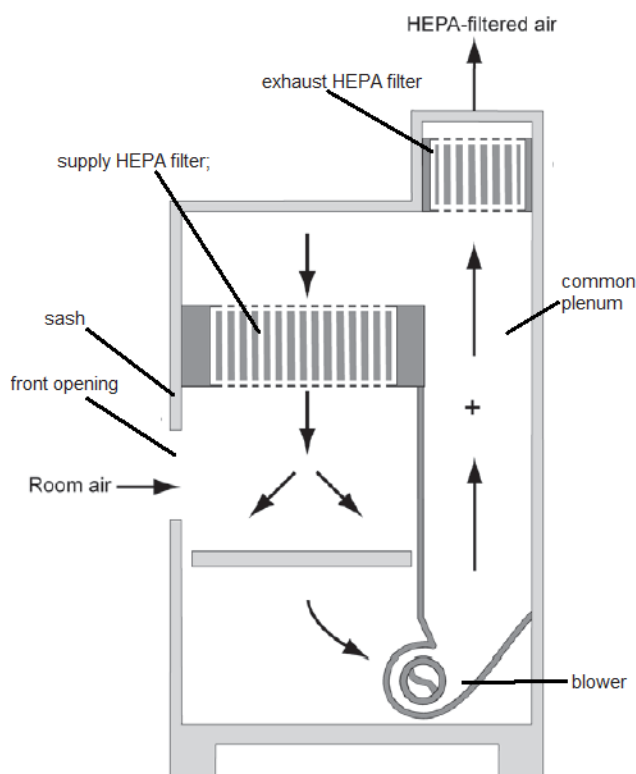
3.2. Class II BSC

As the use of cell and tissue cultures for the propagation of viruses and other purposes grew, it was no longer considered satisfactory for unsterilized room air to pass over the work surface. Class II BSC was designed not only to provide personnel protection but also to protect work surface materials from contaminated room air. It is a partially enclosed ventilated cabinet having inward airflow through the front working opening to minimize the escape of aerosols generated within the cabinet to provide operator protection. A Class II BSC is therefore more susceptible to the effect of operator movement and turbulence within the laboratory than a Class I BSC.

Class II BSC differs from Class I BSC by allowing only HEPA-filtered (sterile) supply air to flow over the work surface. It can be used for working with infectious agents of

Risk Groups 2 and 3. It can also be used for working with infectious agents of Risk Group 4 when positive pressure suits are used. Depending on the design features and the percentage of exhausted air, Class II BSC can be further grouped into four types (A1, A2, B1 and B2).

3.2.1. Class II A1 BSC



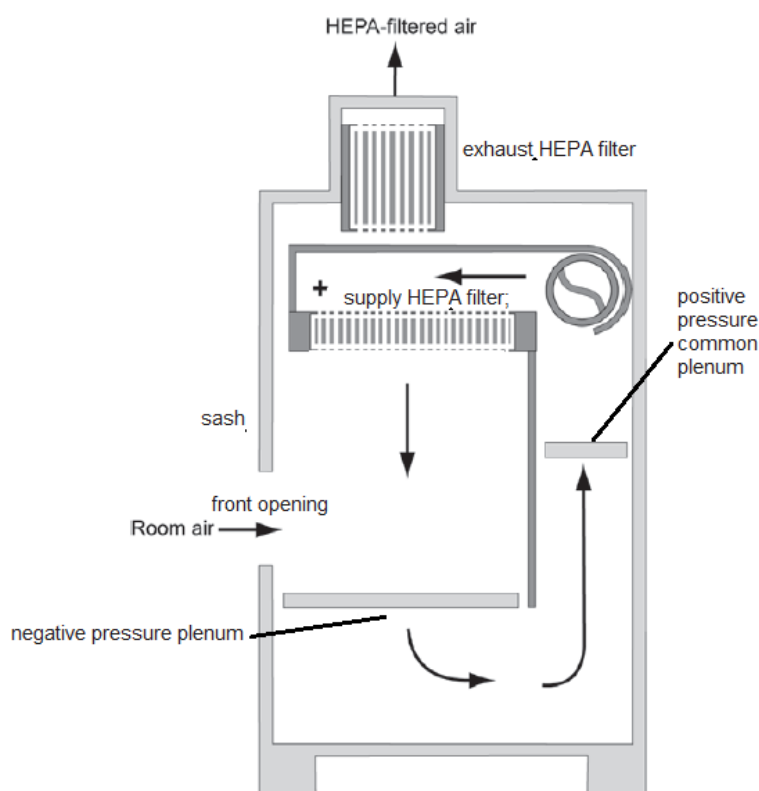
Adopted from CDC Biosafety in Microbiological and Biomedical laboratories, 5th ed.

Class IIA1 BSC is suitable for work with low to moderate risk biological agents (Risk Group 1, 2 & 3) in the absence of volatile toxic chemicals and volatile radionuclides. It has the following basic features:

- a) Minimum average inflow velocity of 0.38 m/s through the front work access opening.
- b) HEPA filtered air from the cabinet may exhaust back into the laboratory.

- c) Contaminated air, both from the workspace of the cabinet and the room, is drawn in by a fan and is then forced through the downflow supply filter (70%) and the exhaust filter (30%). Hence both the HEPA filtered downflow supply air and exhaust air are from a common plenum, which is under positive pressure.

3.2.2. Class II A2 BSC



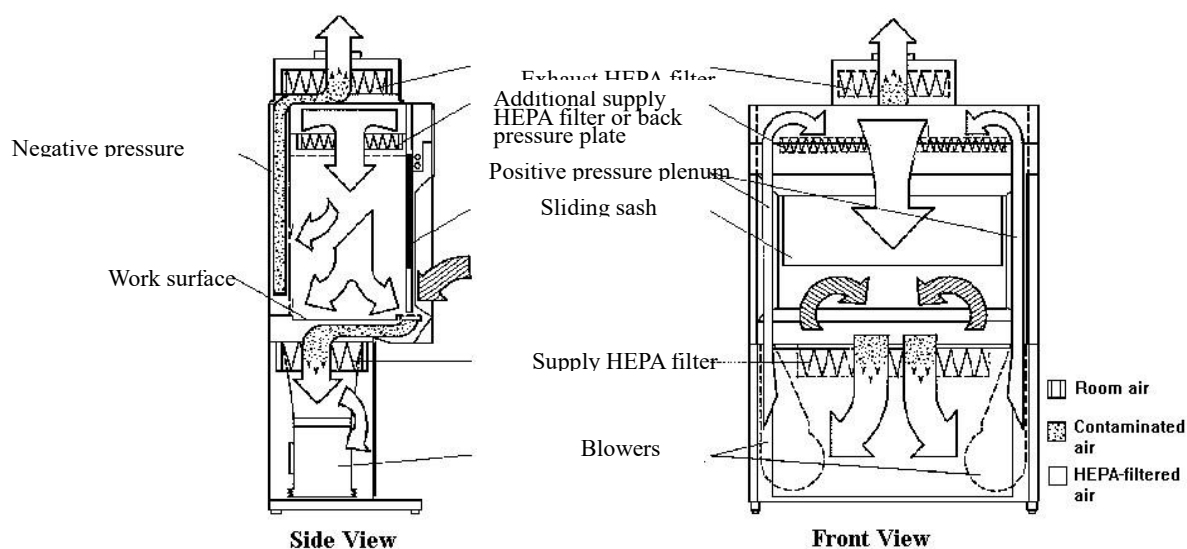
Adopted from CDC Biosafety in Microbiological and Biomedical laboratories, 5th ed.

Class IIA2 BSC is vented to the outside. It is suitable for work with low to moderate risk (Risk Group 1, 2 and 3) biological agents treated with minute quantities of toxic chemicals and trace quantities of radionuclides that will not interfere with the work if re-circulated in the downflow air. It has the following basic features:

- a) A minimum average inflow velocity of 0.5 m/s through the front work opening is maintained.

- b) HEPA filtered downflow air on the workspace of the cabinet is a portion of the mixed downflow and inflow air from a common plenum.
- c) All exhaust air is discharged to outdoors by an exhaust fan after HEPA filtration.
- d) All biological contaminated ducts and plenums are under negative pressure, or all positive pressure contaminated plenums within the cabinet are surrounded by a negative air pressure plenum thus ensuring that any leakage from a contaminated plenum will be drawn into the cabinet and not released to the environment.

3.2.3. Class II B1 BSC



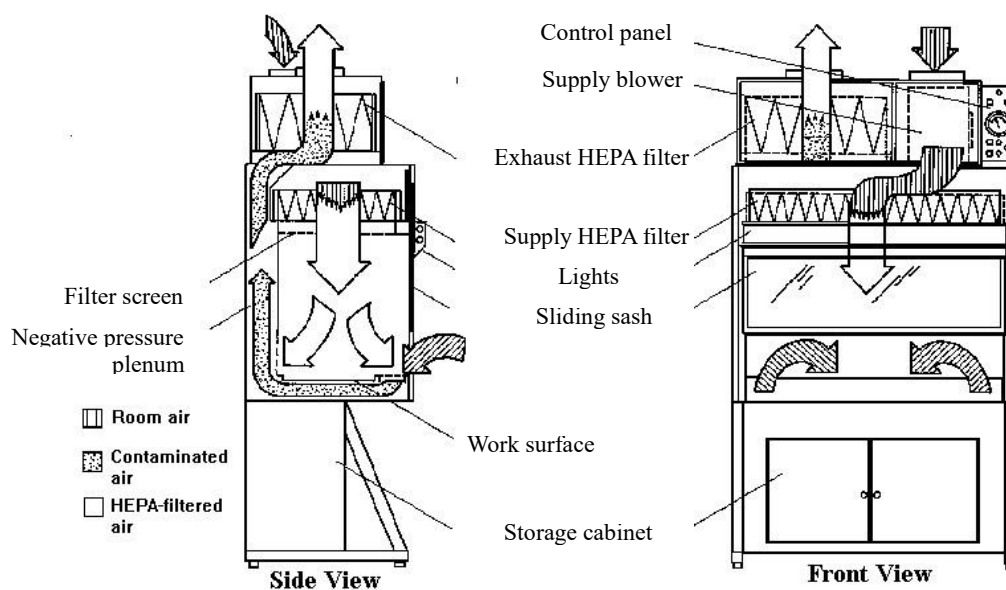
Adopted from WHO Laboratory biosafety manual, 2nd ed.

Class IIB1 and IIB2 BSCs are variations of the type IIA1. Class IIB1 BSC is suitable for work with low to moderate risk (Risk Group 1, 2 and 3) biological agents. It may be used with biological agents treated with minute quantities of toxic chemicals and trace amounts of radionuclides if the chemicals or radionuclides will not interfere with the work when re-circulated in the downflow air. Its design features are listed below:

- a) Intake air velocity at the front work opening is approximately 0.5 m/s.

- b) About 30% of the contaminated air from the workspace together with inflow room air is filtered through the supply HEPA filter and recirculated to the workspace. About 70% of the air from the work space of the cabinet is drawn through a rear grille and exhausted via a dedicated plenum through an HEPA filter to the outdoors.
- c) Air re-circulated to the workspace of the cabinet is never mixed with the exhaust air from the cabinet.
- d) All biological contaminated ducts and plenums are under negative pressure or surrounded by negative pressure ducts and plenums.

3.2.4. Class II B2 BSC

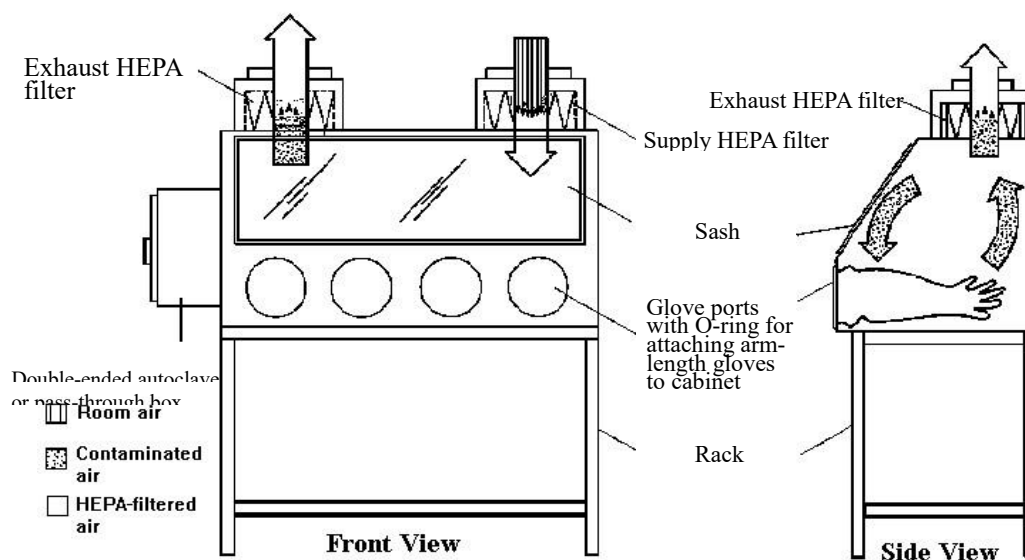


Adopted from WHO Laboratory biosafety manual, 2nd ed.

Class IIB2 BSC is suitable for work with low to moderate risk (Risk Group 1, 2 and 3) biological agents. It may also be used with biological agents treated with toxic chemicals and radionuclides required in the microbiological studies. It has the following basic features:

- a) Minimum average inflow air velocity of 0.5 m/s through the front work access opening.
- b) No air is re-circulated to the workspace of the cabinet. 100% of air from the workspace of the cabinet is exhausted.
- c) All HEPA filtered downflow air is drawn in from the laboratory or from outside by a supply fan. All inflow and downflow air from the workspace of the cabinet is exhausted to the outside after filtration through a HEPA filter by an exhaust fan.
- d) All contaminated ducts and plenums are under negative pressure or surrounded by negative pressure ducts and plenums.
- e) Interlock system should be installed to prevent the supply fan from operating whenever the exhaust flow is insufficient.

3.2.5. Class III BSC



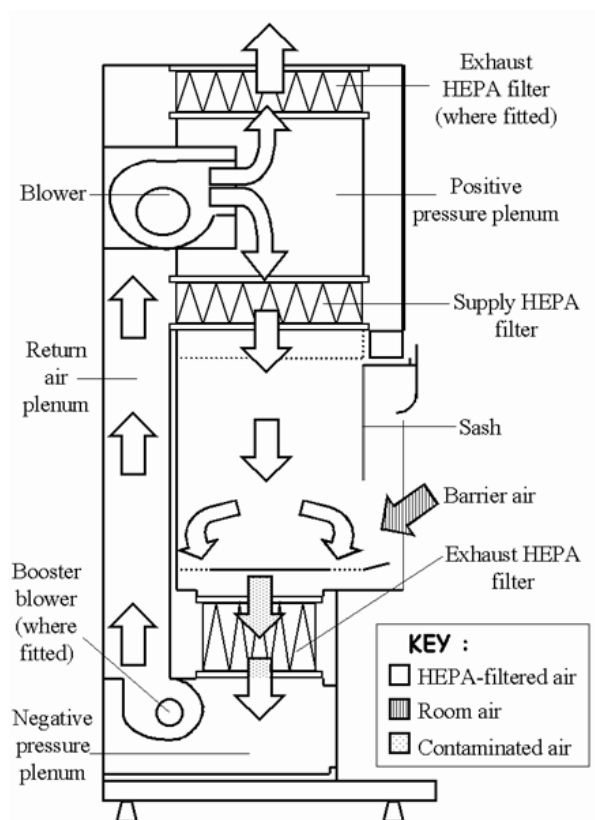
Adopted from WHO Laboratory biosafety manual, 2nd ed.

Class III BSC provides the highest level of protection to the operator and the environment. It is suitable for work with high-risk biological agents (Risk Group 3

and 4). A Class III BSC should not be used alone, but should incorporate the necessary equipment and be sited in specially designed laboratory facilities for handling high-risk samples (i.e. containment level 3 or 4). Several Class III cabinets can be joined together in a "line" which is custom-built to provide a larger work area. A Class III BSC in basic laboratory should not be used to handle high-risk samples. It has the following essential features:

- a) It is a totally enclosed, ventilated cabinet of gas tight construction. The operator is separated from the work by a physical barrier and operations in the cabinet are conducted through attached long-sleeved rubber gloves.
- b) The cabinet is maintained under negative air pressure, usually about 0.8 inches of water pressure relative to the laboratory.
- c) Air enters through a HEPA filter and is exhausted through two HEPA filters in series.
- d) Passage of materials into the cabinet is usually through a sealed airlock, and exit of material may be through an autoclave, a decontamination-type airlock, or a 'dunk-tank' filled with liquid disinfectants
- e) Depending on the design of the cabinet, the supply HEPA filter provides particulate-free, but somewhat turbulent airflow within the work environment.
- f) Flammable gas should not be used because of explosion hazards.

4. Cytotoxic Drug Safety Cabinet



Adopted from Biological Safety Cabinets Manual of HKU Safety Office.

Cytotoxic Drug Safety Cabinet is also a partially enclosed ventilated cabinet that provides the same operator, product and environment protection as Class II BSCs. In addition, it provides protection to the maintenance staff servicing the fans and internal surfaces of the cabinet. It has the following design features:

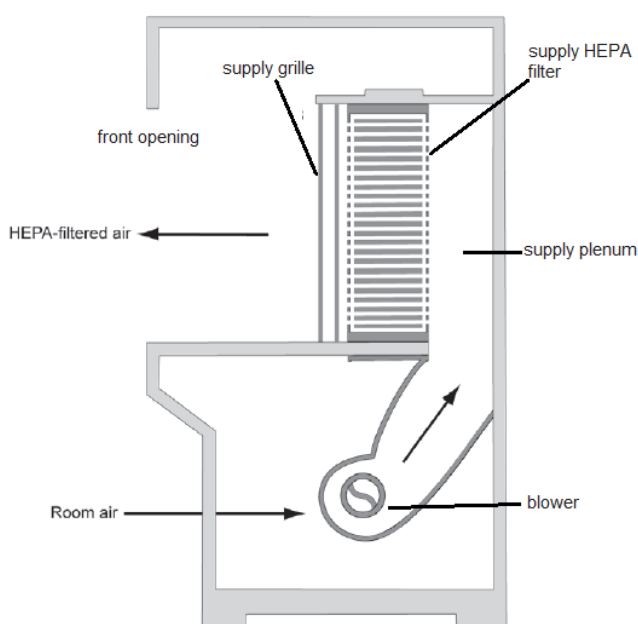
- a) The inward airflow at the front work opening offers the operator protection while the HEPA filtered laminar air flow on the work space of the cabinet protects the product from contamination.
- b) Both the contaminated air from the workspace of the cabinet and the room air from the front work opening mix beneath the work surface and are exhausted through a HEPA filter located directly under the work tray. Hence contaminated air is cleaned first before it reaches the exhaust fan.

- c) The fans, plenums and internal surfaces are protected from contamination by the cytotoxic drugs handled in the cabinet.

5. Laminar Flow Clean Bench or Work Station

A laminar flow clean bench or work station provides only product protection but not personnel protection. It is not a biological safety cabinet and therefore not recommended for use in the microbiology laboratories because in some instances it may increase the risk of infection for the user. It is further divided into two types, i.e. horizontal and vertical laminar flow clean benches with features described below.

5.1. Horizontal Laminar Flow



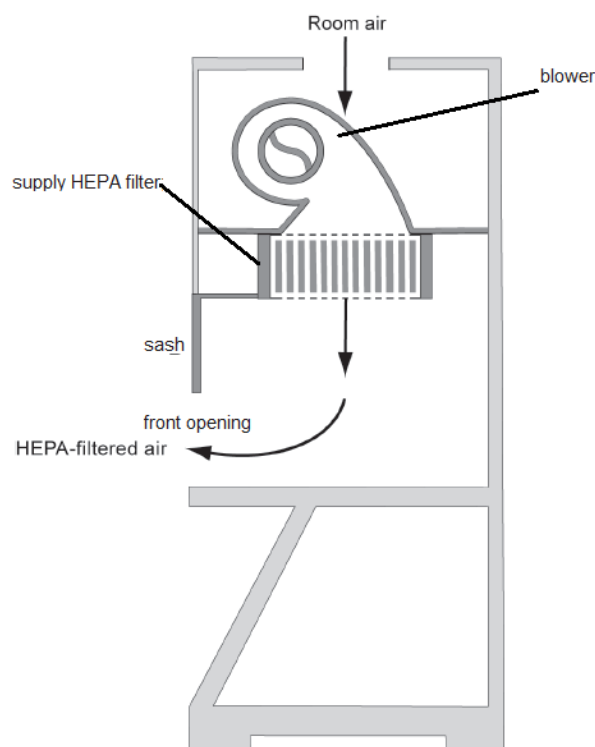
Adopted from CDC Biosafety in Microbiological and Biomedical laboratories, 5th ed.

- a) It discharges HEPA-filtered air across the work surface towards the user.
- b) It should never be used when handling cell culture materials or drug formulations, or when manipulating potentially infectious materials as the operator is exposed

to materials being manipulated in the work station. Even sterile or other seemingly innocuous biological materials may contain potentially allergenic substances.

- c) A horizontal clean work station should never be used as a substitute for a biological safety cabinet.

5.2. Vertical Laminar Flow



Adopted from CDC Biosafety in Microbiological and Biomedical laboratories, 5th ed.

While they look like a Class II BSC with a sash, the air is usually discharged into the room under the sash, resulting in the same potential problems as the horizontal laminar flow clean work stations.

6. Criteria for the Selection of BSCs

A BSC should be selected primarily in accordance with the type of protection needed: product protection; personnel protection against Risk Group 1-4 microorganisms;

personnel protection against exposure to radionuclides and volatile toxic chemicals; or a combination of these.

Volatile or toxic chemicals should not be used in BSCs that recirculate exhaust air to the room, i.e. Class I cabinets that are not ducted to building exhaust systems, or Class IIA1 or Class IIA2 cabinets. Class IIB1 cabinets are acceptable for work with minute amounts of volatile chemicals and radionuclides. A Class IIB2 cabinet, also called a total exhaust cabinet, is necessary when significant amounts of radionuclides and volatile chemicals are expected to be used.

Selection of proper BSC should be based on the criteria listed below.

6.1. What needs to be protected?

- Only the material being worked on (product protection)?
- Only the operator and the laboratory (personnel and environmental protection)?
- Or to protect all three (personnel, product, and environmental protection)?

Selection of a BSC is based on the type of protection needed:

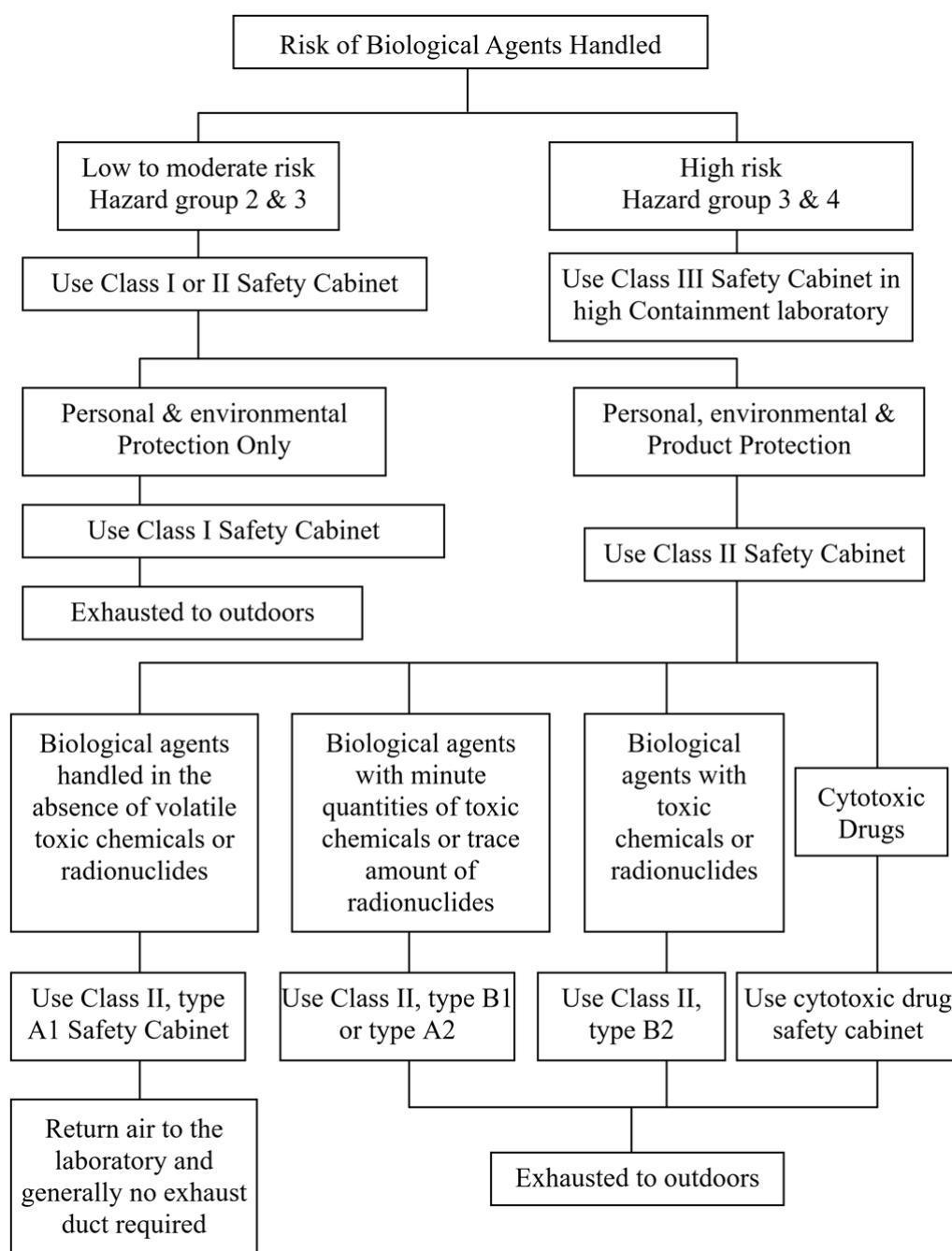
Biological Risk Assessed	Protection Provided			BSC Class
	Personnel	Product	Environmental	
BSL 1 - 3	Yes	No	Yes	I
BSL 1 - 3	Yes	Yes	Yes	II (A1, A2, B1, B2)
BSL 4	Yes	Yes	Yes	III; II - When used in suit room with suit

6.2. What types of work will be done in a Class II BSC?

One of the most difficult tasks in selecting a BSC is trying to foresee all the different

types of work that will be taking place in it. It is critical to decide what things need protection, both now and in the future.

- a) Which Risk Groups of biological agents to be handled in the cabinet?
- b) In addition to biological hazards, are radioisotopes, toxic chemicals or carcinogenic materials to be used inside the cabinet?



6.3. What types of chemical vapors will be generated in the BSC?

As important as the preceding question, the user should also foresee the types and quantities of chemical vapors that will be generated in the cabinet. Because chemical vapors can freely pass through HEPA filters, both Class I and Class II BSCs must be exhausted out of the laboratory when used with these types of chemicals. For the Class II BSCs, Types B1 and B2 must be directly connected to an external exhaust system in order to operate properly.

- a) Class II BSCs typically do not feature explosion-proof electrical components in their work area or internally. Therefore, use of flammable or explosive materials in quantities above their explosive limit is not recommended.
- b) Types of chemicals used in cabinet should be considered as some can destroy the filter medium, housings and gaskets causing loss of containment.

7. Safety Requirements for BSCs

- a) All corners and angles inside the BSC working space and other normally accessible areas (e.g. during cleaning) likely to come into contact with micro-organisms shall be rounded for proper cleaning. When surfaces inside the working space are examined without magnification by normal or corrected vision, there shall be no cracks or surface defects.
- b) Each BSC must have an airflow indicator with audible alarm for incorrect airflow fitted in a position where it is easily visible to the users.
- c) If the BSC is to be connected to an external mechanical exhaust system, first examine the location to ensure that it is compatible with the cabinet's exhaust outlet. Sufficient make-up air into the laboratory is required for the exhaust (quite

substantial for Class I and Class IIB2 cabinets) and whether the current ventilation design is sufficient for this should be checked.

- d) The electrical outlet that the BSC plugs into should have a dedicated circuit breaker. This will prevent the accidental shutdown of the cabinet, should another device overload the circuit.
- e) All service lines to the BSC should meet local building codes, and be equipped with an easily accessible external shut-off valve, should disconnection be required.

Work with Risk Group 3 biological agents requires detailed risk assessment to evaluate if the laboratories involved could meet with Biological Safety Level 3 requirements. Currently Risk Group 3 biological agents are not allowed to be handled in the laboratories at the Science Park.

8. Performance Tests for BSCs

- a) Primary Test
 - i. **Down flow Velocity and Volume Test (Class II BSC only):** to measure the velocity of air moving through the cabinet workspace.
 - ii. **Inflow (Face) Velocity Test:** to determine the calculated or directly measured velocity through the work access opening.
 - iii. **Airflow Smoke Patterns Tests:** to determine if the airflow along the entire perimeter of the work access opening is inward, if airflow within the work area is downward with no dead spots or refluxing, and if there is refluxing to the outside at the window wiper gasket and side seals.

- iv. **HEPA Filter Leak Test:** to determine the integrity of supply and exhaust HEPA filters, filter housing, and filter mounting frames while the cabinet is operated at the nominal set point velocities.
 - v. **Cabinet Leak Tests:** to determine if exterior surfaces of all plenums, welds, gaskets, and plenum penetrations or seals are free of leaks.
 - vi. **Containment Test (optional):** to determine the effectiveness of the cabinet in containing aerosols generated inside the cabinet.
 - vii. **Alarms and Interlocks Test:** to check that the alarms, such as airflow alarms and sash alarms, and interlocks are functional.
- b) Secondary Test
- i. **Lighting Intensity Test:** to measure the light intensity on the work surface of the cabinet.
 - ii. **Noise Level Test:** to measure the noise levels produced by the cabinets, as a guide to satisfactory mechanical performance.
 - iii. **Electrical Leakage and Ground Circuit Resistance and Polarity Tests:** to determine if a potential shock hazard exists.
 - iv. **UV Lamp Test:** to test the UV lamp if installed to ensure the germicidal efficacy of the light.

9. Installation of BSCs

The protection offered by a BSC can be severely compromised by its inappropriate location. A BSC unit should be located out of the traffic flow, and away from doors, openable windows, air supply registers, fume cupboards or laboratory equipment capable of generating air movement that could disrupt the containment provided by the inflow air at the front work opening. Poor location, room air currents, decreased airflow,

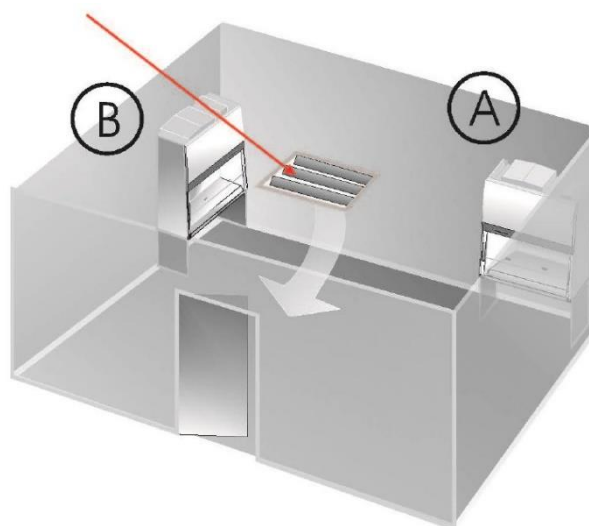
leaking filters, raised sashes, crowded work surfaces, and poor user technique compromise the containment capability of a BSC. For installation of a BSC, considerations should be carefully taken on proper siting, clearance and exhaust requirements.

9.1. Siting and Clearance

- a) All BSCs should be placed in a laboratory at a location that provides a minimum of:
 - i. 6 inches (150 mm) from adjacent walls or columns.
 - ii. 6 inches (150 mm) between two BSCs.
 - iii. 6 inches (150 mm) space between both sides of the cabinet and 6 inches (150 mm) behind the BSC to allow for service operations.
 - iv. 40 inches (1020 mm) of open space in front of the BSC
 - v. 60 inches (1520 mm) from opposing walls, bench tops and areas of occasional traffic.
 - vi. 20 inches (510 mm) between BSC and bench tops along a perpendicular wall.
 - vii. 100 inches (2540 mm) between two BSCs facing each other.
 - viii. 60 inches (1520 mm) from behind a doorway.
 - ix. 40 inches (1020 mm) from an adjacent doorway swing side.
 - x. 6 inches (150 mm) from an adjacent doorway hinge side.
- b) BSCs not connected to an exhaust system should have at least 12 inches (300 mm) clearance from the filter face and any overhead obstructions when the cabinet is in its final operating position, to allow for testing of the exhaust HEPA filter. Such clearance is also required if the use of a thermal anemometer exhaust velocity measurement is needed when calculating cabinet inflow velocity.

- c) The air curtain created at the front of the cabinet is quite fragile, amounting to a nominal inward and downward velocity of 1 mph. Open windows, air supply registers, portable fans or laboratory equipment that creates air movement (e.g., centrifuges, vacuum pumps) should not be located near the BSC. Similarly, chemical fume cupboards must not be located close to BSCs.
- d) For more information about the siting of a BSC, please refer to BS 5726: part 2 (1992) or AS2647 (1994).

Location A is the preferred location.
Location B is an alternate location. The air supply registers directly above or near the cabinet's location should be redirected away from the cabinet face.



Adopted from NSF/ANSI 49 Annex E (2016)

9.2. Exhaust Requirements

- a) If the BSC is to be connected to an external mechanical exhaust system for exhaust to outdoors:
 - i. First examine the location to ensure that it is compatible with the cabinet's exhaust outlet.
 - ii. It is preferable to exhaust the discharge air by a dedicated extraction system. Ducting should be under negative pressure with an exhaust fan sited at the distal end of the ducting with duct length greater than 2 meters or should be air tight with duct length less than 2 meters.

- iii. The discharge should be sited in consideration of the airflow pattern around the building and should be away from the open windows or air intakes of the same and neighboring buildings. The external wind pressure at the exhaust opening up to 250 Pa should not affect the performance of the cabinet.
 - iv. The cabinet shall be fitted with an automatic anti-blowback system downstream of the filters to prevent air flowing back into the cabinet.
 - v. There should be sufficient make up air to the room where the cabinets are located.
- b) For Class IIA BSC where exhaust air is re-circulated back to the laboratory, exhaust point such as nearby fume cupboards, open windows should be available for the exhaust of the fumigant after fumigation.

10. Operation and Maintenance

- a) Most BSCs are designed to permit operation 24 h/day. Cabinets should be turned on at least 5 min before beginning work and after completion of work to allow the cabinet to “purge”, i.e. to allow time for contaminated air to be removed from the cabinet environment.
- b) Open flames should be avoided in the near microbe-free environment created inside the BSC. They disrupt the air flow patterns and can be dangerous when volatile, flammable substances are also used. To sterilize bacteriological loops, the use of microburners or electric “furnaces” is preferable to open flames.
- c) Ultraviolet lights are not required in BSCs. If they are used, they must be cleaned weekly to remove any dust and dirt that may block the germicidal effectiveness of the light. Ultraviolet light intensity should be checked when the cabinet is

recertified to ensure that light emission is appropriate. Ultraviolet lights should be turned off while the room is occupied, to protect eyes and skin from inadvertent exposure.

- d) The sash of the cabinet must not be raised when work is in progress in the cabinet.
- e) Apparatus and materials in the cabinet during operation should be kept to a minimum.
- f) All materials should be placed as far back in the cabinet as practical, toward the rear edge of the work surface and away from the front grille of the cabinet. The front grille must not be blocked with papers or equipment items.
- g) Good laboratory practices are still required during the operation in the cabinet. For example, techniques to reduce splatter and aerosol generation will minimize the potential for personnel exposure to infectious materials manipulated within the cabinet.
- h) It is recommended by some manufacturers that the cabinet should be left running with its sash shut when it is not in use. If not, it should be run for 5 min in order to purge the atmosphere inside before it is switched off.
- i) The inspection certificate of the safety cabinet should be checked to make sure that it is regularly inspected with satisfactory results.
- j) All repairs made on BSCs should be made by qualified personnel. Any malfunction in the operation of the BSC should be reported and repaired before the BSC is used again.
- k) HEPA filters, whether part of a building exhaust system or part of a cabinet, will require replacement when they become loaded to the extent that sufficient airflow can no longer be maintained. In most instances, filters must be decontaminated before removal. To contain the formaldehyde gas typically used for

microbiological decontamination, exhaust systems containing HEPA filters require airtight dampers to be installed on both the inlet and discharge side of the filter housing. This ensures containment of the gas inside the filter housing during decontamination. Access panel ports in the filter housing also allow for performance testing of the HEPA filter.

10.1. Annual Certification

The operational integrity of a BSC must be validated before it is placed into service and after it has been repaired or relocated. Relocation may break the HEPA filter seals or otherwise damage the filters or the cabinet. Each BSC should be tested and certified at least annually to ensure continued, proper operation. The functional operation and integrity of each BSC should be certified to national or international performance standards at the time of installation and regularly thereafter by qualified personnel, according to the manufacturer's instructions. Evaluation of the effectiveness of cabinet containment should include tests for cabinet integrity, HEPA filter leaks, downflow velocity profile, face velocity, negative pressure/ventilation rate, air flow smoke pattern, and alarms and interlocks. Optional tests for electrical leaks, lighting intensity, ultraviolet light intensity, noise level and vibration may also be conducted.

Maintenance record with test results and dates shall be displayed on each BSC for easy reference.

10.2. Cleaning and Disinfection

All items within BSCs, including equipment, should be surface-decontaminated and removed from the cabinet when work is completed, since residual culture media may provide an opportunity for microbial growth.

The interior surfaces of BSCs should be decontaminated before and after each use. The work surfaces and interior walls should be wiped with a disinfectant that will kill any microorganisms that might be found inside the cabinet. At the end of the work day, the final surface decontamination should include a wipe-down of the work surface, the sides, back and interior of the glass. A solution of bleach or 70% alcohol should be used where effective for target organisms. A second wiping with sterile water is needed when a corrosive disinfectant, such as bleach, is used.

Potentially contaminated materials should not be brought out of the cabinet until they have been surface decontaminated or enclosed in a closable container for transfer to an incubator, autoclave or for other decontamination treatment.

10.3. Decontamination

The most common decontamination method is by fumigation with formaldehyde gas. BSC decontamination should be performed by qualified personnel.

Gas decontamination should be carried out:

- a) before maintenance;
- b) before certification;
- c) before the HEPA filters are changed;
- d) before the cabinet is relocated; or
- e) when there is a large spill of infectious material in the cabinet.

11. Applicable Standards for BSCs

A BSC installed and used in the laboratories at the Science Park must meet any of the international standards quoted in the followings or other equivalent standards:

a) British Standard BS 5726:

Microbiological safety cabinets. Information to be supplied by the purchaser to the vendor and to the installer, and siting and use of cabinets. Recommendations and guidance

b) National Sanitation Foundation Standard NSF No.49:

Biosafety Cabinetry Certification

c) Australia Standard AS 2252:

Controlled environments Part 5: Cytotoxic drug safety cabinets (CDSC) - Design, construction, installation, testing and use

d) Australia Standard AS 2567:

Laminar flow cytotoxic drug safety cabinets

e) European Standard EN 12469:

Biotechnology - Performance criteria for microbiological safety cabinets

C14 Guidelines for Handling Human Clinical Samples

1. Introduction

In this document, human clinical samples refer to any biological materials collected primarily from human subjects for the purpose of diagnosis and research works at the Science Park. All these samples should be treated as infective, in other words, capable of transmitting human pathogens. To avoid laboratory acquired infection, laboratory personnel shall follow the safety guidelines laid down in this document which is prepared in accordance with universal / standard precautions and biosafety practices recommended by the Centre for Health Protection, Department of Health, Hong Kong Special Administrative Region and other international / local authorities. They should also refer to relevant sections of HKSTP's SHE Handbook for laboratory biological safety and other useful safety guidelines.

2. Hazards Associated with Clinical Samples

Typical types of clinical samples include urine, faeces, genital tract samples, skin and soft tissues, respiratory tract samples from nose, throat, eye and ear swabs and sputum, cerebrospinal fluid, pus, other fluids such as pleural, pericardial and joint aspirates, blood, bone marrow, biopsy samples, autopsy samples, forensic samples, etc. The main hazard from blood samples are blood borne viruses such as hepatitis B virus (HBV) and human immunodeficiency virus (HIV). Sputum samples and specimens of lung tissues may contain *Mycobacterium tuberculosis*. Samples of neurological origin may contain disease form prion proteins, while faeces may contain various other pathogens.

Based on the classification as described in the Laboratory Biosafety Manual issued by the World Health Organization (WHO), infective microorganisms are classified into 4

Risk Groups (for more information, please refer to the Laboratory Biological Safety Guidelines, Section C03, Part II, SHE Handbook of HKSTP). As human pathogens associated with clinical samples may not be fully recognized, they are usually taken as containing at least Risk Group 2 microorganisms and handled with basic biosafety measures pertaining to Biosafety Level 2 laboratories. However, higher levels of biosafety practices, containment, and facility design may be required as necessary according to risk assessment. Samples known to contain Risk Group 3 or 4 microorganisms shall not be handled in laboratories at the Science Park as currently Biosafety Level 3 or 4 laboratories are not allowed in the Park.

3. Requirements on Sample Identification

Properly keeping Information and documentation regarding each clinical sample is an essential part of the laboratory management. Laboratory is required to have a chain-of-custody protocol describing the documentation of sample transfer from the time of collection until final disposition to ensure sample information is authentic and traceable to the sample donor. Each sample container and chain-of-custody form needs to contain sufficient information including the source and nature of sample, unique identification number, location of collection and time and date of collection.

4. Requirements on Facility Design

Subject to the risk assessment result, human clinical samples shall be handled in laboratories of at least Biosafety Level 2 (BSL2). For details of the requirements on facility design, please refer to the Laboratory Biological Safety Guidelines, Section C03, Part II, SHE Handbook of HKSTP).

5. Requirements on Laboratory Personnel

5.1. Training of Personnel

All laboratory personnel who are involved in handling human clinical samples shall be trained in basic biological safety. They should understand the safe working practices including personal hygiene, appropriate use of personal protective equipment (PPE), good microbiological techniques, safe use of equipment, proper disinfection and waste disposal procedures, emergency procedures, etc. Personal training records shall be properly documented.

5.2. 5.2 Health Surveillance and Immunization

Health surveillance should be provided to all laboratory personnel to ensure their health at work. The program should encompass the followings:

- a) Pre-employment check
- b) Provision of immunization where indicated
- c) Keeping of baseline sera (advisable)
- d) Medical surveillance to monitor personnel sickness through reporting and recording of illness and absence
- e) Provision of medical care as necessary
- f) Proper record keeping

6. Requirements on Handling Procedures

6.1. Sample Packaging, Transportation and Acceptance

- a) The following triple packaging system shall be used for local transport:
 - i. The primary receptacle containing the sample must be watertight, leakproof, and the contents properly labeled. Samples should be kept upright to avoid leakage.

- ii. A second watertight, leakproof packaging encloses and protects the primary receptacle(s). Laboratory related forms or document must be placed outside the secondary packaging.
 - iii. The third layer of outer packaging protects the secondary packaging from physical damage while in transit and should have adequate strength for its capacity, mass and intended use.
- b) The sample package shall be labeled with “Biohazard” symbol and information that describes its content and identifies the originating and recipient company / institution and personnel.
 - c) Corresponding UN recommendations and IATA guidelines should be referred to for international transport.
 - d) A designated area is needed for receiving samples in the laboratory. It should be at least a bench or table with a smooth impervious work surface that is resistant to disinfectants. Facilities for disinfecting the area, including appropriate disinfectant at in-use dilution, disposable absorbent wiping material and disposable plastic gloves are in the vicinity.
 - e) Upon receipt of the samples, laboratory personnel should wear appropriate personal protective equipment (PPE) such as laboratory coat, gloves and goggles/splash shield and check for any damage of the containers, spillage or leakage of the contents.

6.2. Laboratory Practices

- a) Laboratory personnel shall adopt good microbiological techniques and observe personal hygiene when handling human clinical samples.
- b) Standard operating procedures (SOPs) for general works of the laboratory and for each specific equipment and diagnostic / research protocol should be established and followed. Apart from the basic precautions and SOPs as mentioned above, additional

safety practices should also be devised if necessary subject to the risk assessment results.

- c) Incorporating the principles of universal or standard precautions in the clinical setting, the following basic safety practices shall be adopted for handling human clinical samples:
- i. Restrict access to laboratory to authorized persons and keep doors closed;
 - ii. Each procedure should be conducted in a designated area of the laboratory with sufficient space for safe working;
 - iii. The designated working area should be kept clear of any unnecessary equipment;
 - iv. Minimize generation of splashes and aerosols. All aerosol generating procedures shall be performed in an appropriate biosafety cabinet;
 - v. Appropriate PPE including a minimum of laboratory coat, gloves and goggles/splash shield should be worn when handling human clinical samples. Additional PPE such as mask should be worn according to the documented risk and risk assessment of the operation or whenever necessary;
 - vi. Protect the eyes and mouth by using a visor/goggles/safety spectacles and a mask where splashing is possible;
 - vii. Gloves shall be changed and hands washed after completion of sample processing;
 - viii. Cover all breaks in exposed skin by using waterproof dressings and suitable gloves;
 - ix. Wear closed footwear;
 - x. No mouth pipetting is allowed;
 - xi. When possible avoid the use of, or exposure to, sharps such as needles, glass, metal, etc. or if unavoidable take care in handling and disposal;

- xii. Needles must not be recapped; used needles shall be disposed of in an appropriate sharp container;
- xiii. Consider the use of devices incorporating safety features, such as safer needle devices and blunt-ended scissors;
- xiv. Clean and disinfect bench surfaces and any equipment immediately on completing a work session;
- xv. Wash hands after completing laboratory works and remove laboratory coat before leaving the laboratory;

6.3. Disinfection and Sterilization

- a) Disinfection should be carried out for the purpose of protecting laboratory personnel and the environment. It should be carried out by using an appropriate disinfectant (e.g. 10% household bleach) which has sufficient contact time;
- b) Benches and other work surfaces, including those in the sample reception, should be cleaned when necessary as well as before and after work;
- c) Areas spilled with human blood or other body fluids must be decontaminated immediately using disinfectant;
- d) Always wear suitable gloves when carrying out disinfection or decontamination;
- e) All used containers and laboratory tools should be sterilized by means of autoclaving after use;
- f) Reusable equipment and glassware arising from work in the laboratory should be made safe to handle by either autoclaving or disinfection where appropriate;
- g) Decontaminate all potentially contaminated areas and materials using appropriate methods / disinfectants before disposal or processing for re-use.

6.4. Waste Disposal

- a) Potentially infectious materials should be rendered non-infectious as far as possible before disposal.
- b) Otherwise, they are taken as clinical waste and must be segregated, labeled, stored and disposed of following legal requirements laid down in the Waste Disposal (Clinical Waste)(General) Regulation (Cap. 354O, Laws of HKSAR). For details, please refer to the Laboratory Biological Safety Guidelines, Section C03, Part II, SHE Handbook of HKSTP.

7. Emergency Response Procedures

Working with human clinical samples involves certain level of risk associated with unintended events such as accidents and incidents. Laboratories should have mitigation procedures outlined in an emergency response plan to address those unintended events. This plan should cover both events that could occur in the laboratory and events that occur outside the laboratory environment but directly impact laboratory operations. It should be based on a site-specific comprehensive risk assessment that allows the Laboratory Person In-Charge to prioritize the laboratory's response procedures according to the determined level of risk.

Common examples of unintended events such as spillage of samples containing pathogens, accidental exposure to the samples, failure of biosafety cabinet and autoclave, etc. should be included in the emergency response plan.

For spillage of potentially infectious human clinical samples, Laboratory Person In-Charge or other staff should follow the decontamination procedures delineated in the respective emergency response plan or those laid down in the Laboratory Biological

Safety Guidelines, Section C03, Part II, SHE Handbook of HKSTP. In the case of any accidental exposure to potentially infectious samples (including direct skin or mucous membrane contact), Laboratory Person In-Charge or other staff should assist the affected laboratory personnel in washing the exposed body parts and seeking medical consultation if necessary.

Regular drills should also be arranged to familiarize laboratory personnel with the emergency procedures.

8. Accidents and Incidents Reporting

All accidents and incidents involving spillage of potentially infectious human clinical samples or exposure to the samples shall be reported immediately to the Laboratory Person In-Charge. After decontamination or treatment following the emergency procedures, the Laboratory Person In-Charge should report the case to HKSTP timely using the Accident & Incident Report Form (Form L02).

9. References

- a) Guidelines on Biosafety in the Clinical Laboratory, Public Health Laboratory Services Branch, CHP, HKSAR, Feb 2008
- b) Safe Working and the Prevention of Infection in Clinical Laboratories and Similar Facilities, Health and Safety Executive (HSE), UK, 2003
- c) Work with Potentially Infectious Samples Including Blood, Blood Products, Human Tissues and Other Clinical Specimens, Safety Office, HKU, 2009

C15 Requirements for COVID-19 Related Research Projects

1. Introduction

An epidemic outbreak of Coronavirus Disease 2019 (COVID-19) was first reported to WHO in late Dec 2019 and the disease was then rapidly spreading globally. WHO announced COVID-19 as a pandemic in March 2020. The pathogen causing the disease has been identified and named as 2019 novel coronavirus (2019-nCov) by WHO. It was renamed as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses. COVID-19 is extremely transmissible from person to person and it imposes a public health emergency globally. Research scientists and medical professionals are working so hard to understand its epidemiology, transmission, clinical features, diagnosis, treatment, and prevention in order to stop the pandemic as soon as possible. While HKSTP supports local R&D companies for their efforts in fighting the disease, potential risk of laboratory-acquired infection and the safety risk to the community shall be carefully assessed for each research project. As the information with regard to the disease is very dynamic and expanded rapidly, the requirements in this document are set out according to the laboratory biosafety guidance currently established by the Department of Health and WHO. However, any updates or more recent publications from local and international advisory groups will be referred to mitigate health risk associated with COVID-19 related research projects to be conducted at the Science Park.

2. Basic Requirements

- a) All recommendations published by international and national health agencies (including WHO and CDC) have assigned SARS-CoV-2 as a Risk Group 3 organism.

As such, ONLY those COVID-19 related research projects involving non-propagative laboratory works with a laboratory setup at Biosafety Level 2 (BSL2) are permitted at the Science Park.

- b) “Laboratory Biological Safety Guidelines” (Section C03, Part II, SHE Handbook of HKSTP) and the “WHO Laboratory Biosafety Guidance Related to Coronavirus Disease (COVID-19) Interim Guidance” (the latest version) shall be strictly complied with.
- c) If the projects involve the handling of human clinical samples, “Guidelines for Handling Human Clinical Samples” (Section C14, Part II, SHE Handbook of HKSTP) is also applicable concurrently.
- d) Laboratory operators are required to submit all relevant information to HKSTP before starting the project. Necessary information is listed in Appendix 1 of this document.
- e) Prudent approach will be taken by HKSTP in ensuring the health and safety of workers in the laboratories and others in the community. Laboratory operators may be requested to complete a risk assessment for the workplace and activity-specific procedures involved if deemed necessary. Some COVID-19 research projects may require enhanced level of BSL2 (BSL2+) with additional biosafety practices and procedures typically found at BSL3 laboratories. These additional biosafety measures are listed in the next section.

3. Enhanced Biosafety Measures

Upon risk assessment, certain COVID-19 related research projects may be required to be conducted in a BSL2 facility with enhanced biosafety measures in addition to those requirements of a BSL2 laboratory. Such laboratory will be taken as of BSL2+. Typical enhanced biosafety measures are recommended below.

- a) No notebooks nor portable electronic devices can be taken in and out of the BSL2+ laboratory.
- b) There are provisions for information to be transmitted to the office area through a fax machine or a computer that is dedicated to the BSL2+ laboratory.
- c) A hands-free or automatically operated sink for hand washing is installed.
- d) The laboratory is accessible to authorized personnel only.
- e) Sharps such as Pasteur pipettes and needles are prohibited in the BSL2+ laboratory. Plasticware is substituted for glass.
- f) All works are conducted in the biosafety cabinets, including loading and unloading of centrifuge safety cups for the tabletop centrifuge located within the laboratory.
- g) Freshly prepared bleach solutions and 70% ethanol are available and utilized for disinfection of surfaces and equipment in the laboratory.
- h) Autoclave is utilized for decontamination of solid waste and qualitatively tested regularly to ensure cycle performance.
- i) If infectious samples must be moved out of the BSL2+ procedure room, they are enclosed in leakproof secondary containment and the outside of the secondary container is disinfected with an approved disinfectant prior to removing it from the room.

4. References

- a) WHO Laboratory biosafety guidance related to coronavirus disease (COVID-19), Interim guidance, 13 May 2020
- b) A Practical Guide to Implementing a BSL-2+ Biosafety Program in a Research Laboratory Elizabeth Gilman Duane* Environmental Health & Engineering, Inc., Needham, Massachusetts

- c) COVID-19: A Risk Assessment Perspective, Journal of Chemical Health and Safety, Imke Schroder, University of California Center for Laboratory Safety and the Dept. of Microbiology, Immunology and Molecular Genetics, UCLA. May 2020
- d) Laboratory biosafety measures involving SARS-CoV-2 and the classification as a Risk Group 3 biological agent, Pathology. 2020 Dec.

Table 3 Classification of SARS-CoV and SARS-CoV-2 by the Australian Government Department of Health, Centers for Disease Control (CDC) and World Health Organization (WHO)

	Australian Government Department of Health	CDC	WHO
SARS-CoV-2			
Risk Group Classification	Risk Group 3 (tentative)		
Non-propagative diagnostic laboratory work (routine diagnostic testing, sequencing, NAAT)	BSL-2	BSL-2	BSL-2
Propagative work (virus culture, neutralisation assays)	PC-3	BSL-3	BSL-3
SARS-CoV			
Risk Group Classification	Risk Group 3		
Non-propagative diagnostic laboratory work (sequencing, NAAT)	BSL-2	BSL-2	BSL-2
Propagative work (virus culture, neutralisation assays)	BSL-3	BSL-3	BSL-3

NAAT, nucleic acid amplification tests.

Appendix 1: Necessary information to be submitted to HKSTP for approval

1. Detailed project plan addressing the following aspects:
 - 1.1 Company information
 - 1.2 Project objective
 - 1.3 Scale of project and source of samples
 - 1.4 Location for conducting the project
 - 1.5 Methodologies and equipment
2. Laboratory containment design and layout plan:
 - 2.1 The locations for the major activities and equipment
 - 2.2 HAVC design with air flow directions
 - 2.3 Drainage system for discharging lab waste
 - 2.4 Access control
 - 2.5 Emergency shower and eyewash station
 - 2.6 Hand wash basin with hands-free or automatic faucet
3. Availability of laboratory safety equipment and PPE:
 - 3.1 Biological safety cabinet, type, certification status, and preventive maintenance record
 - 3.2 Chemical fume hood
 - 3.3 Emergency shower and eyewash station (if not indicated in the layout plan)
 - 3.4 Autoclave
 - 3.5 Personal protective equipment (PPE)
 - 3.6 Others
4. SOP for laboratory practices:
 - 4.1 Sample or specimen logistics, retention or disposal
 - 4.2 Identify high risk operations and infection control procedures
 - 4.3 Disinfection, inactivation and sterilization procedures
 - 4.4 Waste management procedures
 - 4.5 General emergency response procedures

4.6 Any other applicable procedures

5. Personal competence training on laboratory safety:

5.1 Degree in biological science related disciplines

5.2 Biological safety

5.3 Others

C16 Safety Guidelines for 3D Printing

1. Introduction

Three-dimensional (3D) printers are gaining popularity and being used in most of the laboratories for rapid prototyping and even small scale manufacturing. 3D printing refers to processes used to create a three-dimensional object in which material (thermoplastic filament or powder metal) is joined or solidified under computer control to create an object. However, this revolutionary process does not come without hazards. Numerous of hazards have been identified with the use of 3D printers. The purpose of this document is to provide laboratory personnel at the Science Park with basic information and general guidelines on safe operation of 3D printers.

2. 3D Printing Technology

There are different types of 3D printing technology such as fused diffusion modeling (FDM) / fused filament fabrication (FFF), multi jet printing (MJP), stereolithography apparatus (SLA), selective laser sintering (SLS) and metal 3D printing. FFF is the most common manufacturing technique utilized in 3D printer. This technology makes use of a solid thermoplastic which is forced through a computer-driven heated extrusion nozzle. Using a computer-generated image, a 3D printer heats and melts the feed materials, placing a layer of filament on top of one another on moving bed to form a precise 3D replica of image as the material cools and hardens.

Below shows some of the materials used in 3D printers:

- a) Polylactic acid (PLA);
- b) Acrylonitrile Butadiene Styrene (ABS);
- c) Polyethylene Terephthalate (PET) or Polyethylene Terephthalate Glycol-modified (PETG)

- d) Nylon Polyamide
- e) Polycarbonate
- f) High-impact Polystyrene (HIPS)
- g) Polyphenylsulfone (PPSF or PPSU)
- h) Metal powders
 - i. Reactive metals: Aluminum Alloys, Titanium and its Alloys
 - ii. Non-reactive metals: Steels, Bronze, Cobalt-Chrome Alloys, Gold, Silver

The temperature required for extruder depends on the type of materials ranges from 180° to 310°C. Some printers also have beds maintained at temperature of 50°C to 100°C. The heat beds are used because it can improve the printing quality by keeping the extruded plastic warm and thus preventing warping.

Thermoplastic filament and metal powder are potentially hazardous. Thus, it is important to understand the hazards associated with the 3D printer (s) to be used prior to purchasing and installing in Science Park.

3. Hazards Associated with 3D Printing

The potential hazards associated with 3D printing are related to the processes and technologies applied.

3.1. Chemical vapors exposure

Heating of certain thermoplastic filament can generate toxic vapors and vapors with high volatile organic compounds (VOCs). The printing materials, ABS, PLA and nylon, were reported as a source of dangerous VOCs such as styrene, butanol, cyclohexanone and ethylbenzene. Some studies found that the particle concentration from ABS material was 33-38 times higher than PLA material. The exposure from VOCs causes eye, nose and throat irritation, nausea, and organ damage.

3.2. Nanoparticle and metal powder exposure

Nanoparticles (ultrafine particles less than 100 nanometers) are one of the by-products emitted during the 3D printing process. The two most commonly used types of 3D printer media are PLA and ABS. When heated during the printing process, both media types produce large concentrations of nanoparticles. Nanoparticles are of concern because they are very small, have large surface areas and can interact with the body's system. Exposure to high concentration of nanoparticles can cause adverse health effect including cardio-respiratory mortality, strokes and asthma symptoms.

The inhalation and contact of metal powder should be aware during the loading and sieving process for metal 3D printer. Exposure to metal powders can initiate irritation, potential dermatitis and even neurological problems.

3.3. Exposure to hot surface

The extrusion nozzle and some moving bed needs to maintain at high temperature for operation. Temperatures of such magnitudes can create skin burns if users get in contact with the instrument's heat parts. Skin burns are also common when 3D printer users try to remove the melted plastics from the nozzle while the nozzle is still hot.

3.4. Mechanical hazard from moving parts

3D printers contain many moving parts such as stepper motors, pulleys, threaded rods, carriages and small fans. It may induce trapping hazard to users.

3.5. Electrical hazard

The majority of desktop 3D printers only contain regular internal fuses as electrical safety features. Users have the risk of exposure to high voltage during the maintenance works if the equipment covers are removed without turning off the power supply.

3.6. Exposure to radiation

Some 3D printers use ultraviolet light (UV) or laser in curing process. This poses a radiation hazard that can cause damage to eye and skin.

3.7. Exposure to corrosive and flammable chemicals

Chemicals are used in post-printing processes, such as in material surface finishing or for support material removal. Acetone or tetrahydrofuran (THF) are common solvents used in vapor polishing 3D prints which utilize solvent vapor to melt the surface slightly for achieving desirable surface smoothness. Acetone and THF are harmful and flammable which can create dangerous fumes when heated.

Some 3D printers require the use of alkali bath such as 2% sodium hydroxide (NaOH) solution to remove the extra supporting material surrounding each 3D printed item. NaOH is corrosive and can cause chemical burns and scarring.

3.8. Fire and Explosion

The use of certain metal powders such as titanium and aluminium in metal 3D printer poses a risk of fire or explosion if exposed to source of ignition. The source of ignition includes static electricity, hot surface, mechanically generated sparks and stray electrical currents.

3.9. Asphyxiation

3D metal printers typically use argon or nitrogen to create a non-combustible environment inside the printing chamber where particle welding or sintering takes place. However, should there be a leak in the system during maintenance checks or some other malfunctions, the possibility exists that these gases might collect in an enclosed printer or some other confined lab area creating an asphyxiation hazard.

3.10. Exposure to biological agents

3D printing has expanded its application to include printing of biological materials such as cells for engineered-tissue generation or scaffolding for lung tissue. Users may

expose to the aerosols generated in the process which are harmful to their health.

4. 3D Printing Hazard Control Measures

To ensure the health and safety of laboratory users, the management of each concerned laboratory shall observe the following hazard control measure requirements:

4.1. Risk assessment – Before purchase and installation of a 3D printer, a risk assessment should be conducted taking the followings into consideration:

- a) Type of printer such as metal 3D printer and thermoplastic filament printer
- b) Design of printer such as enclosure with interlock system, closed-loop system for metal powder loading, etc.
- c) Location for printer set-up
- d) Ventilation requirement for the printer

4.2. Facility and Building Services Requirements – The following requirements should be met for providing suitable environment or facility for laboratory users working inside:

- a) Ventilation – Many 3D printers are designed without exhaust ventilation or filtration provisions, therefore particulate, gas and vapor emissions can be problematic for areas without adequate ventilation. In general, 3D printers should be set up in areas with sufficient general ventilation. For those 3D printers using raw materials having potential of generating hazardous air contaminants during operation (subject to the risk assessment results), they should be connected to or located in areas with dedicated local exhaust systems.
- b) Laboratory design – Set up a designated area for work with 3D printer. Access control to the area should be implemented where large-scale printers or larger numbers of printers are installed. To reduce the fire hazard of using metal 3D printer, the printer should be static grounded by using anti-static mats. Oxygen

sensor should be installed in the laboratory area where those 3D printers required inert gas for operation.

- c) Signage – Post signs indicating the relevant hazards such as chemical emission, hot surfaces or radiation on or nearby printers.
- d) Waste storage – A designated area and labeled container for waste should be assigned following the requirements for storing chemical waste.
- e) Printing material storage – A suitable storage location such as chemical cabinet should be available for storage of printing materials. It is crucial to segregate printing materials according to their chemical compatibilities.
- f) Emergency facilities –Standard carbon dioxide and dry chemical fire extinguishers are appropriate for most thermoplastic or photopolymer printers. Class D fire extinguisher should be equipped where flammable or reactive metal powder are used for metal 3D printer. For the circumstances that significant amount of hazardous substances are involved in the 3D printing process, emergency shower, eyewash unit, spill kit and first-aid kit shall also be available at appropriate location in the nearby area.

4.3. Training of Personnel – All personnel working with 3D printers should receive training before commencement of work. The training should address the hazards associated with 3D printing, procedures to prevent exposure, personal protective equipment (PPE) and ventilation requirement, disinfection process of 3D printers involving biological materials and proper disposal of chemical waste.

4.4. Standard Operating Procedures (SOP) – SOP shall be written and approved for 3D printers. SOP is usually a concise document that provides general safety guidelines and

control measures, hazard information, training requirements and emergency procedures.

A copy of the SOP should be posted in the vicinity of the printer.

4.5. Personal Protective Equipment– Depending on the 3D printing process, the support materials and removal process, and all associated chemicals and materials, the following PPE shall be considered.

- a) Eye protection – Safety glasses or goggles appropriate for the chemical hazards must be used, particularly when loading liquid monomer reservoirs or using sodium hydroxide remover.
- b) Hand protection – Handling irritating plastic, uncured printing materials, or corrosive chemicals, chemical resistance gloves such as neoprene or nitrile gloves should be worn.
- c) Proper clothing and shoes – Wear closed-toe shoes or safety shoes, along with lab coat or long sleeve shirt and trousers without cuffs, when handling non-reactive metal powders and thermoplastic materials. Flame retardant lab coats and anti-static shoes should be worn for metal printing with reactive metals.
- d) Respirators – Suitable respirator such as N95 or P100 mask should be used when operates powdered metal printer, particularly when loading, leveling, changing filters, extracting or cleaning that involves reactive materials.

5. General Safe Work Practices for 3D Printing

Laboratory personnel shall adopt the following safety practices during the operation of 3D printers:

- a) All printers shall be installed according to manufacturer's requirement.

- b) Always use and properly maintain the manufacturer's supplied controls and filter system.
- c) Keep area clean and tidy to minimize dust accumulation. Work area should be cleaned daily with wet cleaning methods after operation.
- d) Avoid excessive storage of feed materials, solvent and corrosive chemicals in the lab area.
- e) Ensure the ventilation or local exhaust system is switched on when operating the printer.
- f) Ensure that printers with lasers or UV light are properly shielded to prevent eye exposure.
- g) Read the Safety Data Sheet (SDS) of the specific printer material used to understand the safety hazards and follow all safety requirements.
- h) Wear proper PPE when handling feed materials and accessing the stage area of the 3D printer after printing.
- i) Do not open the cover by overriding the interlock switch once a printing job has been started.
- j) Ensure that the nozzle, heater block, and motors have had sufficient time to cool before touching the printer will prevent any accidental burns.
- k) Printer should not be left unattended during operation for an extend period of time.
- l) Wash hands thoroughly after working with 3D printers.
- m) Handle and dispose of all waste materials including uncured material and cleaning materials in compliance with Waste Disposal (Chemical Waste)(General) Regulation (Cap. 354C). Always follow equipment manufacturer's procedure (if any) for passivation of metal powder prior to collection.

- n) A specialized wet HEPA vacuum must be used to capture reactive metal powders during cleaning of metal 3D printer.
- o) Report any defects or problems regarding a 3D printer to the Laboratory Person In-Charge and stop using it until the problem is fixed. Post a notice “DO NOT USE” on the printer to remind other laboratory personnel.

6. Emergency

Laboratory Person In-Charge should address the potential hazards of the 3D printers involved and the necessary safety measures to all concerned laboratory personnel. Suitable preparedness and arrangements should be in place to ensure that all laboratory personnel take appropriate actions in case of emergency.

In the event of minor spillage of printing material or cleaning material, it is important that nearby personnel are alerted so that exposure to hazardous chemicals is minimized. Always wear appropriate PPE when cleaning up a spill. Clean up the spill by chemical absorbents provided in spill control kit. Dispose of all contaminated materials including absorbents and protective clothing into a polythene bag provided in spill control kit for collection as chemical waste.

In case of larger scale of spillage or uncontrolled situation:

- a) Alert other people and evacuate the area immediately.
- b) Ventilate the area by opening the windows or activate the emergency ventilation system.
- c) Leave the laboratory and close the door.
- d) Report the incident to HKSTP following the “General Laboratory Emergency Procedures” in the SHE Handbook.

- e) Stay away from the laboratory and wait for assistance. Do not allow people to enter the laboratory or go to the nearby areas.

7. References

- a) 3D Printer Safety (2017), Environmental Health and Safety, Concordia University.
- b) 3D Printers - Health and Safety Hazards (2017), Environmental Health and Safety, University of Washington.
- c) 3D Printing with Metal Powders: Health and Safety Questions to Ask (2020), Nanotechnology Research Centre, National Institute for Occupational Safety and Health (NIOSH).
- d) 3D Printing with Filaments: Health and Safety Questions to Ask (2020), Nanotechnology Research Centre, National Institute for Occupational Safety and Health (NIOSH).

Appendix

Appendix 1 – Form L01 – Safety Assessment For Research Spaces

	Safety, Health and Environment Office	SHE Form L01
	Safety Assessment for Research Spaces	(Official use only) (此欄由本公司填寫) Reference No.:

Notes 注意:

- (i) Hong Kong Science and Technology Parks Corporation (HKSTP) requires applicants for all research spaces (including laboratories and workshops) at the Science Park to complete and return this form to HKSTP for safety assessment. Applications shall include relocation and change of use of existing space.
香港科技園公司要求科學園內的所有研究場所(包括實驗室及工場)之使用申請者填寫及提交此表格以作安全評估。此申請範圍包括搬遷及改變現有場所之用途。
- (ii) Applicants are required to fill in this form (including Table 1 and Table 2) carefully and provide the necessary information related to laboratory health and safety as highlighted in Table 2.
申請人必須小心填寫此表格(包括表一及表二)並提供所需有關實驗室健康安全的資料(在表二內所顯示的項目)。
- (iii) Applicants may be requested to submit a more comprehensive risk assessment (that identifies the necessary controls to prevent or mitigate risk to the laboratory personnel, environment and general public) for HKSTP's further evaluation.
申請人可能需要提交更全面的風險評估(確定必要的控制措施以防止或減輕對環境和公眾的危害)以供香港科技園公司進一步評估。
- (iv) Unless determined otherwise by HKSTP, the activities mentioned below are to be conducted only in laboratory-enabled premises and in accordance with HKSTP's laboratory and research safety policy and requirements.
除非香港科技園公司另有規定，否則下述活動只可於實驗室內進行，並符合香港科學園實驗室及研究之安全政策及要求。
- (v) Evaluation will be based on the approval criteria enlisted in Appendix 1.
評估會以附錄一之批核標準為根據。
- (vi) HKSTP offers no guarantee that the requested premises, facilities and laboratory related provisions can be accommodated.
香港科技園公司不保證可滿足申請人對於場所、設施和實驗室的要求。

I. General Information 一般資料		
1.	Name of company or division 公司或部門名稱	☐ New client 新客戶 ☐ Existing client 現有客戶
2.	Business address 商業地址	
3.	<u>Contact person 聯絡人</u> Name 姓名: Position 職位: Telephone no. 電話號碼: Email address 電郵地址:	
4.	Location of laboratory / workshop (only for existing client at the Science Park) 實驗室/工場位置(只適用於現有的科學園客戶)	
5.	Purpose of space request 場所要求之目的	
6.	Type of space required 所需場地種類	☐ Research lab 實驗室 ☐ Workshop 工場 ☐ Biological safety level 2 (BSL 2) lab 生物安全二級實驗室 ☐ Others 其他類別 (Please specify 請註明: _____)
7.	Function of space 用途	☐ Research 研究用途 ☐ Pilot plant manufacturing 試驗生產 ☐ Others 其他類別 (Please specify 請註明: _____)

8.	Nature of research 研究性質	☐ Animal study and drug testing 動物與藥物研究 ☐ Artificial intelligence 人工智能 ☐ Chemistry 化學 /Chemical Technology 化學技術 ☐ Construction / Transportation 建築/運輸 ☐ Electronics / Electrical Engineering 電子/電氣工程 ☐ Life Science 生命科學 /Biotechnology 生物技術 ☐ Material Science 材料科學 ☐ Mechanical Engineering 機械工程 ☐ Physics 物理學 ☐ Others 其他 (Please specify 請註明 : _____) (You may tick one or more items) (可以勾選一個或多個項目)

From Part II to X, please tick **Yes/No** for each question. Applicable local legislation (refers to Table 1 for details) and the document required (refers to Table 2 for details) are indicated in the right columns.

由第二至第十部份，請為每條問題勾選**是/否**。所適用的本地法規(法規名稱請參附表一)及所須提交之文件(文件名稱請參附表二)分別列明於右行。

II.	Chemicals / Dangerous Goods / Drugs 化學品/危險品/藥品	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
9.	Will you handle any hazardous chemicals / dangerous goods /drugs? 會處理危險化學品/危險品/藥物嗎?	☐	☐	R1 - R4	D1
10.	Will you use any compressed gas cylinders? 會使用任何壓縮氣瓶嗎?	☐	☐	R1	D2
11.	Is a Dangerous Goods licence required? 是否需要危險品牌照?	☐	☐	R1	
12.	Are there any controlled chemicals or drugs? 是否會使用受管制化學品或藥物?	☐	☐	R3 – R5	
13.	Will you handle any nanomaterials? 需要處理納米材料? If Yes 若是 – (i) The nanomaterials are in : 納米材料是 : ☐ Solution Form 溶液 and/or 及或 ☐ Powder Form 粉末 (ii) What safety measures will you implement to avoid exposure to nanomaterials? 採取什麼安全措施來避免接觸納米材料?	☐	☐		
14.	Will you install chemical storage cabinet? 會安裝化學品儲藏櫃?	☐	☐		
15.	Will you generate chemical waste? 會產生化學廢物? If Yes, please register as chemical waste producer with EPD 若是，請往環保署登記成為化學廢物生產者	☐	☐	R6	
III.	Biological Agents 生物物質	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
16.	Will you handle any microorganisms (e.g. viruses, bacteria, fungi, protozoa, etc.)? 會處理微生物(例如細菌、病毒、真菌、單細胞動物等)? Note: Biosafety Level 2 (BSL2) Laboratory shall be established for handling Risk Group 2 microorganisms. 注意: 2 級風險組別的微生物必須在生物安全 2 級實驗室內處理	☐	☐		D3
17.	Will you handle any animal cells, tissues or bodily fluids? 會處理動物的細胞、組織、體液等?	☐	☐		D4
18.	Will you handle any animals associated with potentially infectious agents or animals inoculated with microorganisms? 會處理有機會受感染的動物或接種過微生物至體內的動物?	☐	☐		D5
19.	Will you handle any human cells, tissues, or bodily fluids? 會處理人類的細胞、組織、體液等?	☐	☐		D6
20.	Do you need to use biosafety cabinet? 會使用生物安全櫃? If Yes, which class of biosafety cabinet? 若是，使用那一類生物安全櫃? ☐ Class I ☐ Class IIA1 ☐ Class IIA2 ☐ Class IIB1 ☐ Class IIB2 ☐ Class III Note: Biosafety cabinet is necessary for handling Risk Group 2 microorganisms, animal or human cells/tissues/bodily fluids 注意: 二級危險性微生物、動物或人類的細胞/組織/體液必須在生物安全櫃內處理	☐	☐		
21.	Will you generate clinical (biological) waste? 會產生醫療(生物)廢物?	☐	☐	R6	

	If Yes, please state the method of clinical waste disposal: 若是，請說明如何棄置醫療物:				
IV.	Ionizing Radiation Sources 電離輻射源	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
22.	Will you handle any radioactive substances? 會處理放射性物質?	☐	☐	R7	D7
23.	Will you use any irradiating apparatus (e.g. X-ray equipment)? 會使用輻照儀器 (例如 X 射線設備)?	☐	☐	R7	D8
24.	If applicable, what safety measures will you implement to avoid exposure to ionizing radiation from radioactive substances and/or irradiating apparatus? 若適用，會採取那些安全措施來避免接觸由放射性物質及或輻照儀器所產生的電離輻射?	NA	NA		
V.	Sources of Non-ionizing Radiation and Magnetic Fields 非電離輻射和磁場源	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
25.	Will you use any high power (Class 3B or 4) laser equipment? 會使用高能量(3B 或 4 級)激光設備?	☐	☐		D9
26.	Will you use any devices capable of generating ultraviolet (UV) radiation? 會使用能產生紫外線輻射的設備?	☐	☐		D10
27.	Will you use any devices capable of generating strong intensity of radiofrequency or microwave radiation? 會使用能夠產生強烈無線射頻或微波輻射的設備?	☐	☐		D11
28.	Do you intend to use any devices capable of generating strong magnetic fields? 會使用能夠產生強磁場的設備?	☐	☐		D12
29.	If applicable, what safety measures will you implement to avoid exposure to the laser beam / radiofrequency / UV or microwave radiation / magnetic fields? 若適用，有那些相應安全措施來避免暴露於激光束/射頻/紫外線或微波輻射/磁場?	NA	NA		
VI.	Machinery / Boiler & Pressure Vessels 機械/鍋爐和壓力容器	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
30.	Will you use any machinery having moving parts associated with cutting, laceration, piercing, pinching hazards? 會使用具有轉動部份並能構成切割、裂傷、穿孔、擠壓危害的機械?	☐	☐	R8 – R10	D13
31.	Will you use any lifting appliance (LA) or lifting gear (LG)? 會使用任何起重設備(LA)或起重裝置(LG)?	☐	☐	R11	D14
32.	Will you use any boilers or pressure vessels, e.g. autoclave, steam or air receivers, etc.? 會使用鍋爐或壓力容器，例如高壓釜，蒸汽或壓縮空氣接收器等?	☐	☐	R12	D15
VII.	Exposure Control / Monitoring 通風和環境控制/監測	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
33.	Will you use fume cupboard for handling hazardous chemicals in the facility? 會使用通風櫃處理設施中的危險化學品? If Yes, what type of fume cupboard do you need? 若是，需要什麼類型的通風櫃? ☐ Fume cupboard without scrubber 沒有洗滌器的通風櫃 ☐ Fume cupboard with scrubber 帶有洗滌器的通風櫃 ☐ Fume cupboard with wash down system and scrubber 具有沖洗系統和洗滌器的通風櫃 ☐ Other special fume cupboard (Please name the type) 其他特殊通風櫃(請註明):	☐	☐		
34.	Are there any equipment (other than fume cupboard) require connection to local exhaust ventilation for proper discharge of air contaminants? 除通風櫃之外，是否有其他設備需連接到排氣裝置，以有效排出空氣污染物?	☐	☐		D16
35.	Will your research activities generate air contaminants, odors, steam or excessive heat? 研究活動是否會產生空氣污染物，氣味，蒸汽或過多的熱力? If Yes, what control measure(s) will you adopt to avoid exposure to these air contaminants, odors, steam or excessive heat? 若是，會採取什麼控制措施以避免暴露於這些空氣污染物、氣味、蒸汽或過多的熱力?	☐	☐		

36.	Will you install any of the following monitoring / emergency system(s) for safe processing of your research activities? 為安全進行研究活動，會否安裝以下的監測或緊急系統？ If Yes, please indicate the system(s) to be installed: 若是，請指出將安裝之系統： ☐ Gas sensor and alarm system 氣體探測器和警報系統 ☐ Room differential pressure gauge / sensor 房間壓差計 ☐ Emergency exhaust system 緊急排氣系統 ☐ Emergency alarm system 緊急警報系統 ☐ Others 其他 (Please state 請註明: _____) Note: Maintenance of negative pressure, and installation of differential pressure gauge, emergency exhaust and alarm systems are mandatory for wet laboratories. 注意: 濕式實驗室必須維持負壓及配備壓差計、緊急排氣和警報系統	☐	☐		
VIII.	Other Special Features 其他特別詳情	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
37.	Will any special installations / facilities be required in your laboratory areas? 實驗室區域是否需要特殊的裝置或設施？ If Yes, please tick the applicable items as listed below: 若是，請選擇以下所需之項目： ☐ Clean room 無塵室 ☐ Confined space 密閉空間 ☐ Cytotoxic drug safety cabinet 細胞毒性藥物安全櫃 ☐ Dangerous goods store 危險品貯存倉庫 ☐ Fire extinguisher (Class D) for metal fire 用於金屬火災的 D 類滅火筒 ☐ Fire extinguishing system (Total flooding) 整合性滅火系統 (e.g. FM200, etc.) ☐ Fire sprinkler system (Pre-action type) 預作用式灑水滅火系統 ☐ Positive pressure environment 正氣壓環境 ☐ Raised flooring or platform 升高地台 ☐ Waste treatment facilities 廢棄物處理設施 ☐ Others 其他 (Please state 請註明: _____)	☐	☐		
38.	Will your research / operations involve any significant high risk activities which are not specified above? 你的研究 / 操作涉及以上未有提及的高風險活動？ If Yes, please briefly describe the high risk activities: 若是，請概括描述該高風險活動： _____	☐	☐		
IX.	Utilities and Centralized Laboratory Provisions 中央實驗室設施及供應項目	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
39.	Do you need any of the following central laboratory provisions that may be available? 是否需要以下有可能提供之中央實驗室設施及供應？ If Yes, please indicate the required provision(s): 若是，請選擇以下所需之供應項目： ☐ Compressed air 壓縮空氣 (4 Bar) ☐ Compressed air 壓縮空氣 (7 Bar) ☐ Vacuum 真空氣壓 (450 mmHg) ☐ Purified Water 純水 (1 MΩ) ☐ De-ionized Water 去離子水 (18 MΩ) ☐ Nitrogen gas 氮氣 (99.99%; 5.5 bar) ☐ Carbon dioxide gas 二氧化碳 (99.9%; 4 bar) Note: The provisions vary depending on the premises. 注意: 以上所列之設施及供應，會按不同建築物而有所不同。	☐	☐		
40.	Do you need any other centralized facilities or equipment (e.g. uninterrupted power supply (UPS), heat exhaust / cooling for high power equipment, etc.)? 是否需要使用其他中央供應的設施(例如不間斷電源(UPS)、大功率設備的散熱/冷卻等)？	☐	☐		

	If Yes, please specify: 若是，請具體說明:				
X.	Safety Provisions 安全配備項目	Yes 是	No 否	Applicable Legislation 適用之法規	Document Required 所須之文件
41.	Will emergency response plan (ERP) be implemented? 是否設有緊急應變計劃?	☐	☐		D17
42.	Will Standard Operating Procedures (SOP) be established for potentially hazardous activities? 對於有潛在危險的活動，有否製訂標準操作程序?	☐	☐		
43.	Will proper firefighting equipment be provided? 會否提供適當的滅火器具?	☐	☐		
44.	Will emergency shower / eyewash unit be installed? 會否安裝緊急沖淋裝置/洗眼器?	☐	☐		
45.	Will proper personal protective equipment be provided? 會否提供適當的個人防護裝備?	☐	☐		
46.	Will first aid kit be provided? 會否提供急救箱?	☐	☐		
47.	Will hazardous substances spill kit be provided? 會否提供有害物質洩漏套裝?	☐	☐		

Table 1 Local Legislation for Compliance

表一 須要遵守的本地法規

I agree to follow all applicable local legislations (including but not limited to those listed below) in connection with my prospective operations at the Science Park. 我同意在科學園內進行預期的操作，會遵守所有相關的本地法規(包括但不限於以下所列出的)。		☐ Yes 是 ☐ No 否
Reg No. 號碼	Name of Legislation 法規名稱	
R1	Dangerous Goods Ordinance (Cap. 295) 危險品條例 (香港法例第 295 章)	
R2	Dangerous Drugs Ordinance (Cap. 134) 危險藥物條例 (香港法例第 134 章)	
R3	Control of Chemicals Ordinance (Cap. 145) 化學品管制條例 (香港法例第 145 章)	
R4	Hazardous Chemicals Control Ordinance (Cap. 595) 有毒化學品管制條例 (香港法例第 595 章)	
R5	Import & Export (Strategic Commodities) Regulations (Cap. 60G) 進出口條例 (香港法例第 60G 章)	
R6	Waste Disposal Ordinance (Cap. 354) 廢物處置條例 (香港法例第 354 章)	
R7	Radiation Ordinance (Cap. 303) 輻射條例(香港法例第 303 章)	
R8	Occupational Safety & Health Ordinance (Cap. 509) 職業安全及健康條例(香港法例第 509 章)	
R9	Factories & Industrial Undertakings (Abrasive Wheels) Regulations (Cap. 59L) 工廠及工業經營(砂輪)規例(香港法例第 59L 章)	
R10	Factories & Industrial Undertakings (Guarding & Operation of Machinery) Regulations (Cap. 59Q) 工廠及工業經營(機械的防護及操作)規例(香港法例第 59Q 章)	
R11	Factories & Industrial Undertakings (Lifting Appliances & Lifting Gear) Regulations (Cap. 59J) 工廠及工業經營(起重機械及起重裝置)規例(香港法例 第 59J 章)	
R12	Boilers & Pressure Vessels Ordinance (Cap. 56) 鍋爐及壓力容器條例(香港法例 第 56 章)	

Table 2 Document to be submitted for further safety review

表二 所需提交作安全評估之文件

I have attached the following necessary documents (please tick where appropriate in the table below) together with this application for submission to HKSTP. 我已經附上下列所需之文件(請在下表內鉤選)，連同這份申請一併提交給香港科學園。		☐ Yes 是 ☐ No 否
List No. 號碼	Name of Document 文件名稱	Attached 已附上
D1	List of chemicals, dangerous goods or drugs and their quantities 化學品、危險品或藥物及其數量的清單	☐
D2	List of gases and the quantity of cylinder 氣體名稱和氣瓶數量的清單	☐
D3	List of microorganisms involved and their corresponding risk groups 涉及的微生物清單及其風險組別	☐
D4	List of animal cells, tissues or bodily fluids 動物細胞、組織、體液等清單	☐
D5	List of animals associated with potentially infectious agents or animals inoculated with microorganisms 有機會受感染的動物或接種過微生物至體內的動物清單	☐
D6	List of human cells, tissues or bodily fluids 人類細胞、組織、體液等清單	☐
D7	List of radioactive substances 放射性物質清單	☐
D8	List of irradiating apparatus 輻照儀器清單	☐
D9	List of laser equipment having information about class of laser and if the laser beam is totally enclosed 激光設備清單：包含每種設備的激光類別、激光束是否完全被屏蔽等資料	☐
D10	List of devices or equipment capable of generating ultraviolet (UV) radiation 能夠產生紫外線的設備清單	☐
D11	List of devices or equipment capable of generating strong intensity of radiofrequency or microwave radiation 能夠產生強烈無線射頻或微波輻射的設備清單	☐
D12	List of devices or equipment capable of generating strong magnetic fields 能夠產生強磁場的設備清單	☐
D13	List of machinery involved having moving parts associated with cutting, laceration, piercing, pinching hazards 具有切割、裂傷、穿孔、擠壓等危險的機械清單	☐
D14	List of lifting appliance (LA) or lifting gear (LG) involved 起重設備或裝置清單	☐
D15	List of boilers or pressure vessels involved 鍋爐或壓力容器清單	☐
D16	List of equipment (other than fume cupboard) require connection to local exhaust ventilation for proper discharge of air contaminants 其他需要連接到排氣裝置(除通風櫃之外)以有效排出空氣污染物的設備清單	☐
D17	Emergency response plan (ERP) 緊急應變計劃	☐

This form is completed by the undersigned. 此表格由以下簽署者填寫。

Name:

姓名: _____

Position/ Designation:

職位: _____

Authorized Signature
with Company Chop:

公司蓋章及授權簽署 _____

Date:

日期 _____

Appendix 1 Approval Criteria with respect to Safety, Health & Environment (SHE)

附錄一 有關安全健康環境之批核準則

No.	Element of SHE 安全健康環境之元素	Approval Criteria 批核準則
1.	Chemicals and drugs 化學品/藥品	- The use and storage of chemicals / dangerous goods and drugs complies with relevant local legislation 化學品/危險品/藥品之使用及儲存符合相關法規 - The handling of hazardous chemicals conforms with HKSTP Corporation's safety requirements 危險化學物品之處理符合香港科技園公司之相關安全要求
2.	Biological agents 生物物質	- Highly infectious microorganisms (Risk Group 3 or 4) are not involved 不涉及處理高度傳染性的微生物 (風險組別 3 或 4) - Animals (including vertebrates and invertebrates) involved are not associated with any potentially infectious agents which may result in the spreading of diseases 不涉及處理有機會受感染及可傳染疾病的動物(包括脊椎及無脊椎動物) - Microorganisms of Risk Group 2 are handled in proper biosafety cabinets with Biosafety Level 2 practices 以適當的 2 級生物安全操作程序及在生物安全櫃內處理 2 級風險之微生物 - Animal or human cells, tissues or bodily fluids are handled in proper biosafety cabinets with Biosafety Level 2 practices 以適當的 2 級生物安全操作程序及在生物安全櫃內處理動物或人體之細胞、組織、體液等 - Biosafety cabinets are regularly maintained with proper disinfection and certification 會定期保養、消毒及檢驗生物安全櫃
3.	Ionizing radiation sources 電離輻射源	- The use of irradiating apparatus such as X-ray machines complies with relevant local legislation 輻照儀器(例如 X 射線設備)之使用符合本地之相關法規 - The use and handling of sealed or unsealed radiation sources complies with relevant local legislation 放射性物質之處理及使用符合本地之相關法規 - Sufficient shielding, PPE and safety measures are provided / employed to protect against personnel exposure to ionizing radiation 採取足夠之安全措施及使用適當的屏隔及防護衣物以避免接觸電離輻射
4.	Non-ionizing radiation / magnetic field sources 非電離輻射和磁場的來源	- The use of high power laser equipment (Class 3B or 4) conforms with international safety practices and HKSTP Corporation's safety requirements 高能量(3B 或 4 級)激光設備之使用符合相關國際安全守則及香港科技園公司之安全要求 - The use of UV devices conforms with international safety practices and HKSTP Corporation's safety requirements 可產生紫外線輻射的設備之使用符合相關國際安全守則及香港科技園公司之安全要求 - Devices capable of generating strong intensity of radiofrequency, microwave radiation or magnetic fields are used following proper safety measures and practices 採用適當的安全措施使用可產生強烈無線射頻、微波輻射或磁場的設備
5.	Hazardous wastes 有害廢棄物	Hazardous wastes including chemical, clinical and radioactive wastes are properly handled, packaged, stored and disposed of in compliance with local legislation 有害廢棄物包括化學廢料、醫療廢物及放射性廢物之處理、包裝、儲存及棄置均符合本地之相關的法規
6.	Boilers & pressure vessels 鍋爐和壓力容器	The use of boilers and pressure vessels complies with relevant local legislation 鍋爐和壓力容器之使用符合本地之相關法規
7.	Machinery 機械	- Moving parts of machinery are properly guarded following local legislation 根據本地相關法規之要求，機械之轉動部分安裝有適當之護罩 - Lifting appliances and lifting gears are properly installed, used and maintained with certifications following local legislation 根據本地相關法規之要求，適當地安裝、使用、保養及檢驗起重設備及裝置
8.	Ventilation 通風	- Laboratory areas where hazardous substances are handled are maintained under negative pressure 涉及處理危害物質的實驗室環境必須維持負壓 - Proper type of fume cupboard(s) is/are available for handling hazardous substances 使用適當類型的通風櫃處理危害物質 - Fume cupboards are exhausted at least 3 meters above the rooftop of a building 通風櫃之抽風出口必須置於建築物頂樓 3 米或以上 - Other local exhaust ventilation system(s) is/are available for extraction of air contaminants 安裝局部抽風系統以排放其他的空氣污染物 Note: Please refer to HKSTP Laboratory Design Guide for more information about the requirements for installation of fume cupboards 注意：有關通風櫃安裝要求之詳情，請參考香港科技園公司之實驗室設計指引
9.	Other high risk operations / conditions 其他高風險操作/狀況	- Proper safety measures shall be in place in case of other high risk operations and conditions 必須採取適當的安全措施及程序以進行或處理其他具高風險的操作或狀況 - Risk assessment shall be carried out based on the information provided by the applicant 將根據申請人提供之資料進行風險評估
10.	Safety Provisions 安全配備	- Necessary laboratory safety equipment shall be provided or installed. These include proper firefighting equipment, emergency shower and eyewash unit, spill kit, first aid kit, and personal protective equipment, etc. 提供實驗室所需之安全設施，包括滅火器具、緊急沖淋和洗眼器、危害物洩漏套件、急救箱和個人防護裝備等 - Emergency response plan and emergency procedures, etc. shall be established 制訂緊急應變計劃和程序等

Appendix 2 – Form L02 – Accident & Incident Report Form

	Safety, Health and Environment Office Accident & Incident Report Form	SHE Form L02
		(Official use only)
		Reference No.:

Note: This report form should be completed and sent to the Safety, Health & Environment (SHE) Office of HKSTP within 72 hours of the accident or incident. The information provided herein will be used for investigation and compiling accident statistics.

In case of work-related accident to employee resulting in death or partial incapacity, the concerned unit of HKSTP or the client should fill in the relevant form provided by the Labor Department of Hong Kong and return it in duplicate to the Commissioner for Labor within the statutory required period.

1. Accident / Incident Information		
Date:	Time:	Location:
Type of Area: ☐ Office ☐ Laboratory / Workshop ☐ Others (Please specify):		
2. Nature of Accident / Incident		
☐ Personal injury	☐ Fire / Explosion	☐ Spillage of hazardous substances
☐ Flooding	☐ Unpleasant smell	☐ Damage to property / equipment
☐ Others (Please specify):		
3. Personal Details (For the injured or person concerned)		
Name:	Sex: ☐ Male ☐ Female	
Post Title:	Phone No.:	
Division / Company Name:		
Company Address:		
Nature of Injury: ☐ Amputation ☐ Burn ☐ Contusion ☐ Fracture ☐ Laceration ☐ Sprain ☐ Others (Please specify):		
Part of Body Injured: ☐ Hand ☐ Leg ☐ Head / Face ☐ Eye ☐ Others (Please specify):		
The injured received medical treatment: ☐ Yes ☐ No		
The injured was hospitalized: ☐ Yes ☐ No		
The injured took sick leave: ☐ Yes (No. of days:) ☐ No		
4. Accident / Incident Reported By		
Name:	Signature:	
Post Title:	Date:	
5. Accident / Incident Report Endorsed By		
Name:	Signature:	
Post Title:	Date:	

	Safety, Health and Environment Office Accident & Incident Report Form	SHE Form L02
		(Official use only) Reference No.:

Please fill in details about the accident / incident in the next page.

6. Brief Description of Accident / Incident
7. Causes of Accident / Incident
8. Recommendation for Prevention of Recurrence

For Internal Use by SHE Office of HKSTP
Further investigation required: ☐ Yes ☐ No Investigation Report No.:
Accident / Incident Classification Code:
Accident / Incident Cause Code:
Remark:

Appendix 3 – Form L03 – Self-Inspection Checklist For Laboratories



Safety, Health and Environment Office Self-Inspection Checklist for Laboratories

SHE Form L03

Reference No.:

Part 1 – Particulars:

Name of Client:		Lab Location:	
Person In-Charge:		Post:	
Inspected By:		Post:	
Inspection Date:		Signature:	

Part 2 – Inspection Findings:

No.	Item	NA	Yes	No	Rectification (if “No”)	
					Action	Date Completed
1.	General Safety:					
1.1	Access control exits and functions					
1.2	Lab placard with necessary info at the entrance					
1.3	Pressure gauge functions and lab under negative pressure					
1.4	Emergency exhaust functions					
1.5	Exit sign illuminated					
1.6	Emergency escape route displayed					
1.7	Emergency escape route / aisle(s) clear without obstruction					
1.8	General ventilation system functions properly					
1.9	Local exhaust ventilation system(s) function(s) properly					
1.10	Walk-in enclosure / chamber can be opened from inside					
1.11	Good housekeeping					
1.12	Active lab working areas are free from foods and drinks					
1.13	Broken glass and sharps are kept in proper containers					
2.	Electrical Safety:					
2.1	Adaptor(s) / extension board(s) in compliance with standards					
2.2	Adaptor(s) / extension board(s) are used in a safe manner					
2.3	Extension boards are not placed near water source or location prone to water splash					
2.4	Extension boards are not placed inside fume cupboard(s)					
2.5	Electric cables are running on the floor with protection					
2.6	Live parts of electrical cables are not exposed					

No.	Item	NA	Yes	No	Rectification (if "No")	
					Action	Date Completed
3.	Dangerous Goods & Controlled Chemicals Regulatory Issues					
3.1	The quantities of chemicals kept are within the legal limits					
3.2	Valid DG license(s) for chemicals available					
3.3	The quantities of gas cylinders kept are within the legal limits					
3.4	Gas cylinders pressure tested within the preceding 5 years					
3.5	Valid DG license(s) for gas cylinders available					
3.6	Valid license(s) or permit(s) for other controlled chemical(s) available					
4.	Chemical Safety:					
4.1	Chemical inventory available and up-to-date					
4.2	MSDSs / SDSs for chemicals available					
4.3	Chemical containers are intact and properly labeled					
4.4	Chemicals are kept in accordance with their compatibilities					
4.5	Appropriate chemical storage cabinet(s) with hazard symbols available					
4.6	Chemicals on the floor are kept in secondary containers					
4.7	Liquid chemicals are kept in upright positions					
4.8	Liquid chemicals are kept below eye level					
4.9	Flammable chemicals are kept in spark-proof refrigerators					
4.10	Peroxide forming chemicals are labeled with the date opened					
4.11	SOP where necessary is available and followed					
4.12	Fume cupboard(s) function(s) properly					
4.13	Fume cupboard(s) tested and certified periodically with records displayed					
4.14	Air flow into the fume cupboard not obstructed					
4.15	Glove box properly exhausted					
4.16	Proper chemical waste containers clearly labeled with the type of waste available					
4.17	Chemical waste containers are properly kept with secondary containers					
4.18	Chemical waste is collected by licensed collector					
5.	Gas Safety:					
5.1	Gas cylinders properly secured					
5.2	Gas cylinders labeled as to contents					
5.3	Gas cylinders away from direct sunlight or ignition source					
5.4	Gas piping in good conditions					

No.	Item	NA	Yes	No	Rectification (if "No")	
					Action	Date Completed
5.5	Flame arrestor in use where appropriate					
5.6	Gas cabinet(s) function(s) properly					
5.7	Gas detector(s) installed where necessary and properly maintained / calibrated periodically					
6.	Biological Safety:					
6.1	All microorganisms being used are of Risk Group 1 or 2					
6.2	Microorganisms and clinical specimens are handled following Biosafety Level 2 practices					
6.3	Biological agents are properly kept in closed containers					
6.4	Biosafety cabinet(s) function(s) properly					
6.5	Biosafety cabinet(s) tested and certified periodically with records displayed					
6.6	Proper disinfectants for decontamination purpose are readily available					
6.7	Autoclave(s) examined within the previous 14 months					
6.8	Clinical waste is properly packaged, labeled and temporarily kept in suitable closed container(s) with signage					
6.9	Storage cabinet for clinical waste is lockable with proper signage and label					
6.10	Clinical waste is collected by licensed collector					
7.	Laser Safety:					
7.1	Warning sign displayed					
7.2	Warning light functions					
7.3	Laser stably mounted					
7.4	Switch control exists					
7.5	Laser beam not at eye level					
7.6	Laser beam not directed towards entrance or walkway					
7.7	Laser beam confined in enclosure with interlocking system					
7.8	SOP available and followed					
7.9	Away from reflective surfaces and flammables					
7.10	Local exhaust ventilation system is in place where necessary					
7.11	Proper firefighting equipment in the vicinity of Class 4 lasers					
8.	Ionizing Radiation Safety:					
8.1	Warning sign displayed					
8.2	Relevant and valid IA or RS license(s) available					
8.3	Users have been trained in radiation safety					

No.	Item	NA	Yes	No	Rectification (if "No")	
					Action	Date Completed
8.4	Users are personally monitored (using TLDs) on radiation exposure					
8.5	For open beam X-ray equipment: Warning light at the entrance functions					
8.6	For open beam X-ray equipment: X-ray beam is directed away from the operator, room entrance and walkway					
8.7	For open beam X-ray equipment: No flammables in the vicinity					
8.8	For closed beam X-ray equipment: Interlocking mechanism of the X-ray equipment enclosure functions properly					
8.9	Visible /audible alarm on the X-ray equipment is automatically activated when the equipment is energizing					
8.10	Sealed radioactive substances are wipe tested annually in accordance with legal requirements					
8.11	Unsealed radioactive substances are used in accordance with the licensing conditions					
8.12	Appropriate shielding available					
8.13	SOP available and followed					
8.14	Appropriate radiation survey meter available					
8.15	Radioactive waste is properly kept and disposed of in accordance with the licensing conditions					
9.	Non-ionizing Radiation / Magnetic Fields Safety:					
9.1	Warning sign displayed					
9.2	Hazard areas demarcated					
9.3	Appropriate shielding available for protection against exposure					
9.4	SOP where necessary is available and followed					
10.	Machinery / Equipment Safety:					
10.1	Moving parts of machinery properly guarded					
10.2	Abrasive wheel(s) is/are used in compliance with relevant legal requirements					
10.3	Valid user certificate(s) available					
10.4	Eye protectors are used where necessary					
10.5	Equipment capable of generating fumes / particulates / odors is/are exhausted by proper local exhaust ventilation system					
10.6	SOP where necessary is available and followed					
11.	Boilers and Pressure Vessels:					
11.1	Valid examination certificate(s) for boilers, steam receivers, air receivers, autoclaves, etc. are available					
11.2	Valid user certificate(s) for boilers, steam receivers,					

No.	Item	NA	Yes	No	Rectification (if "No")	
					Action	Date Completed
	autoclaves, etc. are available					
11.3	Air compressor(s) with air receiver(s) tested and certified with certification displayed					
11.4	SOP where necessary is available and followed					
12.	Lifting Appliances and Lifting Gear (LALG):					
12.1	Valid examination certificate(s) for cranes, pulley blocks, chains, wires, ropes, shackles, etc. are available					
12.2	Valid operator certificate(s) for fork-lift trucks, bulldozers, etc. are available					
12.3	SOP where necessary is available and followed					
13.	Safety Provisions:					
13.1	Firefighting equipment available and periodically maintained with record displayed					
13.2	Access to firefighting equipment unobstructed					
13.3	500 mm clearance for each fire sprinkler head maintained					
13.4	Emergency shower(s) available with signage(s)					
13.5	Emergency shower(s) periodically maintained with record(s) displayed					
13.6	Eyewash unit(s) available with signage(s)					
13.7	Eyewash unit(s) periodically maintained with record(s) displayed					
13.8	Access to emergency shower(s) and eyewash unit(s) unobstructed					
13.9	Appropriate type of spill kit(s) available and in good condition					
13.10	First aid kit(s) available and in condition meeting relevant legal requirements					
13.11	Necessary PPE available and in good conditions					
13.12	Emergency Response Plan or Procedures (where necessary) properly displayed					
14.	Furniture:					
14.1	Upholstery of lab chairs / stools is smooth, impervious and chemical resistant					
14.2	Benchtops of suitable material in good condition					
15.	Others:					

Appendix 4 – Form L04 – Laboratory Safety Orientation Checklist

	Safety, Health and Environment Office Laboratory Safety Orientation Checklist	SHE Form L04
		Reference No.:

Note:

1. This checklist serves to facilitate the safety orientation for new laboratory staff at the Science Park.
2. The corresponding Laboratory Person In-Charge or his/her delegate should brief the new laboratory staff as soon as possible after his/her reporting duty with the content in this checklist as a minimum.
3. Completed checklist shall be documented at the corresponding laboratory.

(I) Particulars of New Laboratory Staff:

Name:		Position:	
Signature:		Date:	

(II) Orientation Conducted By:

Name:		Position:	
Signature:		Date:	
Company/Division:		Lab Location:	

(III) Orientation Content: (please tick where appropriate)

(A) Health and Safety Policy of HKSTP and tenant:	
(i) ☐ General safety rules of HKSTP (e.g. HKSTP's Laboratory & Research Safety Policy, SHE Handbook, etc.)	(ii) ☐ General safety rules of tenant (e.g. company's health and safety guide, safety handbook, etc.)
(iii) ☐ Tour and facilities introduction (Including introduction of potential hazards)	(iv) ☐ Health & safety responsibilities (Including employer's and employee's responsibilities)
(B) General Safety:	
☐ Fire extinguishers and fire blankets	☐ Emergency shower and eyewash unit
☐ Floor plan, exit sign and evacuation procedures	☐ Ventilation system operation
☐ Location of first aid box and spill kits	☐ Electrical and mechanic safety introduction
(C) Use of Personal Protective Equipment (PPE):	
☐ Discussion on what PPE is required /will be issued	
☐ Brief description on the procedures for obtaining, cleaning, repairing, replacing and storing PPE	



Safety, Health and Environment Office
Laboratory Safety Orientation Checklist

SHE Form L04

Reference No.:

(D) Laboratory Safety:

(i) Laser safety: ☐ Additional training ☐ Use of PPE (e.g. laser goggles)	(ii) Radiation safety: ☐ Additional training ☐ Licenses / TLD ☐ Medical examination
(iii) Chemical safety: ☐ Standard operating procedures ☐ Operation of fume hoods ☐ Chemical storage cabinets ☐ Proper labeling and hazard symbols ☐ MSDS for chemicals in use ☐ Procedures to deal with minor chemical spill	(iv) Biological safety: ☐ Standard operating procedures ☐ Operation of biological safety cabinets ☒ Proper labeling and hazard symbols ☐ Operation of autoclave and related license ☐ Good microbiological practices ☐ Safe use of other equipment (e.g. cryostat, centrifuge, etc.) ☐ Procedures to deal with minor biological spill
(v) Chemical waste: ☐ Requirements for chemical waste packaging, labeling, storage, transport and collection	(vi) Clinical waste: ☐ Requirements for clinical waste segregation, packaging, labeling, storage, transport and collection

(E) Manual Handling Operation (MHO):

☐ Handling of gas cylinders	☐ Handling of chemical containers / carboys
☐ Handling of water carboys	☐ MHO risk assessment training

(F) Emergency Preparedness:

☐ Introduction to the company's emergency response plan	☐ Assigning two responsible persons for the first aid box
☐ HKSTP's emergency contact numbers	☐ Proper accident or incident reporting procedures

Appendix 5 – Form L05 – Risk Assessment Form



Safety, Health and Environment Office

Risk Assessment Form

SHE Form L05

Reference No.:

Name of Client:				Venue:			
Person In-Charge:				Tel:			
Description of Activity:							
Assessment Done By:				Date:			
Assessment Reviewed By:				Date:			
Hazard(s)	People at Risk	Existing Control Measure(s)	Risk Rating*	Proposed Action(s) to Further Reduce Risk	Residual Risk Rating*	Responsible Person	Completed By (Date)

*Note: Risk rating is based on the risk matrix as described in Appendix 1

Appendix 1 Risk Matrix

Risk rating is based on the following 5 x 5 risk matrix and is calculated according to this simple equation: **Risk Rating = Severity (S) x Likelihood (L)**

Severity Table		Likelihood Table	
Severity Index (S)	Description	Likelihood Index (L)	Description
5	Catastrophic (could result in death or permanent total disability, irreversible severe environmental damage, huge financial loss)	5	Almost certain (Is expected to occur in most circumstances)
4	Major (could result in serious injury or occupational illness, significant impact to the environment, major financial loss)	4	Likely (Will probably occur in most circumstances)
3	Moderate (could result in minor to moderate injury or illness, considerable impact to the environment, medium financial loss)	3	Possible (Might occur at some time)
2	Minor (could result in minor injury or illness, environmental impact, or financial loss)	2	Unlikely (Could occur at some time)
1	Insignificant (No injuries, low financial loss)	1	Rare (May occur only in exceptional circumstances)

Risk Matrix					
Likelihood of Occurrence	Severity of Consequences				
	Insignificant [1]	Minor [2]	Moderate [3]	Major [4]	Catastrophic [5]
Rare [1]	1	2	3	4	5
Unlikely [2]	2	4	6	8	10
Possible [3]	3	6	9	12	15
Likely [4]	4	8	12	16	20
Almost certain [5]	5	10	15	20	25

Risk Rating	Low [1 - 3]	Medium [4 - 9]	High [10 - 16]	Very High [20 - 25]
Action	Acceptable risk, no additional control measure is needed.	Monitor continuously and consider if any further remedial action is feasible to eliminate or reduce the risk.	Urgent remedial action is required and the work activity should be closely monitored for further safety enhancement.	The work activity must be suspended immediately till proper risk control measures are in place.

Appendix 6 – Form L06 – Job Hazard Analysis Form



Safety, Health and Environment Office
Job Hazard Analysis Form

SHE Form L06

Reference No.:

Name of Client:		Venue:	
Person In-Charge:		Tel:	
Title of Job / Operation:			
Item	Job Step	Potential Hazard	Control Measure

Analysis Conducted By: _____ **Signature:** _____ **Date:** _____

Appendix 7 – Form L07 – Laboratory Safety Clearance Form

	Safety, Health and Environment Office Laboratory Safety Clearance Form	SHE Form L07
		(Official use only) Reference No.:

Note:

1. Upon completion, this form must be returned to Lab FM of HKSTP for documentation or following up actions if necessary.

Part 1 – Particulars

Name of Client:			
Type of Client:	☐ Tenant ☐ Incubatee ☐ Licencee ☐ HKSTP ☐ Others:		
Lab Location:		Person In-Charge:	
Date Checked:		Phone No.:	
Checked By:		Signature:	
Witnessed By:		Signature:	

Part 2 – Checklist (please tick where appropriate)

No.	Check Item	Yes	No	NA
1.	All client's belongings (including chemical reagents, biological agents, experimental animals, radioactive substances, hazardous waste materials, laboratory equipment and apparatus) have been removed.			
2.	All work surfaces (including bench tops, floors, fume cupboard worktops, shelves, etc.) with potential hazardous substances contaminations have been cleaned and decontaminated.			
3.	Others:			
Remarks: 				

The Hong Kong Science & Technology Parks Corporation
(HKSTP)

Safety, Health, and Environment (SHE) Handbook

Part III

Ethics for Research Involving Animals & Humans

Section A Importance Of Ethics In Animal & Human Research

Innovative technology impacts human and animal healthcare. Companies in this industry often face a range of complex ethical choices during product research and development (R&D) that are part of their business decision-making. Since research ethics governs the standards of conduct for scientific researchers, demonstrating ethical practices in research reflects the **research integrity** of a company and can enhance its **reputation** in the industry. **Compliance to research ethics** can often smooth the path to regulatory approval and market adoption for a product. Moreover, it can be an enabling factor for the company when considering to working with other (especially larger) corporations and investors in the future.

It is in the best interest of companies to take proactive measures in all stages of R&D to ensure that high standards of research ethics are maintained. It is the **responsibility of companies** to comply with research ethics standards and guidelines for their conduct of R&D that involve humans and animals.

Further to the policy on research ethics which is stated at Part II, Section A01, Paragraph 7.2 of this SHE Handbook (Part II page A01-14), all HKSTP partner companies are responsible for complying with the ethics guides which are shown in the following sections:

- Section B) HKSTP Ethics Guide on Research Involving Animals
- Section C) HKSTP Ethics Guide on Research Involving Humans

The scope of “animal research” and “human research”, as well as the requirements for partner companies, are outlined in the corresponding guides. These guides are managed by the Biomedical Technology Cluster of HKSTP.

For enquiries:

- Enquiries for animal research ethics can be directed to: iacuc@hkstp.org
- Enquiries for human research ethics can be directed to: ethicsenquiry@hkstp.org

Section B HKSTP Ethics Guide On Research Involving Animals

Hong Kong Science and Technology Parks Corporation (HKSTP) Ethics Guide on Research Involving Animals

Short title: HKSTP Ethics Guide for Animal Research (“Ethics Guide”)

Effective: 2020-06-18

Version: 1

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Background

1. Innovative technology impacts human and animal healthcare. Companies in this industry often face a range of complex ethical choices during product research and development (R&D) that are part of their business decision-making. Since research ethics governs the standards of conduct for scientific researchers,¹ demonstrating ethical practices in research reflects the **research integrity** of a company and can enhance its **reputation** in the industry.

Compliance to research ethics can often smooth the path to regulatory approval and market adoption for a product. Moreover, it can be an enabling factor for the company when considering to working with other (especially larger) corporations and investors in the future.

2. It is **in the best interest of companies** to take proactive measures in all stages of R&D to ensure that high standards of research ethics are maintained. It is the **responsibility of companies** to comply with research ethics standards and guidelines, including, without limitation the following:
 - a)  International Guiding Principles for Biomedical Research Involving Animals (2012)
https://olaw.nih.gov/sites/default/files/Guiding_Principles_2012.pdf
 - b)  HK Code of Practice for Care & Use of Animals for Experimental Purposes (2004)
https://www.afcd.gov.hk/english/aboutus/abt_adv/files/Code_of_Practice_Care_and_Use_of_Animals_for_Experimental_Purposes_English.pdf
 - c)  EU Directive 2010/63/EU on the protection of animals used for scientific purposes
<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:276:0033:0079:EN:PDF>

For reference, please also refer to [Annex 1](#) for additional requirements related to animal research that companies must comply if applicable.

Scope of Animal Research Covered in this Ethics Guide

3. R&D that involve the use of **animals²**, i.e.,:
 - **live non-human vertebrates**, including (i) their independently feeding larval forms & (ii) fetal forms of mammals as from the last third of their normal development, and
 - **live cephalopods**,are referred to as “**animal research**” in this document.

Requirements for Partner Companies in HKSTP Premises

4. Research ethics review and clearance:
 - a) **Before a company is to start any animal research** as outlined in [point 3](#) above (including starting any housing of animals that will be used in its R&D activity), the company shall obtain **ethics clearance** of such new / revised / extended study to ensure appropriate ethical standards are being upheld for animal care and use.
 - b) An ethics clearance is normally in the form of an **ethics approval or exemption** that is provided/acknowledged by an **independent** animal research ethics committee (AEC) or institutional animal care and use committee (IACUC), after the relevant committee has carried out **ethics review** of the research study. The peer review process of ethics review is to ensure a proper balance between innovation and ethics.
5. Where to seek ethics review and clearance:

Ethics review and clearance may be obtained through the following channels:

 - a) If a company collaborates with a researcher in an organization that has an AEC/IACUC, such as those listed in [Annex 2](#), normally that external researcher will act as the study's Principal Investigator (PI) there and will apply for ethics review for the study. Such ethics review and approval may be extended to cover the part of the study that is conducted in HKSTP premises. (For BMT & InnoHK companies, please also see [Note 1 in point 7 \(c\).](#))

¹ <https://www.who.int/ethics/research/en>

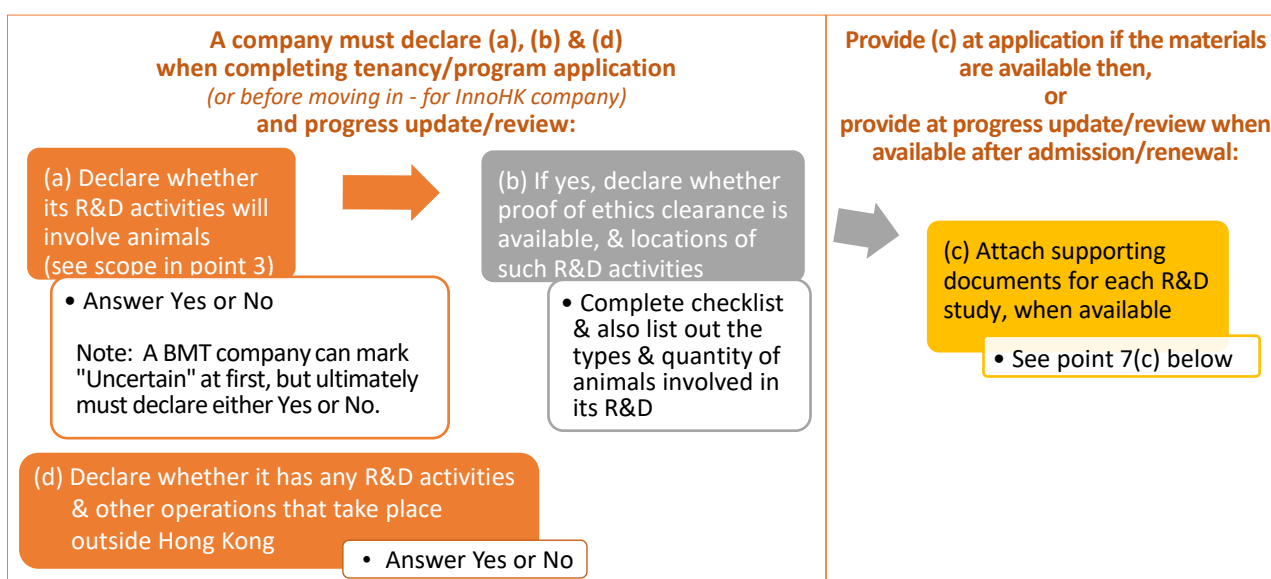
² Scope of animals that shall be protected. (Source: EU Directive 2010/63/EU – see Clauses 3 & 4 at Article 1, Chapter 1)

- b) If a company works with a clinical research organization (CRO) for the research study, normally the CRO will obtain ethics clearance for it.
- c) A company may form its own independent AEC/IACUC according to established guidelines.
- d) A company may seek ethics review through HKSTP IACUC once it is formed and commences operation.

6. Compliance:

- a) Obtain all necessary ethics clearance as outlined in [points 4 & 5](#) above.
- b) All procedures performed by the company shall be in accordance with the protocols approved by the AEC/IACUC.
- c) If any approval from AEC/IACUC is suspended or withdrawn, the company must cease all relevant animal research activities.
- d) To facilitate a company's ethics and regulatory compliance, the company is required to acknowledge and agree that representatives from an AEC/IACUC and/or the relevant government department(s) have a right by prior appointment to conduct periodic inspection/monitoring visits at the company's animal housing and laboratory areas and the company shall provide all assistance in relation to such visits, including allowing access of the relevant areas to such representatives and provide relevant information as may be requested.

Additional Requirements for Biomedical Technology (BMT) & InnoHK Companies in HKSTP Premises



7. A BMT company must declare and provide the following to HKSTP during tenancy/program application and progress update/review.³

Similarly, a company to be moved in to HKSTP premises under the InnoHK project (an “InnoHK company”) shall provide the same information and/or documentation on or prior to its moving in to its HKSTP premises and thereafter on each anniversary of its lease of the relevant premises as an update:

- a) **declare** whether its tentative, planned or on-going R&D activities during its tenancy/program period **involve animal research or not**, including those that will take place / have taken place:
 - in HKSTP premises, and/or
 - elsewhere in Hong Kong, if related to the company's R&D in HKSTP premises.
(eg. Drug safety test on rats for its IND in a lab at HKU;
Toxicology test using its technology on zebrafish embryos in a lab at Poly U)
- b) if yes, also **answer the checklist** at the “Ethical Considerations” section on the form, and

³ Application -- such as that for new tenancy applicants or existing tenants with expansion/reduction requests (using the online form, “Business Information & Suitability Assessment” (BISA)).

Progress update/review -- such as that for existing tenants (using the online form, “Annual Business Update” (ABU) which is accessible any time of the year at the “HKSTP Partners Connect” online system).

- c) **provide supporting document** for each animal research study for compliance as follows:
- If any part of the study will be done in HKSTP premises: Submission of a copy of the relevant ethics clearance is mandatory;
 - If any part of the study will be done outside of HKSTP premises: Submission of a copy of the relevant ethics clearance is recommended.

Types of animal research:	Indicate on checklist:	Supporting document as attachments on the form:
i) Involve live non-human vertebrates	Types & quantity of animals	Ethics clearance *
ii) Involve live cephalopods	Types & quantity of animals	Ethics clearance *
iii) Any other type of animal use	Please specify accordingly	Ethics clearance * may be necessary

* **Ethics clearance:** See [point 4](#) for examples.

Note 1) If ethics clearance of an animal research study has been obtained by the company's external collaborator (eg. PI in another organization), which covers the part of the research study in HKSTP premises, but the company cannot obtain a copy of that ethics clearance –

- The company can provide a copy of its email correspondence with the PI, or a statement issued by the company itself, which states that ethics approval for which part of the study in HKSTP premise has been obtained by which PI (name, title, department, his/her relationship with the company) at which organization for what ethics approval period, and any reference number (if available), by uploading this email/statement as proof of ethics clearance for the study.

- d) and also **declare** that it will comply with all relevant ethical and statutory requirements for its R&D activities and operations outside Hong Kong (if any).

8. If deemed necessary by HKSTP, a company shall provide further proof of ethical appropriateness of its R&D activities.

Dispute Resolution

9. If any matters arising from this Ethics Guide cannot be resolved between the company and HKSTP, HKSTP reserves the right to seek advice from relevant external experts.

Annex 1: Additional requirements related to animal research

Besides ethics compliance, companies and researchers also need to comply with local requirements where the animal research takes place and must obtain relevant licenses accordingly.

For reference, companies and its researchers in Hong Kong shall comply with the following ordinances and their regulations as applicable, but are not limited to:

- a)  Prevention of Cruelty to Animals Ordinance (HKSARG Cap. 169)
<https://www.elegislation.gov.hk/hk/cap169>
 - b)  Animals (Control of Experiments) Ordinance (HKSARG Cap. 340)
(for experimentation or teaching or attaining manual skills that involve the use of animals)
<https://www.elegislation.gov.hk/hk/cap340>
→ To apply for relevant permits for animal experimentations:
https://www.dh.gov.hk/english/useful/useful_alo/useful_alo.html
 - c)  Public Health (Animals and Birds) Ordinance (HKSARG Cap. 139)
(for research involving the import or export of animals)
<https://www.elegislation.gov.hk/hk/cap139>
→ To apply for relevant permit:
https://www.afcd.gov.hk/english/quarantine/qua_ie/qua_ie.html
 - d)  Rabies Ordinance (HKSARG Cap. 421)
(for research involving the import of animal carcasses and animal products (eg. plasma, skin))
<https://www.elegislation.gov.hk/hk/cap421>
→ To apply for relevant permit:
https://www.afcd.gov.hk/english/quarantine/qua_ie/qua_ie_ipab/qua_ie_ipab_iap/qua_ie_ipab_iap.html
 - e)  Import and Export Ordinance (HKSARG Cap. 60)
(for research involving the import or export of pharmaceutical products/medicines and dangerous drugs)
<https://www.elegislation.gov.hk/hk/cap60>
→ To apply for relevant approval:
https://www.drugoffice.gov.hk/eps/do/en/pharmaceutical_trade/guidelines_forms/useful_guidelines_forms.html
 - f)  Prevention and Control of Disease Regulation (HKSARG Cap. 599A)
(for research involving the import or transshipment of biological materials)
<https://www.elegislation.gov.hk/hk/cap599A>
→ To apply for relevant permit:
https://www.dh.gov.hk/english/useful/useful_forms/files/dh2465.pdf
 - g)  Pharmacy and Poisons Ordinance (HKSARG Cap.138)
<https://www.elegislation.gov.hk/hk/cap138>
→ To apply for relevant certificates & licenses:
https://www.drugoffice.gov.hk/eps/do/en/pharmaceutical_trade/guidelines_forms/useful_guidelines_forms.html
- and
- h)  Genetically Modified Organisms (Control of Release) Ordinance (HKSARG Cap. 607)
(for R&D involving genetically modified animals)
<https://www.elegislation.gov.hk/hk/cap607>
→ To apply for relevant permit / exemption:
https://www.afcd.gov.hk/english/conservation/con_gmo/gmo_control/gmo_control.html

**Annex 2: Local organizations which have established
AEC/IACUC for animal research**

Local organizations that have established animal research AEC/IACUC to provide ethical oversight for research studies that are carried out by their staff / students (for universities) or at their locations include the following. Companies shall discuss with them directly for any research collaboration opportunities and specifics of their research studies.

Universities:

- Chinese University of Hong Kong
- City University of Hong Kong
- Hong Kong Baptist University
- Hong Kong University of Science and Technology
- Hong Kong Polytechnic University
- The Open University of Hong Kong
- The University of Hong Kong

Other organizations:

- Hong Kong Jockey Club
- Ocean Park Hong Kong

Section C HKSTP Ethics Guide On Research Involving Humans

Hong Kong Science and Technology Parks Corporation (HKSTP) Ethics Guide on Research Involving Humans

Short title: HKSTP Ethics Guide for Human Research (“Ethics Guide”)

Effective: 2020-06-18

Version: 1

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Background

1. Innovative technology impacts human and animal healthcare. Companies in this industry often face a range of complex ethical choices during product research and development (R&D) that are part of their business decision-making. Since research ethics governs the standards of conduct for scientific researchers,¹ demonstrating ethical practices in research reflects the **research integrity** of a company and can enhance its **reputation** in the industry.

Compliance to research ethics can often smooth the path to regulatory approval and market adoption for a product. Moreover, it can be an enabling factor for the company when considering to working with other (especially larger) corporations and investors in the future.

2. It is **in the best interest of companies** to take proactive measures in all stages of R&D to ensure that high standards of research ethics are maintained. It is the **responsibility of companies** to comply with research ethics standards and guidelines, most notably the Declaration of Helsinki, without limitation the following:

- a)  Declaration of Helsinki (World Medical Association, 2013)
(the statement of ethical principles for medical research involving human subjects, including research on identifiable human material and data)
<https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/>
- b)  International Ethical Guidelines for Health-related Research Involving Humans (CIOMS/WHO, 2016)
<https://cioms.ch/wp-content/uploads/2017/01/WEB-CIOMS-EthicalGuidelines.pdf>

For reference, please also refer to [Annex 1](#) for common expectations of researchers for human research and [Annex 2](#) for other requirements (as applicable) that companies must comply if applicable.

Scope of Human Research Covered in this Ethics Guide

3. R&D that involve **human subjects**, including research on **identifiable**² **human materials**³ and **data**⁴, eg.
 - living individuals and their biological materials,
 - cadavers and cadaveric materials, or
 - human data (eg. collection, processing, manipulation or analysis of personal / health / genomic data)
 are referred to as “**human research**” in this document.
 - a) In general if coded private information, data, or specimens are used, a company’s research will be considered to involve human subjects unless it meets both of the following conditions:⁵
 - i) The company is not collecting samples by interacting or intervening with living people.
 - ii) None of the investigators or collaborators can identify the subjects through coded private information or specimens (eg. an investigator's access to their identities is prohibited by a written agreement).
 - b) If any investigator involved in the research can determine a subject's identity or has access to identifiers, the research is considered to involve human subjects and human subjects requirements apply.⁶

¹ <https://www.who.int/ethics/research/en/>

² **Identifiable:** carry a person’s name or is linked to a person by a code (Source: CIOMS/WHO 2016 guideline)

³ **Materials:** refer to biological materials including but are not limited to tissues, organs, blood, plasma, skin, serum, DNA, RNA, proteins, cells, hair, nail clippings, urine, saliva, or other bodily fluids (Source: CIOMS/WHO 2016 guideline in point 2b)

⁴ Including research on identifiable human material and data (Source: Declaration of Helsinki)

⁵ <https://www.niaid.nih.gov/grants-contracts/human-subjects#A9>

⁶ Same source as above.

Requirements for Partner Companies in HKSTP Premises

4. Research ethics review and clearance:

- a) **Before a company is to start any human research** as outlined in [point 3](#) above (including starting subject recruitment and data collection/analysis), the company shall obtain **ethics clearance** for such new / revised / extended study to ensure appropriate ethical standards are being upheld.
- b) An ethics clearance is normally in the form of **an ethics approval or exemption** that is provided/acknowledged by an **independent** research ethics committee (REC) or institutional review board (IRB) after the relevant committee has carried out **ethics review** of the research study.

i) About ethics review:

The peer review process of ethics review is to ensure a proper balance between innovation and ethics. An ethics review will consider, among other aspects --- the study design; provisions for minimizing risk; an appropriate balance of risks in relation to potential individual benefits for participants and the social value of the research; safety of the study site, medical interventions and monitoring safety during the study; and feasibility of the research. Scientifically unsound research involving humans is unethical in that it may expose them to risk or inconvenience for no purpose.⁷

ii) References to determine whether a study requires ethics approval:

- <https://www.bio.cam.ac.uk/psyres/approval>
- <https://www.bu.edu/researchsupport/compliance/human-subjects/determining-if-irb-approval-is-needed/>

5. Where to seek ethics review and clearance:

Ethics review and clearance may be obtained through the following channels:

- e) If a company collaborates with a researcher in an organization that has an REC/IRB, such as those listed in [Annex 3](#), normally that external researcher will act as the study's Principal Investigator (PI) there and will apply for ethics review for the study. Such ethics review and approval may be extended to cover the part of the study that is conducted in HKSTP premises. (For BMT & InnoHK companies, please also see [Note 1 in point 7 \(c\)](#).)
- f) If a company works with a clinical research organization (CRO) for the research study, normally the CRO will obtain ethics clearance for it.
- g) A company may form its own independent REC/IRB according to established guidelines.
- h) A company can also refer to [Annex 4](#) for some examples of other independent REC/IRBs that would review research studies of external parties.

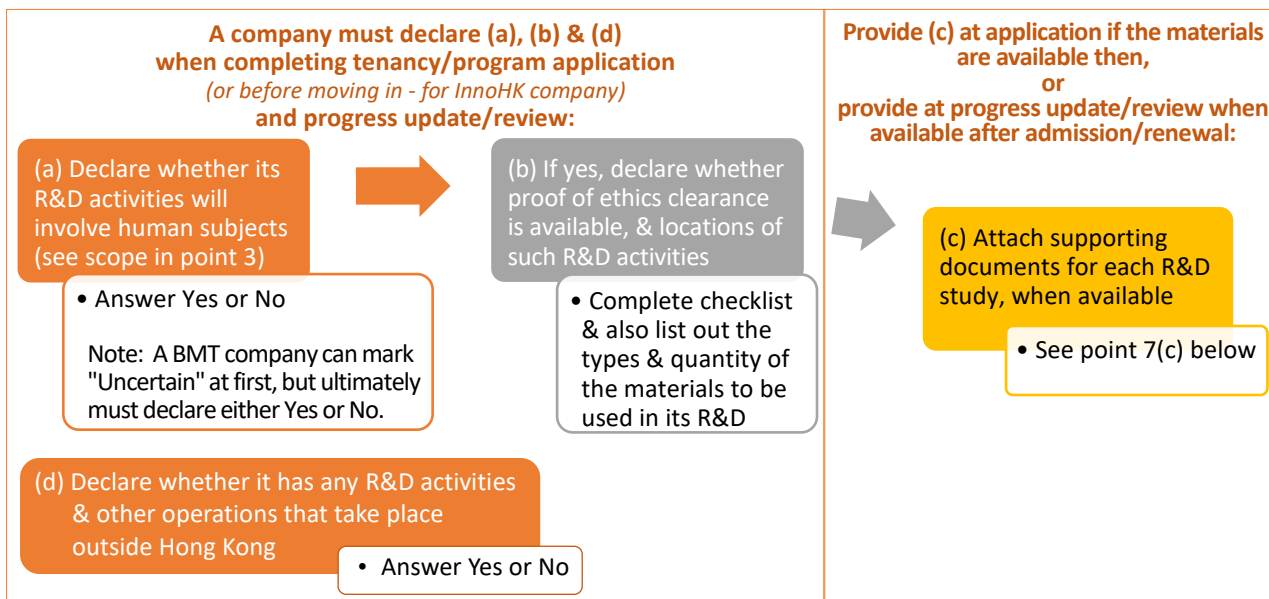
6. Compliance:

- a) Obtain all necessary ethics clearance as outlined in [points 4 & 5](#) above.
- b) All procedures performed by the company shall be in accordance with the protocols approved by the REC/IRB.
- c) If any approval from REC/IRB is suspended or withdrawn, the company must cease all relevant human research activities.
- d) To facilitate a company's ethics and regulatory compliance, the company is required to acknowledge and agree that representatives from an REC/IRB and/or the relevant government department(s) have a right by prior appointment to conduct periodic inspection/monitoring visits at the company's relevant areas and the company shall provide all assistance in relation to such visits, including allowing access of the relevant areas to such representatives and provide relevant information as may be requested.

⁷ See Guideline 23 "Requirements for establishing research ethics committees and for their review of protocols". (CIOMS/WHO 2016 guideline)

Additional Requirements for Biomedical Technology (BMT) & InnoHK Companies in HKSTP

Premises



7. A BMT company **must declare and provide the following** to HKSTP during tenancy/program application and progress update/review.⁸

Similarly, a company to be moved in to HKSTP premises under the InnoHK project (an “InnoHK company”) **shall provide the same information and/or documentation** on or prior to its moving in to its HKSTP premises and thereafter on each anniversary of its lease of the relevant premises as an update:

- declare** whether its tentative, planned or on-going R&D activities during its tenancy/program period **involve human research or not**, including those that will take place / have taken place:
 - in HKSTP premises, and/or
 - elsewhere in Hong Kong, if related to the company's R&D in HKSTP premises.
(eg. testing of its device on 50 caregivers at 2 HK elderly centers;
phase I/II trial of a biologic it is developing – on 20 patients at 3 hospitals in Hong Kong)
- if yes, also **answer the checklist** at the “Ethical Considerations” section on the form, and
- provide the following supporting document** for each human research study for compliance as follows:
 - If any part of the study will be done in HKSTP premises: Submission of a copy of the relevant ethics clearance is mandatory;
 - If any part of the study will be done outside of HKSTP premises: Submission of a copy of the relevant ethics clearance is recommended.

Types of human research:	Please indicate on checklist:	Supporting document as attachments on the form:
i) Involve identifiable materials of living individuals	Types & quantity of materials	Ethics clearance *
ii) Involve identifiable materials of cadavers	Types & quantity of materials	Proof of ethical acquisition & use of the cadaveric materials
iii) Involve living individuals (eg. clinical trials)	--	Ethics clearance *
iv) Involve cadavers	--	Proof of ethical acquisition & use of the cadavers

⁸ Application -- such as that for new tenancy applicants or existing tenants with expansion/reduction request (using the online form, “Business Information & Suitability Assessment” (BISA)).

Progress update/review -- such as that for existing tenants (using the online form, “Annual Business Update” (ABU) which is accessible any time of the year at the “HKSTP Partners Connect” system).

Types of human research:	Please indicate on checklist:	Supporting document as attachments on the form:
v) Involve identifiable human data	--	Ethics clearance *, unless there is proof that: • both conditions in (i) & (ii) of point 3(a) are met, or • the data are from openly shared source
vi) Any other type of human research not shown above	Please specify accordingly	Ethics clearance * may be necessary

* **Ethics clearance:** See [point 4](#) for examples.

Note 1) If ethics clearance of a human research study has been obtained by the company's external collaborator (eg. PI in another organization), which covers the part of the research study in HKSTP premises, but the company cannot obtain a copy of that ethics clearance –

- The company can provide a copy of its email correspondence with the PI, or a statement issued by the company itself, which states that ethics approval for which part of the study in HKSTP premise has been obtained by which PI (name, title, department, his/her relationship with the company) at which organization for what ethics approval period, and any reference number (if available), by uploading this email/statement as proof of ethics clearance for the study.

d) and also **declare** that it will comply with all relevant ethical and statutory requirements for its R&D activities and operations outside Hong Kong (if any).

8. If deemed necessary by HKSTP, a company shall provide further proof of ethical appropriateness of its R&D activities.

Dispute Resolution

9. If matters cannot be resolved between the company and HKSTP, HKSTP reserves the rights to seek advice from external experts.

Annex 1: Common expectations of researchers for human research

1. Research that involve humans should not be carried out unless the importance of the research objective outweighs the inherent risks & burdens to the human subjects. Every research project involving humans should be preceded by careful assessment of predictable risks in comparison with foreseeable benefits to the human subject or to others. Concern for the interests of the human subject must always prevail over the interest of science & society.
2. Determination of risks in research projects:
 - a) Risk may arise from both non-invasive & invasive procedures.
 - b) Non-invasive procedures are those which do not interact directly with the body (eg. asking patients to adopt a particular (normal) posture for measurement purpose).
 - c) Invasive procedures are those which interact directly with the body (eg. asking patients to take a drug or instilling a drug into the eyes).
 - d) In the social/psychological sense, invasive procedures are those which impinge on the right to privacy of the individual, in his or her personal life, or his or her medical & social records. In many respects, all social procedures are invasive, since it cannot be known what impact they may have on a particular individual.
 - e) Collection of personal data such as opinions, attitudes or beliefs through interviews, questionnaires, participant observation, diaries & letters, may involve psychological risk. Where no record is maintained of the individual's identity in a particular research study, breach of confidentiality is not an issue. However, there may be risks in terms of provoking anxiety or other undesirable states in the interview or questionnaire situation.
 - f) Normal routine clinical examination may involve the use of invasive procedures with potential risks, and consent to the clinical examination implies consent to have these procedures performed. However, if such procedures are performed as part of a project, then informed consent to participate in the project will normally be necessary after the potential risks involved in such procedures are clearly explained.
3. The following guidelines should also be observed:
 - a) For enrolling human subject(s) to participate in a research project:
 - Voluntary informed consent, in writing, should be obtained from any subject who is able to give such consent.
 - Most procedures of the project should be explained on an informed consent form written in simple language that is easily comprehensible by the potential subject.
 - The informed consent form should set out:
 - the purpose of the investigation or research study;
 - the procedures that the subject will go through;
 - the risks (including psychological distress);
 - the benefits, or absence of them, to the individual or to other or future individuals or to society;
 - procedures for protecting the confidentiality of subjects & their data ([see Annex 1 point 4\(e\) below for details](#));
 - a statement that the subjects may choose to decline to participate & also that they will be free to withdraw from the study at any time without giving a reason (and without in any way impairing their care); and
 - an invitation to ask questions.
 - Procedures involving no physical & psychological discomfort, such as measurement of height & weight, may be carried out after a simple explanation & a verbal response.
 - b) For prospective research projects that involve specimen collection:
 - Informed consent should be obtained from the patients/subjects concerned. Quantity of specimens to be collected should not exceed what is required for the research work.

- c) For research that involve DNA work:
- The specific nature of the genetic data and the purposes for which they should be collected, treated, used and stored are to be considered on the basis of ethically acceptable procedures, and should be in compliance with the International Declaration on Human Genetic Data (UNSECO, 2003)
4. Guidelines on ensuring confidentiality of research data:
- a) Research projects may involve collecting & storing data relating to individuals & groups, and such data, if disclosed to third parties, may cause harm or distress. Consequently, researchers should make arrangements for protecting the confidentiality of such data. Confidentiality is ensured by the researcher's ability to keep data sources protected and subjects involved in the project nameless.
 - b) The general principle is that at all times, the researchers & other collaborators shall deal with all data obtained through their project in such a manner as not to compromise the personal dignity of the subject and not to infringe upon the subject's right to privacy.
 - c) Information obtained in the course of a project should be considered privileged information & should under no circumstances be publicly disclosed in a fashion that would identify any specific person or organization (except if subpoenaed by a court).
 - d) Researchers must outline to prospective subjects the methods that protect the identity of subjects & information obtained in the course of the project.
 - e) Procedures for protecting the confidentiality of subjects and their data should be outlined in the informed consent form and include:
 - (i) securing individual confidentiality statements from all researchers;
 - (ii) coding data with numbers instead of names so as not to reveal to unauthorized persons the identity of the subjects (names and code numbers are kept in different locations);
 - (iii) maintaining data with any identifying information in a locked file to which only one or two identified investigators have access;¹
 - (iv) using pseudonyms for subjects, agencies & geographical settings in the publishing of reports (the keys to the pseudonyms are kept locked & in different locations); and
 - (v) disposing of information that can reveal the identity of subjects or places carefully (e.g. being burned or shredded rather than thrown into wastebaskets)
 - f) Under no circumstances shall the identity of the subject, or any information which may identify the subject, be revealed without the subject's adequate prior consent in writing.
 - g) When personal identifiers are used in a study, researchers should explain to the approving authority why this is necessary & how confidentiality will be protected.
 - h) In case where confidentiality is threatened, relevant records should be destroyed.
 - i) It is the researcher's responsibility to ensure that all pledges of confidentiality are strictly honored.
 - j) The steps to be followed to maintain confidentiality of data and the use to which data will be put, need to be revealed to the approving authority.

Reference:

Guidelines for Ethics Review of Research/Teaching Projects involving Human Subjects, Hong Kong Polytechnic University. <https://www.polyu.edu.hk/ro/publication/hsears/guide.pdf>

¹ The use of computers for processing the data collected for projects poses a special set of risks to anonymity, privacy & confidentiality. The security of the computer-stored data & project reports is of special concern. Security breaches may result in unauthorized access to data, possibly resulting in change to the data or even its loss, and use of data for purposes other than that for which informed consent of subjects allows. Substituting identification numbers for subjects' names on computer files & storing the files under lock & key are possible ways to prevent any accidental breach of confidentiality.

Annex 2: Additional requirements related to human research

Besides research ethics compliance, companies and researchers also need to comply with local requirements where the human research takes place and must obtain relevant licenses accordingly.

For reference, companies and their researchers in Hong Kong shall comply with the following ordinances and their regulations as applicable, but are not limited to:

- a)  Personal Data (Privacy) Ordinance (HKSARG Cap. 486)
<https://www.elegislation.gov.hk/hk/cap486>
<https://www.pcpd.org.hk>
 - b)  Import and Export Ordinance (HKSARG Cap. 60)
(for research involving the import or export of pharmaceutical products/medicines and dangerous drugs)
<https://www.elegislation.gov.hk/hk/cap60>
 ➔ To apply for relevant approval for import/export of pharmaceutical products:
https://www.drugoffice.gov.hk/eps/do/en/pharmaceutical_trade/guidelines_forms/useful_guidelines_forms.html
 - c)  Prevention and Control of Disease Regulation (HKSARG Cap. 599A)
(for research involving the import or transshipment of biological materials)
<https://www.elegislation.gov.hk/hk/cap599A>
 ➔ To apply for relevant permit:
https://www.dh.gov.hk/english/useful/useful_forms/files/dh2465.pdf
 - d)  Pharmacy and Poisons Ordinance (HKSARG Cap.138)
<https://www.elegislation.gov.hk/hk/cap138>
 ➔ To apply for relevant certificates & licenses:
https://www.drugoffice.gov.hk/eps/do/en/pharmaceutical_trade/guidelines_forms/useful_guidelines_forms.html
 - e)  Chinese Medicine Ordinance (HKSARG Cap.549)
<https://www.elegislation.gov.hk/hk/cap549>
 ➔ To apply for relevant certificate:
https://www.cmchk.org.hk/pcm/eng/#main_reg09.htm

*In relation to (d) & (e), a **certificate of clinical trial/medicinal test** for research involving living individuals must be issued by the Pharmacy & Poisons Board (PPB) for pharmaceutical products, and by the Chinese Medicine Council of Hong Kong (CMCHK) for proprietary Chinese medicines, before the clinical trial or medicinal test can be started in Hong Kong. The PPB and CMCHK would not review applications that do not have ethics approval.*
 - f)  Human Organ Transplant Ordinance (HKSARG Cap. 465)
(for research involving the use of human organs, blood & bone marrow)
<https://www.elegislation.gov.hk/hk/cap465>
 ➔ To apply for relevant approval:
https://www.dh.gov.hk/english/links/links_hot.html
 - g)  Human Reproductive Technology Ordinance (HKSARG Cap. 561)
(for research involving reproductive technology procedures, pre-implantation genetic diagnosis and use of embryos & gametes)
<https://www.elegislation.gov.hk/hk/cap561>
 ➔ To apply for relevant license:
<http://www.chrt.org.hk>
- and
- h)  International Declaration on Human Genetic Data (UNSECO, 2003)
(for research involving human genetic data)
<http://www.unesco.org/new/en/social-and-human-sciences/themes/bioethics/human-genetic-data/>
 - i)  General Data Protection Regulation (EU, 2016)
(for research involving any EU citizen, or for company that is subject to EU regulation)
https://www.pcpd.org.hk/english/data_privacy_law/eu/eu.html

Annex 3: Local organizations which have established REC/IRB for human research

Local organizations that have established human research REC/IRB to provide ethics oversight for research studies that are carried out by their staff / union members / students (for universities) or at their locations include the following. Companies shall discuss with them directly for any research collaboration opportunities and specifics of your research studies.

Universities:

- Chinese University of Hong Kong
- City University of Hong Kong
- Education University of Hong Kong
- Hong Kong Baptist University
- Hong Kong Shue Yan University
- Hong Kong University of Science and Technology
- Hong Kong Polytechnic University
- The Open University of Hong Kong
- The University of Hong Kong

Public hospitals and clinics:

- **those managed by the Hospital Authority**
--- *There are 6 clinical research ethics committees overseeing clinical studies in 7 public hospital clusters. Two of them, the HKU/HA HKW IRB and the Joint CUHK-NTEC CREC, are being jointly operated with HKU and CUHK respectively.*

Private hospitals and their clinics:

- Canossa Hospital
- CUHK Medical Center
- Evangel Hospital
- Gleneagles Hong Kong Hospital
- Hong Kong Adventist Hospital – Stubbs Road
- Hong Kong Adventist Hospital – Tsuen Wan
- Hong Kong Baptist Hospital
- Hon Kong Sanatorium & Hospital
- Matilda International Hospital
- Precious Blood Hospital
- St Paul's Hospital
- St Teresa's Hospital
- Union Hospital

Union / association:

- Hong Kong Doctors Union

Annex 4: Examples of independent REC/IRBs

Below are some examples of REC/IRBs that would review for external parties. Most of them are commercial IRBs. Companies shall discuss with them directly for your needs.

Location:	Examples of REC/IRBs:
Hong Kong	Hong Kong Human Research Independent Review Board (香港人類研究倫理審查委員會) https://hk-hr-irb.org/ <i>Note: It does not provide consulting service on how to prepare ethics review application. Companies can contact a CRO for assistance or refer to guidelines such as ICH-GCP E6 for preparation.</i>
Outside Hong Kong	REC/IRBs listed by <i>Citizens for Responsible Care and Research</i> (CIRCARE), a US non-profit national organization: http://www.circare.org/info/commercialirb.htm Those accredited by the <i>Association for the Accreditation of Human Research Protection Programs</i> (AAHRPP), an independent accrediting body that runs a voluntary accreditation scheme: www.aahrpp.org eg. Among those listed above, Western Institutional Review Board (WIRB) is known to have provided IRB review service to a Hong Kong company for its biomedical research: http://www.wirb.com Liverpool School of Tropical Medicine IRB, in the UK: https://www.lstmed.ac.uk/research/research-integrity/research-sponsorship-ethics

Note: All use English as the medium of language.

Supplementary Document – Chinese Version of HKSTP Safety, Health and
Environment (SHE) Handbook (Part I)

香港科技園公司

安全、健康及環境手冊

第一部份

基本安全、健康及環境要求

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Section A 政策聲明

A01 健康及安全政策

香港科技園公司致力為科技園處所內員工及訪客提供健康及安全的工作環境。透過推廣預防工傷及疾病的文化，讓員工、合作機構、供應商及承辦商肩負起個人責任。為此，我們將會：

- 在香港科技園定義清晰的健康及安全責任、角色及目的；
- 遵守適用的法例、守則及相關要求；
- 提供資源及培訓推廣健康及安全意識及文化；
- 以有系統的方法識別和管理健康及安全風險；及
- 監察、諮詢和檢視健康及安全政策及其成效，並邀請員工參與持續的改進工作。

A02 環境政策

香港科技園公司致力帶領推動環境管理。作為負責任的企業公民，我們致力執行以下政策以達到節能減廢、防止環境污染及減緩氣候變化。為此，我們將會：

- 以有系統的方法管理日常運作及設施帶來的影響；
- 採納創新、具有成本效益的技術，以及實踐持續改進的最佳做法；
- 向各級員工培養對環境負責的工作文化；
- 促使合作公司、供應商及承辦商了解我們的環境標準並參與其中；及
- 履行我們的合規責任，並向利益相關者展現成效。

Section B 安全、健康及環境的重要性

B01 安全、健康及環境期望

香港科技園公司的員工、租戶、培育公司及設施是我們最寶貴的資源。我們旨在提供安全、有保障的工作場所及以對環境無害的方式營運，這方面比所有業務都更為重要。有效執行安全、健康及環境計劃可預防受傷、控制損失並對環境的影響減到最少。我們期望科技園處所內所有租戶、培育公司及承辦商與我們共同努力，攜手建造一個對人及環境無害的工作場所。

在健康、安全及環境方面，每個人應履行以下責任：

- 在任何時候應遵守法律要求及香港科技園的安全和環境規定
- 積極執行健康、安全及環境措施
- 工作時，應關注自己及他人的安全及健康
- 報告與安全及健康事項有關的事件或意外事故
- 不得故意或魯莽地干擾或錯誤地使用為健康及安全所提供的任何資源

香港科技園安全、健康及環境手冊的製作旨在向所有租戶、培育公司及承辦商清楚說明香港科技園在安全、健康及環境方面的要求及期望。儘管如此，本手冊並不能取代或限制本地法例要求。不論安全、健康及環境的要求是否在本文中提及，租戶、培育公司及承辦商均有義務遵守適用於他們的相關要求，以確保其僱員及分包商了解這些要求。此外，我們對實驗室活動亦有其他要求及期望，因此租戶、培育公司及承辦商應參考安全、健康及環境手冊—實驗室及研究安全要求。

請參閱本文件開首部分的同意書。租戶、培育公司及承辦商的授權代表應在香港科技園處所開始工作前簽署同意書，並將副本遞交給香港科技園。簽署即代表同意及了解本文件要求。本文件的資料應向香港科技園人員、設施管理處 / 實驗室設施管理處、租戶、培育公司、承辦商及分判商傳閱並共同履行。

在搬進或開始在香港科技園處所工作前，租戶、培育公司及承辦商應聯絡有關香港科技園人員，並遵守安全、健康及環境手冊的要求。在香港科技園任何處所開始工作前，承

辦商必須在該大樓的接待處登記。

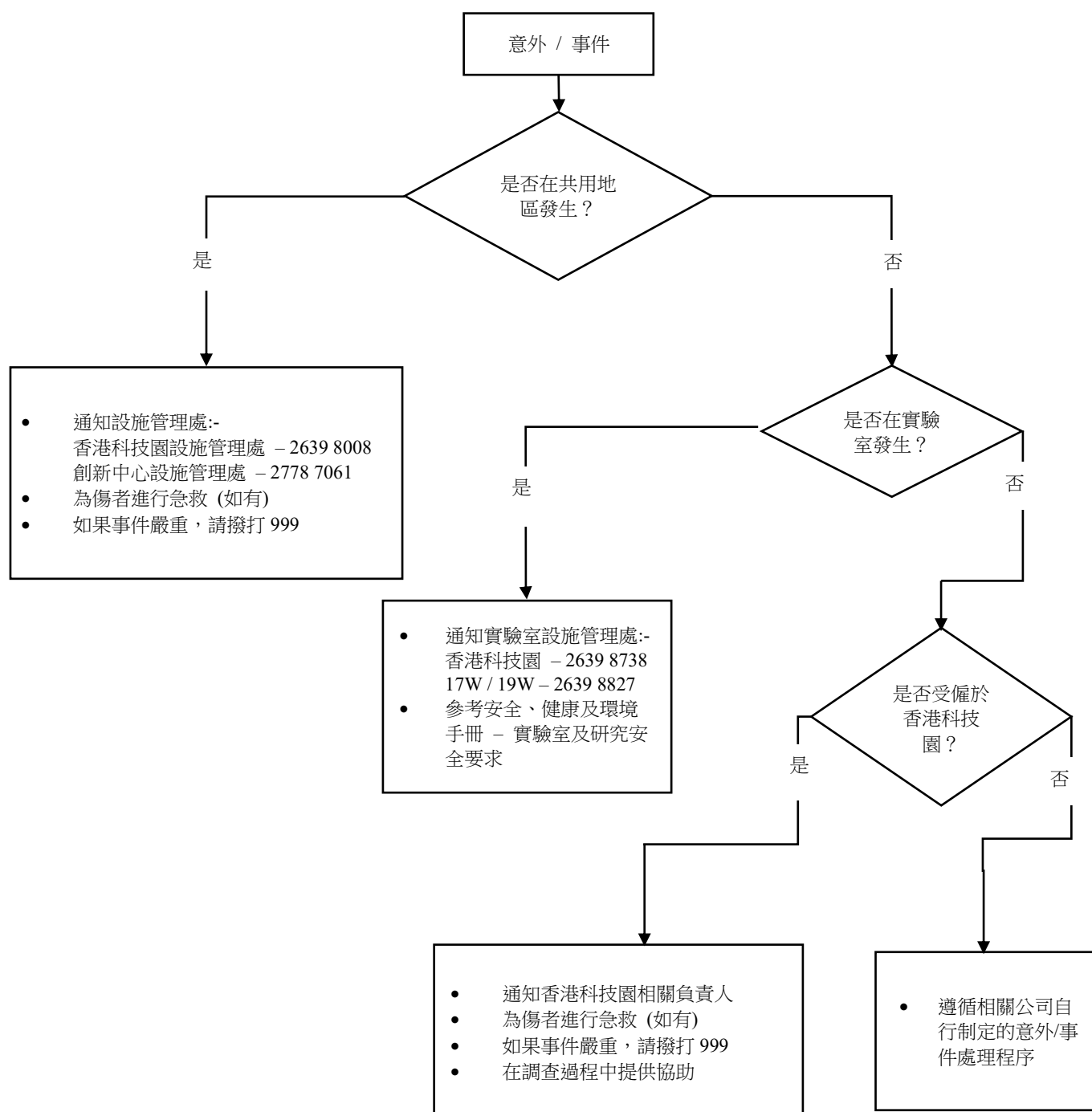
Section C 安全、健康及環境要求

C01 基本工作安全規則

- a. 任何時候不可在工作場所內穿著涼鞋。
- b. 工作時切勿飲酒或吸毒。
- c. 禁止工作時玩鬧。
- d. 注意個人衛生。
- e. 離開前清理工作場所。
- f. 緊急疏散通道應保持暢通無阻。
- g. 必須遵循正確的工作程序。
- h. 了解工作場所的緊急應變計劃。
- i. 保持警惕並專心工作。
- j. 使用適當的設備及工具工作
- k. 在執行工作時，必須佩戴適當的個人防護裝備。
- l. 在沒有任何保護下，切勿接觸帶電設備。
- m. 報告所有危險情況，包括未遂事故。
- n. 在面對潛在危險時應停止工作。
- o. 除非已接受適當培訓，否則請勿使用任何機器或設備。
- p. 室內及建築工地禁止吸煙。
- q. 進行附有相關法例要求的工作，如密閉空間或電力工作，必須獲得其工作專門的培訓證書。

C02 事件報告

- a. 公司應制定事件處理程序，以處理在工作場所範圍內所發生的任何事件。
- b. 如事件於香港科技園共用/公共區域發生，請通知設施管理處並遵循以下報告程序：



- c. 所有人應熟悉緊急情況報告程序。當以電話報告緊急情況時，應提供以下資

料：

- 事件發生的準確位置，包括大廈名稱及房號
 - 緊急情況類型
 - 你的姓名及聯絡電話
- d. 報案人應保持通話，直至接線員結束通話。
- e. 應制定並實施緊急疏散程序。
- f. 24 小時緊急聯絡電話應提交給設施管理處。

C03 安全、健康及環境巡查 / 審核

- a. 現場巡查的目的是找出工作場所內所有潛在危險，並採取適當的控制措施防止事故發生。為確保達到最高安全標準，我們強烈建議園區公司對工作環境、機械、設備及工作行為進行自我檢查。
- b. 檢查記錄應保存至少一年，以便在有需要時可供審核。
- c. 如有不安全情況，而該處所由香港科技園管理，則應立即處理並向該處所負責人報告。所有跟進工作應以報告形式記錄並提交給該處所負責人。
- d. 香港科技園有權在需要時對租戶、培育公司及承辦商的工作場所進行安全、健康及環境巡查或審核，包括但不限於辦公室、實驗室和儲物區（包括危險品倉）。

C04 緊急應變計劃

為做好應對緊急情況的準備，香港科技園建議各租戶、培育公司及承辦商實行以下措施：

- a. 如果在香港科技園範圍內聽到任何緊急情況的警鐘或廣播，你必須：
 - 保持冷靜；
 - 停止使用電話以作緊急之需；
 - 盡可能關閉所有電器；
 - 如有充足時間，請攜帶重要的個人物品；
 - 遵循緊急應變人員/防火督導員的指示，前往最近的出口，並經逃生路線疏散至指定的緊急集合點。切勿奔跑；
 - 切勿使用升降機；
 - 向緊急應變人員/防火督導員報告，並留在指定的集合區等待進一步指示；
 - 切勿試圖走進辦公室，直至設施管理處/緊急應變人員/防火督導員發出進一步指示。
- b. 必須制定緊急程序以應對不同的緊急情況。所有工作人員都應透過接受培訓或定期演習來熟練有關程序。
- c. 必須提供適當的應急設備，並擺放在工作場所的當眼位置。
- d. 必須遵循法例要求提供及妥善保存急救設施：
 - 建築工地須為每 50 名或以內工人提供和妥善保存獨立的急救設備；
 - 建築工地以外的工作場所須為每 100 名或以內員工提供並妥善保存獨立的急救設備。
- e. 急救箱擺放在當眼位置。
- f. 負責人的姓名須標記在急救箱上。
- g. 負責人應定期檢查及確保急救箱所提供的用品及數量符合《急救指南》所訂立的要求。
- h. 如果特定的工作需使用有害物質，則可能需要提供緊急花灑及洗眼裝置。使用者應接受培訓，了解緊急設備的用法及其擺放位置。

C05 防火安全

- 香港科技園禁止在其設施/處所內吸煙。違反者會被要求離開處所。
- 適當使用滅火設備，以處理已識別的火災隱患。

應用在不同火源的區別				
常見滅火筒 的種類	水劑	泡劑	二氧化碳	乾粉劑
火源的 類別				
第壹類： 普通火源 —— 紙、布、木、 塑膠等 	✓	✓	✗	✓
第貳類： 易燃液體 及氣體 —— 溶劑、燃油、 石油氣等 	✗	✓	✓	✓
第參類： 電器用具 —— 摩打、電掣等 	✗	✗	✓	✓

資料來源：工作地點防火安全須知-職業安全健康局

- 將滅火設備擺放在當眼位置。
- 切勿擺放雜物於出口、逃生路線、消防設備或防火門。
- 除非經過適當的訓練，否則請勿使用滅火設備。
- 易燃液體及可燃物料容易著火，因此應妥善貯存。
- 每年應由消防處認可的承辦商安排進行消防設備檢查。
- 所有科學園使用者應參與定期消防演習。工地的承辦商亦應定期安排和進行消防演習。
- 了解疏散程序，並熟悉逃生路線及集合點位置。

C06 個人防護裝備

- a. 當其他危害控制措施無法消除所有危險時，使用個人防護裝備是最後防線。
- b. 在進行某些活動或於指定地區工作時，必須適當地選擇並提供個人防護裝備。

保護類型	個人防護裝備
頭部保護	Y 型下顎帶安全帽
眼部保護	安全護目鏡、面罩、焊接護目鏡
聽覺保護	耳罩及耳塞
手部保護	安全手套（防割、防熱及化學保護手套等）
足部保護	安全鞋、安全靴
皮膚保護	實驗室外套、安全手套
呼吸系統保護	防微粒子面罩（N95、配備過濾器半面式面罩等）、防化學呼吸防護器

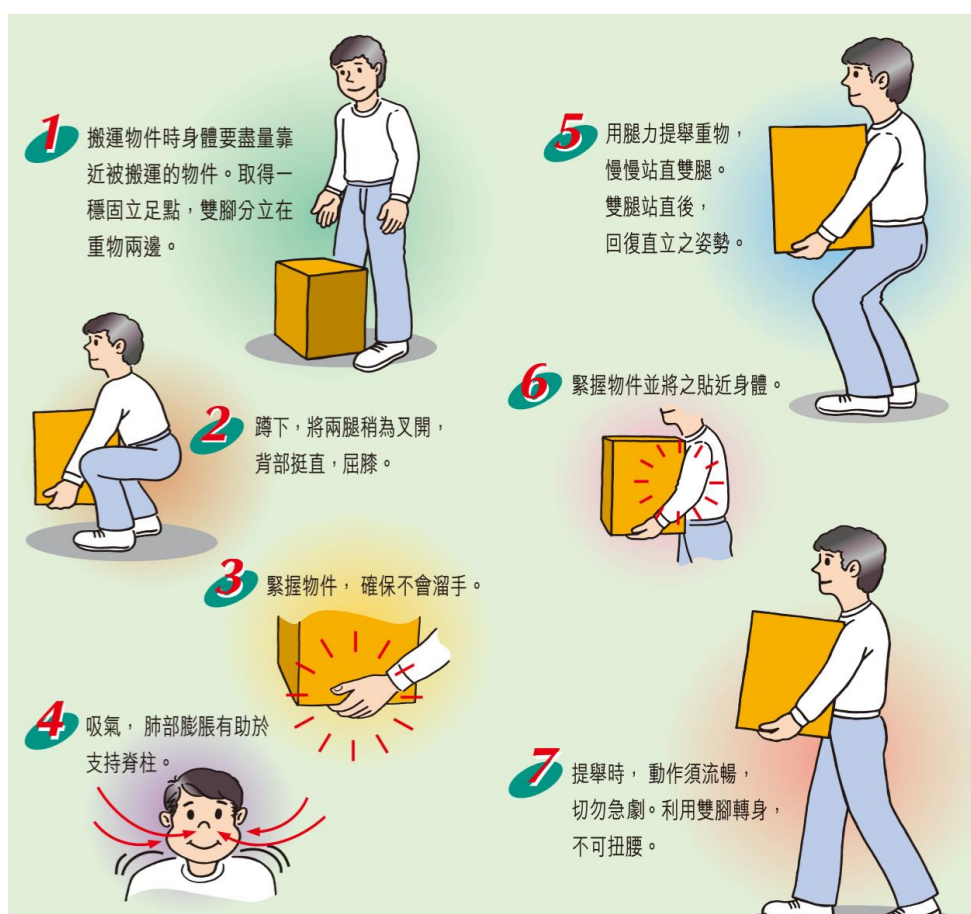
- c. 所有個人防護裝備應符合相關法例要求/規範或同等標準，以滿足國際安全標準的強制性要求。
- d. 所有個人防護裝備應定期檢查，確保性能良好及完好無損。任何有缺陷或過期的個人防護設備都不應使用，並應立即更換。
- e. 應向工作人員提供有關個人防護裝備檢查及使用的充足培訓。
- f. 未使用個人防護裝備時，應貯存在適當的地方。
- g. 如未有正確使用個人防護裝備，香港科技園 / 設施管理處/ 實驗室設施管理處將要求該公司停止工作。

C07 一般工作場所整理

- a. 保持工作場所及儲物區清潔整齊。
- b. 將所有物料及設備堆放並貯存在指定位置。物料應平均安全疊放，以防止移動、掉落或塌下。重物應堆放在靠近地面的地方，以建立重心低的穩定底座。
- c. 禁止任何人在堆放物料上攀爬。
- d. 為避免臨時電線或喉管穿越行人通道上，臨時電線或喉管應懸掛在合理的高度。
- e. 所有工作場所、通道及樓梯應保持暢通無阻。
- f. 清理溢出的液體或其他物質，防止滑倒及跌倒的風險。必要時請標示警告提示。
- g. 妥善保存並隔離鋒利的物件及其他物料。盡可能除去所有凸出物。
- h. 定期檢查、清潔和維修所有設備及工具，除去損壞的設備和工具。
- i. 定期清理廢物及碎屑。
- j. 保持衛生設施乾淨整潔。
- k. 定期檢查工作場所，確保整潔。
- l. 拆開機器維修時，應以整潔及整齊的方式貯存容器組件或零件。

C08 人力提舉 / 物料搬運

- a. 處理負重超過 16 公斤的貨物時，應由合資格的評估員進行體力處理操作評估。
- b. 向體力處理操作員提供適當的培訓。
- c. 在進行體力操作前，應考慮工作性質、負載、工作環境、個人能力及其他因素。
- d. 有需要時，使用適當的配件或輔助機械，避免或過分依賴體力操作。
- e. 如未有使用輔助機械裝置，不得進行任何提舉、卸下或搬運超過 55 公斤的貨物。
- f. 使用正確的體力處理操作技巧：

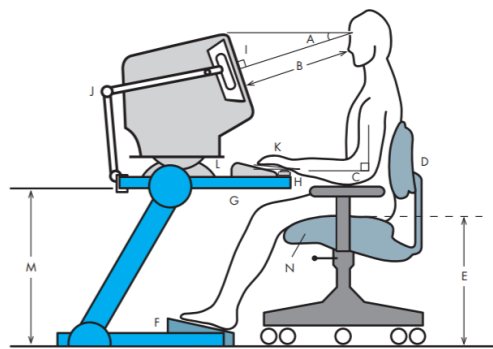


資料來源：一般安全體力處理操作守則 – 職業安全健康局

- g. 有關正確的體力提舉 / 物料搬運資料，請參閱《體力處理操作 – 僱員須知》及《體力處理操作指引》。

C09 顯示屏幕設備

- a. 如果僱員由於其工作性質而幾乎每天都需要使用顯示屏幕設備– (i) 每天至少連續 4 小時； 或 (ii) 每天至少累計 6 小時，則為「顯示屏幕設備使用者」。
- b. 使用顯示屏幕設備時，必須遵守香港《職業安全與健康(顯示屏幕設備)規例》的要求。
- c. 在使用者首次使用工作場所的工作間前，應先進行風險評估。如果以往評估的情況或工作間有顯著改變，應檢討評估。
- d. 在合理可行的範圍內，採取適當的措施將風險評估中確認的任何風險減至最低。



- A 舒適的觀望角度，約為 15° - 20°
- B 舒適的觀望距離，觀望一般大小的文字，約為 350 - 600 毫米
- C 前臂與手臂大約成直角
- D 可調校的椅背
- E 可調校的座位高度
- F 如有需要，可使用穩固的腳踏
- G 足夠的空間與下肢伸展
- H 如有需要，可使用腕墊
- I 屏幕與視線成直角
- J 可調校的文件夾
- K 手腕保持平直或最多少許傾斜
- L 屏幕支座，可旋轉屏幕及調校其斜度
- M 桌面高度（可調校更佳）
- N 座墊前端有圓或渦形邊

資料來源： 使用電腦工作的指南 – 勞工處職業安全及健康部

- e. 要了解更多，請參閱《使用顯示屏幕設備的工作守則》及《使用顯示屏幕設備的健康指引》。

C10 電力安全

- a. 所有便攜式電器應處於良好的運作狀態。
- b. 所有便攜式電器必須符合相關法律規定的要求。
- c. 所有便攜式電器設備須配備有效的開關掣，以供操作。
- d. 所有於戶外使用的電源插頭/連結器必須為工業防濺型。
- e. 所有便攜式電器的電線必須為軟線。
- f. 硬線只可使用於固定裝置，並且須確保穩固。
- g. 在含有可燃或易燃蒸氣、灰塵或纖維地區使用的便攜式電器設備必須為防爆型。
- h. 設備的外罩或外殼不可有裂紋或損壞。
- i. 插頭及拖板不應負荷過重，並應配備適當額定值的保險絲。
- j. 破裂或磨損的電線應立即更換。
- k. 如發現任何問題，應停止使用有缺陷的設備並立即修理。
- l. 確保為便攜式電器設備提供防漏電保護，例如雙重絕緣、漏電斷路器或電流斷路器。使用漏電斷路裝置時，應檢查其功能，並定期進行測試。
- m. 強烈建議使用乾電池或充電電池為電源的手提式工具和手提燈。
- n. 切勿在晚上將電器保持開啟狀態，全天候開啟設計的電器（如冰箱）除外。
- o. 每一個供電插座只可插上一個萬能蘇或一個拖板以避免電路負荷過重而造成火警危險。
- p. 只使用符合安全規格的萬能蘇和拖板。
- q. 所有電力裝置應由合資格人員（例如是註冊電工）妥善安裝並保持良好的運作狀態。
- r. 所有線路應符合規範或法規安裝，並保持在安全狀態。
- s. 所有外露的電導體應適當地絕緣、覆蓋或隔離，以防員工不慎接觸。
- t. 不得使用已損壞或故障的開關、插頭、接頭、保險絲/接線箱或配電板等。
- u. 不得使用鬆動的電線索頭、未經授權改動的設備、非安全的臨時接線、臨時連接及錯誤安裝的開關掣。
- v. 只有授權的電工才可操作開關盤。

- w. 治療受電擊的告示須展示在所有發電、將電力變壓或使用電力的場所及有關地方。
- x. 電力工作只可由合資格電工進行，並需有能力地執行工作。
- y. 所有臨時配電箱應上鎖；同時須要顯示負責電工的姓名、聯絡資料及法定告示。



資料來源：勞工署 – 電擊

C11 化學物及有害物資

- a. 定期制定和更新所有危險化學物質清單。
- b. 應定期檢閱存貨清單。
- c. 使用適當的容器貯存化學物質。所有容器應附有正確的標籤及標誌以作識別。
標籤中包含的內容應為兩種語言，即中文及英文。
- d. 使用每種有害化學物質時，應提供中文或英文的物質安全資料表。
- e. 危險化學物質的貯存或運送應遵守以下相關法律：
 - 第 295 章《危險品條例》
 - 第 59AB 章《工廠及工業經營（危險物質）規例》
 - 第 59AA 章《工廠及工業經營（可致癌物質）規例》
- f. 危險化學物質的貯存不得超過第 295 章《危險品條例》規定的最大數量。任何人貯存、使用或運送超過個別危險品的法訂豁免量或下列第 5 類危險品的總豁免量，必須申請有關的危險品牌照。
 - i. 第 5 類第 1 分類危險品的總豁免量為 40 公升；
 - ii. 第 5 類第 2 分類危險品的總豁免量為 40 公升。

以下是其中一些例子：

名稱	類/分類/部	豁免量
丙酮 (Acetone)	第 5 類、第 1 分類、第 2 部	20 升
乙醇 (Ethyl Alcoho)	第 5 類、第 1 分類、第 2 部	20 升
異性丙醇 (Isopropy Alcohol)	第 5 類、第 1 分類、第 2 部	20 升
漆油類 (Paint)	第 5 類	見纖維素（總容量不超過 250 升）
松節油及其代品 (Turpentine and Turpentine Substitutes)	第 5 類、第 1 分類、第 2 部	20 升

- g. 危險化學物質貯存區的基本條件如下：
- 通風良好；
 - 與公共場所及其他有害物質保持適當距離；
 - 不同類型的物質應分開貯存；
 - 應在貯存室外貼上適當的警告標誌。
- h. 負責處理和/或使用或監督有害化學物質的工作人員應接受有關該物質處理的適當培訓，並了解潛在的危險及處理物質的緊急程序。
- i. 所有與危險化學物質密切接觸的人士必須佩戴個人防護裝備例如手套、護目鏡等。
- j. 任何化學品不應無人看管，以及在未使用的情況下打開。應將化學品妥善貯存在儲物櫃內。
- k. 如對危險化學物質之間的化學反應未有深入了解，切勿混合其他物質。
- l. 易燃化學物質不得在帶電的電器設備及其附近範圍或明火及及其附近範圍使用。
- m. 使用易燃或揮發性化學物質時，應保持良好通風。
- n. 根據有害化學物質的風險評估制定緊急應變計劃，包括緊急聯絡電話和/或聯絡人資料。
- o. 化學廢物產生者必須在環境保護署註冊。
- p. 化學廢物應由持牌化學廢物收集者收集。切勿將化學廢物當作一般垃圾丟棄。
- q. 如發生與化學品相關的事故，例如在香港科技園處所內的公共地方/實驗室發生洩漏，化學物質使用者應立即向設施管理處/實驗室設施管理處報告。
- r. 要了解更多，請參閱《防火通告第四號—危險品》、《化學品使用過程的危險及安全指南》及《化學廢物管制計劃指南》。

C12 壓縮氣瓶

- a. 任何氣瓶應：
 - 貼上標籤或標記以識別氣體，及適當貯存。
 - 避免貯存在出口或逃生路線、潮濕、近鹽或腐蝕性化學藥品的位置，或煙霧、熱源附近，或露天地方；
 - 存放在通風良好的地方；
 - 氣瓶應分組存放在貯放架或貯放室中，並以獨立鏈條將氣瓶固定及直立安放。
 - 遠離所有易燃、可燃或不相容物質。
 - 避免拖動或親手攜帶。使用專用手推車運送氣瓶，並且在運送過程中應固定氣瓶蓋。
- b. 為防止發生化學反應，成份不同的氣瓶不應放在一起。
- c. 當氣瓶閒置、空置或移動時，請關閉閥門。移動或貯存氣瓶時，應蓋上閥門保護蓋。
- d. 閥門關閉後，從軟管釋放殘餘的氣體壓力。
- e. 壓縮氣瓶的貯存不得超過消防處規定的最大數量（要了解更多，請參閱《防火通告第 4 號–危險品》）。以下是其中一些例子：

名稱	類/分類/部	豁免量
乙炔 (Acetylene)	第 2 類第 3 分類	2 瓶
氬 (Argon)	第 2 類第 1 分類	1 瓶
二氧化碳 (Carbon Dioxide)	第 2 類第 2 分類	1 瓶
氮 (Nitrogen)	第 2 類第 1 分類	1 瓶
氧 (Oxygen)	第 2 類第 1 分類	2 瓶

- f. 任何人貯存、使用或運送超過個別危險品的法訂豁免量或下列第 2 類危險品的總豁免量，必須申請有關的危險品牌照：
 - 第 2 類危險品的總豁免量為 5 個氣瓶或 25 升氣體，而 1 個氣瓶等於 5 升；

- g. 禁止使用載客升降機運送壓縮氣瓶。向有關設施管理處的客戶服務台註冊後，只可經載貨升降機運送。
- h. 調節器、軟管及火炬組件應處於運作狀態，並應在首次使用或安裝前檢查是否有洩漏。如果發生洩漏，請將氣瓶移至大樓外的安全位置，並在必要時將情況報告給香港科技園有關部門、設施管理處及政府部門。
- i. 必須使用主管當局批准的氣瓶類型：
 - 永久和液化氣體氣須於過去 5 年內由當局批准作出試驗與檢驗
 - 溶解氣體須於過去 12 個月內由當局批准作出檢驗。
- j. 供應商收集或交付時，使用者必須讓設施管理處記錄往返科學園大樓壓縮氣瓶的類型及數量。

C13 熱工序（電弧焊接、氣體焊接及風煤切割）

如需進行熱工序，承辦商應準備施工方法及風險評估，並將文件交給設施管理處（負責科學園大樓內的工程）或香港科技園 Project Development 部門（負責建築工程），評估包括可能對附近造成危害的其他工序。進行熱工序前，應由設施管理處或建築地盤承辦商的管理人員發放並檢查熱工序許可證。

- a. 風險評估應由合資格人士進行，並執行熱工序許可證制度去進行熱工序活動。
- b. 評估風險時應考慮的因素包括供氣系統、工作環境、工序細節、工作場所的空間大小及形狀。
- c. 確認熱工序設備處於正常運作狀態。
- d. 應分隔/遠離所有易燃/可燃物質的源頭。
- e. 提供合適的通風系統。
- f. 應提供消防設備，例如便攜式滅火器、滅火毯及沙桶等。
- g. 應使用不可燃或防火的擋板，以保護附近的人員免受電弧的直接傷害。
- h. 任何人從事熱工序必須接受適當培訓以使用相關設備。
- i. 在氣瓶上配備適合的防止回火器及止回閥。
- j. 佩戴適當的個人防護裝備，例如護目鏡、安全口罩/面罩及防護手套。
- k. 進行手工電弧焊時，將工件接地。
- l. 在切實可行的情況下，將燒焊變壓器及調節器放在密閉空間以外。
- m. 在潮濕的工作場所進行電弧焊接時，應站在絕緣墊或非導電台架上。
- n. 離開工作場所前，應確保爐渣、火花及工件已完全冷卻。
- o. 如需要作任何涉及明火或產生火花的短暫操作，包括但不限於焊接、切割、打磨及硬焊，請預先通知香港科技園 Project Development 部門/設施管理處/實驗室設施管理處操作日期、時間及地點。
- p. 要了解更多，請參閱《工作守則：氣體焊接及火焰切割工作的安全與健康》及《工作守則：手工電弧焊工作的安全與健康》。

C14 鍋爐及壓力容器

- a. 新鍋爐、空氣容器或壓力容器的擁有人須於其擬將該設備投入使用的日期前至少 30 天向勞工處鍋爐及壓力容器科註冊（表格 3）。
- b. 每個鍋爐及壓力容器應定期由鍋爐檢驗師/空氣容器檢驗師檢驗（鍋爐：每 14 / 26 個月，視乎鍋爐的類型及使用年期；空氣容器及蒸汽容器：每 26 個月）。在大型維修或更換處所後，亦應重新由鍋爐檢驗師/空氣容器檢驗師檢查每個鍋爐及壓力容器。檢驗員應根據該法例簽發效能良好證明書（適用於蒸汽鍋爐的表格 1 / 適用於壓力燃料容器以外壓力容器的表格 2）。
- c. 效能良好證明書應存放在裝有鍋爐或壓力容器的處所/位置。
- d. 所有鍋爐和壓力容器應加上標籤及編號。試驗壓力及最高可使用壓力應標示在鍋爐和壓力容器上。
- e. 鍋爐或蒸汽容器只可在持有合資格證書(該證書證明持有人有足夠能力操作所有級別或類型的鍋爐及蒸汽容器，或有足夠能力操作有關的級別或類型的鍋爐或蒸汽容器)的合資格人員直接監管下操作。
- f. 鍋爐或壓力容器操作時的壓力不得超過其在最近期獲發給的效能良好證明書內指明為可操作該鍋爐或壓力容器的最高可使用壓力。
- g. 禁止任何人拆下安全閥的鉛封或試圖調整安全閥的設定以增加蒸汽壓力。
- h. 如鍋爐或壓力容器或其配件出現問題，導致有生命危險或財產損失的風險，則必須立即關閉鍋爐或壓力容器。擁有人應在 24 小時內向鍋爐和壓力容器科報告事故。
- i. 要了解更多，請參閱《第 56 章-鍋爐及壓力容器條例》。

C15 高空工作

- a. 高空工作時，須配戴安全帶並將懸掛繩繫於特定的繫穩位置，並應提供使用防墮設備的相關資料、指示及培訓。
- b. 所有防墮設備在使用前應加以檢查。
- c. 高空工作時，須配戴附有帽帶的安全帽。
- d. 高空工作應以屏障分隔以防止物料下墮而撞擊下方行人。
- e. 禁止高空擲物或墮物。
- f. 任何 2 米或以上的高空工作，應優先考慮使用工作平台（棚架/流動工作台/升降工作台）。梯子不應用於 2 米或以上的高空工作。
- g. 工作台應以夾板、木板或金屬板鋪密。工作平台的夾板或木板應：
 - i. 闊度不得小於 200 毫米而厚度不得小於 25 毫米；或
 - ii. 如厚度超逾 50 毫米，則其闊度不得小於 150 毫米
- h. 工作台闊度不得小於 400 毫米，任何用於搬運物料路徑的闊度不得小於 650 毫米。
- i. 工作台須設有護欄，最高的護欄高度須為 900 毫米至 1150 毫米，中間亦須提供高度為 450 毫米至 600 毫米的護欄。
- j. 踢腳板的高度不得低於 200 毫米，以防止物件從工作台墮下。
- k. 任何 2 米以下的高空工作，應在合理可行的範圍內使用輕便工作台（梯台（圖一）、功夫橈（圖二）、流動工作台（圖三）。



圖一：梯台



圖二：功夫梯



圖三：流動工作台

- I. 如有特殊原因而未能遵循上述規定，則評估員應進行現場風險評估，透過工作許可證制度，證明使用梯子，包括梯台（A 字梯），是合理可行。

C16 使用梯子的基本安全及預防措施

- a. 不得於香港科技園處所內使用木梯。
- b. 梯子只作上落高處之用。
- c. 使用前先檢查梯子狀況，並記錄在完整的核對表。
- d. 切勿使用有破爛梯級、沒有防滑支腳或其他有缺陷的梯子。
- e. 進行電力工作時，應使用玻璃纖維梯。
- f. 上落時應面向梯子，確保三點接觸梯子。
- g. 梯子應安放在平穩防滑地面。
- h. 應使用繩索運送物料，不應攜帶著物料去爬梯運送。
- i. 梯子每次只可供一人使用。
- j. 梯子底部與高度須保持 1:4 的比例。
- k. 梯子須高於頂部落腳點最少 1 米。

C17 棚架安全

- a. 架設、更改和拆卸棚架的工作須由合資格人士及曾受訓練的工人進行。
- b. 進行棚架工作時，須配戴安全帶並將懸掛繩繫於繫穩物或配備防墮裝置的獨立救生繩上。
- c. 工作台須設有距離平台面 900 至 1150 毫米高的護欄及 450 至 600 毫米高的中間護欄。
- d. 須設有至少 200 毫米高的踢腳板，以防止物料從工作台上墮下。
- e. 所有棚架應建立在堅固穩定的地面上。
- f. 棚架須在每十四天內由合資格人士安排進行檢查及將結果填報於法定表格內（《建築地盤（安全）規例》的表格五）。
- g. 圍封工地並貼上警告告示。
- h. 禁止高處擲下或傾倒棚架物料。
- i. 應制定惡劣天氣應急計劃。在惡劣天氣後須檢查棚架。
- j. 金屬棚架/竹棚建造及鋪板應符合製造商說明的技術規定，以及由勞工處發出的《竹棚架工作安全守則》和《金屬棚架工作安全守則》所訂立的要求。
- k. 如棚架所建造的位置有機會影響樓宇結構就必須預先通知設施管理處並獲得批准。
- l. 某類型的棚架須由結構或土木工程界別的專業工程師進行設計或檢查。詳細要求請根據由勞工處發出的《竹棚架工作安全守則》和《金屬棚架工作安全守則》。
- m. 要了解更多，請參考《竹棚架工作安全守則》、《金屬棚架工作安全守則》及《竹棚架工作平台安排指引》。

C18 動力操作升降工作台

- a. 應進行風險評估，去找出動力操作升降工作台在操作方面的所有潛在危害。
- b. 應為所需進行的作業訂明安全的工作方法和程序。
- c. 動力操作升降工作台的操作員必須已完成該類動力操作升降工作台的操作訓練。
- d. 動力操作升降工作台在使用前或重大修理後，應由合資格檢驗員徹底檢驗及測試。
- e. 動力操作升降工作台須有清晰永久標記或標示，以清楚註明安全操作負荷、負載人數上限及最大操作高度和半徑。
- f. 應由合資格的機械工程技術人員或操作員進行每星期檢查。
- g. 應配戴適當的安全帶，而安全帶的懸掛繩應繫穩在特定繫穩位置。
- h. 工作台應提供適當的護欄及踢腳板。
- i. 當眼位置應設有能切斷所有系統電源的緊急掣。
- j. 工作台應安裝一個性能良好的鎖定制動器或其他儀器，使該機器停留在已設定的最大斜面，能夠維持安全負載。
- k. 使用動力操作升降工作台時，應考慮工作環境及地面情況等。
- l. 要了解更多，請參考《安全使用動力操作升降工作台指引》。

C19 吊船使用安全

- a. 吊船須由曾受訓練的工作人員使用。
- b. 使用吊船時，須配戴安全帶並且將該安全帶的懸掛繩繫於配備防墮裝置的獨立救生繩或指定的繫穩物上。
- c. 展示安全操作負荷及容許人數的標記。
- d. 切勿把身體過分伸出吊船外或使用吊船人數超出安全負荷。
- e. 切勿在惡劣天氣下使用吊船。
- f. 須保存吊船維修記錄。
- g. 有關吊船架設、拆卸及改裝須向合資格人士諮詢。
- h. 所有懸吊纜及安全纜索須由合資格人士檢查。
- i. 每週檢查須由合資格人士進行並記錄於法定檢查表格（吊船表格一）。
- j. 吊船須按法例要求定期進行徹底檢驗、檢查及測試。
- k. 設施管理處負責控制可以操作大廈吊船的人士；只有授權列表中的人士可操作大廈吊船。
- l. 在組裝/使用臨時吊船前，必須先獲得設施管理處的批准。
- m. 要了解更多，請參考《安全使用和操作吊船工作守則》。

吊船法例規定			
適用規例:	《工廠及工業經營（吊船）規例》		
項目	檢查表格(吊船)		
吊船	1	2	3
時間	7 天	緊接使用前或經重大修理、重新架設、調校其任何構件、失靈或倒塌後的 6 個月內	緊接使用前 12 個月內

C20 起重機械及起重裝置

- a. 所有起重機械及起重裝置須按法例要求定期進行徹底檢驗、檢查及測試。
- b. 建議實施顏色識別制度以展示起重裝置已檢查並處於安全操作狀態。
- c. 須為起重機械提供所有安全裝置，並確保處於良好狀態，包括安全負荷自動顯示器。
- d. 所有起重機械操作員必須曾接受訓練並有足夠能力操作該起重機械。
- e. 操作員應檢查起重機械並完成法定檢查表格（起重機械及起重裝置表格一）。
- f. 任何情況下吊運物不可無人看管。任何人不可逗留在吊運範圍之內。吊運時，索具工及訊號員應向途人發出警告。
- g. 所有索具工及訊號員應有適當訓練並有足夠能力進行吊運工作。
- h. 架設路障及以其他適當措施限制工作範圍，盡量減少因物件搖擺或墜下而對其他人造成的危機。
- i. 進行吊運工作前，須留意工作環境和天氣狀況。
- j. 如須為起重機械進行架設、拆卸和改裝工作，必須諮詢合資格人士。
- k. 進行吊運工作前，應安排風險評估以識別潛在危害並制定施工方案及控制措施。
- l. 要了解更多，請參考《安全使用塔式起重機工作守則》、《安全使用流動式起重機工作守則》及《起重機械及起重裝置的檢查、檢驗和測試指南》。

起重機械及起重裝置法例規定							
適用規例:	《起重機械及起重裝置規例》						
項目	檢查表格 (起重機械及起重裝置)						
	1	2	3	4	5	6	7
起重機	√		√		√		
設有錨定及壓重裝置的起重機	√	√	√		√		
絞車和起重滑車	√		√		√		
滑輪組、吊重輪、腳架起重機、打樁機、拔樁機、挖掘	√			√	√		

機、架空軌道、拉 索挖機等							
起重裝置						√	√
纖維纜索							√
時間	7 天	架設 後	4 年		12 個 月	使用 前	6 個 月
			使用前或重大修 理、重新架設、 失靈、翻倒或倒 塌後				

C21 機械裝置

- a. 機械裝置是指任何以動力操作的流動機器，該機器須由人在機器上操作，包括挖掘機、推土機、搬土機、鏟車、起重機及電動升降平台車等。
- b. 只有曾受訓練的操作員可根據法例去操控機械裝置。
- c. 應定期安排檢查機械裝置並記錄在檢查表格中，確保裝置處於安全的操作狀態。
- d. 切勿使用安全功能失效的裝置，待維修完成後才可使用。
- e. 應在通風良好的地方添加燃料。發動機操作時，切勿為機械裝置添加燃料。
- f. 所有機械裝置應保持其專有狀態，除非得到製造商的認證或書面許可，否則不得對裝置進行任何修改。
- g. 所有機械裝置應遵守非道路移動機械排放規例的規定，以及展示認可或豁免的標籤。
- h. 要了解更多，請參考刊物《工廠及工業經營（負荷物移動機械）規例簡介》、《在建築地盤安全使用負荷物移動機作搬土工作指引》及《建築地盤車輛及流動機械的安全指引》。

C22 木工機械

- a. 操作木工機械的人必須能勝任該操作工作。
- b. 木工機械的所有危險部件應適當地防護。
- c. 須有可供使用的推杆/擋塊，防止工人雙手移近鋸片。
- d. 必須安裝緊急停止裝置，以便在緊急情況下停止機器。
- e. 須提供開關裝置以控制木工機械。
- f. 木工機械必須定期檢查並保持良好狀態。如有任何故障跡象，操作員不得使用機器。
- g. 工作範圍應保持整潔及暢通無阻，並定期清理木屑。
- h. 設置木工機械的地面應保持良好及平坦狀況。
- i. 使用木工機械時，應配戴適當的個人防護設備（護目鏡及護耳器）。
- j. 有關木工機械安全使用的具體規定，請參考刊物《工廠及工業經營（木工機械）規例簡介》。

C23 機械防護

- a. 在工人正常接觸範圍內的所有機械危險部件應完全防護，以防止工人接觸機械或設備的移動部件。
- b. 確保機械設有有效的防護裝置並正常操作。
- c. 所有護罩必須堅固，構造須妥當。
- d. 所有設備和機器應定期檢查並保持良好狀態，包括連帶的護罩。
- e. 當部件運作時，護罩應固定在適當的位置。
- f. 切勿試圖改動或移除護罩。
- g. 更換或修理護罩時，請關閉機器。
- h. 請參考《機械的防護及操作手冊》，了解護罩的設計及安裝規定。

C24 砂輪

- 砂輪的安裝工作只可由曾受完善訓練的合資格人士進行。
- 切勿使用已損壞的砂輪。
- 確保標記及清晰展示砂輪的最高許可速度。
- 確保機器心軸的速度以中文及英文清楚標記在磨機上。
- 確保砂輪的最高許可速度高於心軸的速度。
- 安裝砂輪後，確保護罩穩固在適當的位置。
- 確保在砂輪附近或當眼的位置清楚展示使用砂輪的法定警告告示。

此告示已由勞工處處長批准，並須根據
工廠及工業經營(砂輪)規例第 14 條所規定而張貼

使用砂輪時 應注意下列

危險	安全預防措施
(1) 砂輪爆裂之原因： 砂輪之內有缺陷	用聲響試驗法，檢查砂輪之 完整性。
砂輪爆裂	在磨砂輪機使用之砂輪， 不可超過其最高許可速度。
砂輪破裂	砂輪應由一合資格人士安裝及 檢查，以確保其完整性。
使用不當	在磨砂輪機上， 應在砂輪與工件之間保持適當 之距離。
(2) 磨損輪子與軸端之磨損	在磨砂輪機上， 應在砂輪與工件之間保持適當 之距離。
(3) 與砂輪接觸	使用：護目鏡、手套、防護服 (或護目鏡)。
(4) 飛濺之磨粒引起眼部受傷	砂輪應安裝在正確位置。

使用前須檢查清楚

This warning notice has been approved by the Commissioner for Labour
and must be posted for the purpose of Regulation 14 of the Factories and
Industrial Undertakings (Abrasives Wheels) Regulations

WARNING NOTICE WHEN USING ABRASIVE WHEELS

DANGERS	SAFETY PRECAUTIONS
(1) Bursting of wheel, due to: Latent defect of wheel	Check soundness of wheel by ring test.
Over-speeding	Do not exceed maximum permissible speed of wheel as specified by manufacturer.
Faulty mounting	The wheel must be mounted by a trained and competent person appointed in writing.
Misuse by operator	Never use excessive pressure on the wheel. Use particular care when grinding on the side of a straight-grained wheel.
(2) Fractures of mounted wheels and points	The overhang not to exceed that is permissible by the manufacturer. The wheel to be secured properly in the collet of chuck.
(3) Contact with wheel	Use: Wheel guards, work-rest, protective screens (or eye protectors).
(4) Eye injuries from flying particles	Wheels must be properly braced and threaded.

ALWAYS CHECK
BEFORE YOU OPERATE

資料來源：使用砂輪時應注意下列- 勞工處

- 砂輪應由合資格人士定期檢查和維護。
- 使用磨機時須確保地板處於良好狀況，暢通無阻以及不滑溜。
- 進行磨輪工序時時須佩戴適當的眼睛保護用具，例如護目鏡。
- 要了解更多資料，請參考刊物《砂輪的安全使用》。

C25 密閉空間工作

- a. 密閉空間指任何被圍封的地方，而基於其被圍封的性質，會產生可合理預見的指明危險，在不局限上文的一般性的原則下，密閉空間包括任何產生該等危險的密室，貯槽，下桶，坑槽，井，污水渠，隧道，喉管，煙道，鍋爐，壓力受器，艙口，沉箱，豎井或筒倉。
- b. 指明危險包括：
 - 指因發生火警或爆炸，而引致任何正在工作的人嚴重損傷的危險；
 - 指因體溫上升，而引致任何正在工作的人喪失知覺的危險；
 - 指因氣體，煙氣，蒸氣或空氣貧氧，而引致正在工作的人喪失知覺或窒息的危險；
 - 指因任何水平升高，而引致任何正在工作的人遇溺的危險；或
 - 指因自由流動的固體，而引致任何正在工作的人窒息的危險；或指因陷入自由流動的固體，而引致任何正在工作的人無力達至可呼吸空氣的環境的危險。
- c. 任何在密閉空間工作的人須接受勞工處認可的密閉空間核准工人安全培訓課程，並持有相關證書。
- d. 風險評估應由合資格人士進行，該人士須曾接受勞工處認可的密閉空間合資格人士安全訓練課程及持有有關的證書。任何環境狀況轉變都必須重新進行風險評估。
- e. 風險評估結果應展示在密閉空間的入口處，並展示警告標誌和告示。
- f. 進入密閉空間前，密閉空間應用適當的方法足夠地清洗，例如水蒸氣清潔、惰性氣體清洗和強制通風等，並應從密閉空間外進行大氣測試。
- g. 確保使用安全設備及個人防護裝備，包括大氣測試設備、防護服裝、安全帽、呼吸器、救生繩、通風設備及安全帶等。
- h. 在整個操作過程中，應安排工人在密閉空間的入口處待命以便緊急溝通及協調。
- i. 進入密閉空間前，請確保執行所有相關控制措施，例如隔離主要喉管或供應新鮮空氣。

- j. 建立緊急救援程序，以處理密閉空間工作的所有緊急情況。
- k. 要了解更多資料，請參考《工作守則-密閉空間工作的安全與健康》。

C26 挖掘及探溝

- a. 進行挖掘工作前，確保已放置地下公共設施標誌、標牌、路障及支撐物。
- b. 在挖掘前，請標記地下公共設施的位置，防止服務中斷或有公共設施管線的危機。如地下電纜位置已確認並外露便需要人手挖掘。
- c. 應適當挑選及定期維修挖掘設備，以確保其適合施工。
- d. 挖掘機須由合資格及曾受訓練使用挖掘機的人使用。挖掘機須進行每週檢查並記錄於法定檢查表格（起重機械及起重裝置表格一）。
- e. 在挖掘溝槽各面放置告示及適當的屏障，以防行人經過。
- f. 挖掘工程檢查應由合資格人士按法例規定進行，並記錄在法定檢查表（建築地盤安全規例表格 4）中。
- g. 所有挖掘應設置安全通道。
- h. 開始挖掘工作前，請與香港科技園 Project Development 部門/設施管理處聯繫。
- i. 要了解更多，請參考《安全使用挖土機工作守則》。

挖掘法例規定			
項目	適用法則	檢查表格	時間
檢查挖掘工作	《建築地盤安全規例》	表格四	7 天
檢查挖土機	《起重機械及起重裝置規例》	表格一	7 天
		表格四	使用前或重大修理、重新架設、失靈、翻倒或倒塌後
		表格五	12 個月

C27 交通安全

- a. 所有在馬路上進行工程的工人必須穿著反光背心。
- b. 所有行車路上的道路工程範圍必須用交通圓筒清楚界定。交通圓筒必須符合英國歐盟標準 13422:2004 的一般規定，並符合適當的高度。圓筒的白色部分必須反光，而紅色部分可以是反光或螢光表面。
- c. 圓筒之間最大的間距須參考路政署發佈的《道路工程的照明、標誌及防護工作守則》中所列出的規定。
- d. 障礙物及挖掘處不論何時均須有足夠的防護。
- e. 行人與工地及車輛之間應有穩固的防欄（注水或臨時管狀防欄）作為保護，而防欄擺放位置須清楚分隔行人與工地及行車路，以及警告行人有關改變。防欄應與挖掘處、物料或機械保持足夠距離，避免危害行人。
- f. 水注或臨時管狀防欄在豎設後應有清晰及一致的整體外表。相鄰的防欄須互相緊扣並不可有過大的空隙，以免影響其防護功能。防欄的防撞等級設計須符合英國歐盟標準 1317-2:2010 防撞等級 T2 或以上的規定。
- g. 在黑夜時段中或當能見度低時，所有障礙物或道路工程必須用規定的道路危險警告燈標示，使道路使用者得知工程區的範圍。
- h. 一般道路工程標誌須適當顯示在工地。標誌的顯示方式應符合《道路工程的照明、標誌及防護工作守則》的標準及要求。
- i. 必須設置楔形引入和引出路段引導駕駛人士安全駛經工地。應使用交通圓筒及路障，向駕駛人士發出統一和一致的指示，顯示行車路上有障礙物或挖掘處。在視線可能有問題的地點，應同時使用路障標誌及閃爍箭咀指示燈號。
- j. 楔形引入路段的長度和圓筒的高度及間距，須根據《道路工程的照明、標誌及防護工作守則》的一般標準及要求釐定。所有交通安排須獲得設施管理處同意。
- k. 在行人路施工時，應維持不少於 1.5 米淨闊的行人路。如未能符合上述要求，在獲得設施管理處同意的情況下，可另行提供一條適當的通道，縮短路段的闊度。
- l. 任何行車路或行人路上的存放物料，必須用連續的護欄適當防護。機械和材料的存放地點應盡可能遠離車路邊緣及不阻礙視線。如需在行車路貯放物料，必

須獲得設施管理處許可。

- m. 在單車路上進行工程時，應保留淨闊最少為 1.8 米的單車路，讓騎單車人士下車。
- n. 工地與有車輛行駛的道路任何部分之間應保持適當橫向安全淨距。
- o. 在楔形引入路段末端和施工地區之間的空間，須設置縱向安全淨距。該空間不應佔據作施工之用，以提供安全距離予交通和道路工程人員。此外，根據《道路工程的照明、標誌及防護》建議提供 10 米長的縱向安全淨距區。如未能提供，須通知設施管理處其他可行安排的成效。
- p. 在任何時候，不應阻塞緊急車輛通道。

C28 工作噪音

- a. 確保採取適當措施以減低聽力受損的風險，例如機械維護及提供資訊、指示及培訓。
- b. 如果認為噪音水平難以接受（例如相距約 2 米之間都難以聽到對方說話），請使用噪音量度儀器進行初步評估。如果確認噪聲水平為 85 分貝（A）或以上，則需要由合資格人士進行噪音評估。
- c. 須劃分噪音水平達到 90 分貝（A）或以上的工作場所為聽覺保護區。任何在該區內工作的人均須配戴適合及受認可的聽覺保護器；張貼標籤以標明及識別聽覺保護區。
- d. 降低噪音強度，例如設置噪音屏障。
- e. 要了解更多，請參考《工廠及工業經營（工作噪音）規例指引》。

C29 僱用安全主任及安全督導員

《工廠及工業經營條例》是為保障工人的安全和健康而訂定的條文。這條條例適用於任何工業經營，包括工廠、建築地盤、食肆、貨物及貨櫃搬運經營、維修工場和其他工業工場。根據《工廠及工業經營（安全主任及安全督導員）規例》，所有工業經營的僱主必須僱用安全主任及安全督導員以協助管理安全及健康事項。

- a. 凡在建築地盤僱用工作的人總人數合共達 100 名或以上，須僱用全職註冊安全主任一名。
- b. 凡在建築地盤僱用工作的人總人數合共達 20 名或以上，須僱用安全督導員一名。
- c. 承辦商活動的工作場所可歸類為建築工程。建築工程指：-
 - i. 建造、架設、安裝、重建、修葺、維修(包括重新修飾及外圍清理)、翻新、遷移、改動、改善、拆除或拆卸任何指明的構築物或工程；
 - ii. 為預備進行(i)段所提述的工程行動而涉及的任何工程，包括鋪築地基和鋪築地基前的挖掘泥土及沙石工程；
 - iii. 為進行(i)或(ii)段所提述的任何工程行動而使用機械、工業裝置、工具、裝置及物料。
- d. 要了解更多，請參考第 59Z 章《工廠及工業經營(安全主任及安全督導員)規例》。

C30 許可證及牌照

- a. 任何需要在香港科技園處所進行承包工程的人，必須向香港科技園項目負責人/設施管理處提交施工方案及風險評估，以供審核。如要在香港科學園/創新中心內展開工作，則須從設施管理處獲得工作許可證。以下是需要提交施工方案及風險評估的例子：
- 金屬棚架/竹棚架
 - 挖掘工程
 - 焊接工作
 - 吊運工作
 - 使用機械設備進行高空工作
 - 使用化學品
- b. 租戶/培育公司/承辦商必須負責確保只有獲正確註冊及/或許可證的人方可執行任何需要指定許可證的工作。

C31 有害廢物管理

- a. 租戶/培育公司/承辦商須完全遵守所有本地與廢物處置相關的法例，以處理他們在香港科技園處所產生的有害廢物。有害廢物均有機會從香港科技園處所內進行營運、維修、建造及翻新工序及其他活動時產生。

香港科技園所產生的常見有害廢物可能包括：

- 生物/醫療廢物；
- 放射性廢物；
- 氣體排效，包括運送時所產生的溫室氣體及管制污染物；
- 廢溶劑及化學物；
- 各種操作所產生的廢油及潤滑劑；
- 不再需要、非符合規格、已受污染、已超過其使用壽命或無法使用的未使用化學物及其他有害物質，例如強酸和強鹼、油漆、氣霧罐等；
- 用過的乙二醇及其他冷卻劑；
- 印刷電路板、電池、含鉛油漆及其他雜物，包括受污染的抹布、破爛的含水銀燈管（螢光燈）及溫度計。

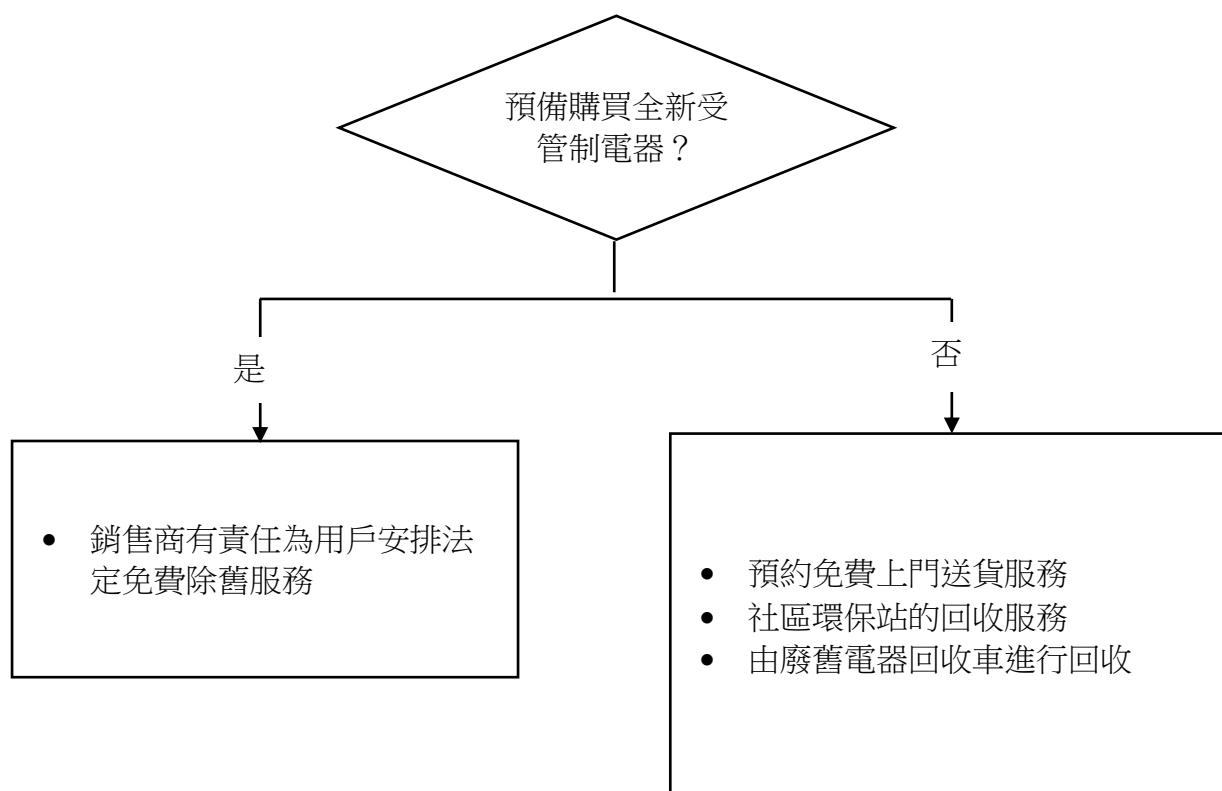
- b. 如在香港科技園處所工作期間，有有害物質釋出至環境中，則租戶/培育公司/承辦商須與香港科技園有關部門/設施管理處/實驗室設施管理處及政府部門聯絡。

C32 化學瓶處置程序

- a. 用於存放化學物質的玻璃或塑膠溶劑瓶可能會造成污染，因此不應回收。
- b. 如果將化學瓶當作一般廢物處理，丟棄前必須將這些瓶沖洗 3 次。必須確保在通風良好的地方或通風櫃進行沖洗。切勿用於可與水產生劇烈反應的化學物（有機金屬、金屬氫化物及自燃試劑）或劇毒試劑（苯酚、水銀試劑、氰化物試劑或其他試劑）。
 - 三次沖洗：
 - i. 每次沖洗時，應盡量潑濺最少水在有蓋容器四周。
 - ii. 第一次沖洗的污水是化學廢物，必須收集在適當的化學廢物容器中。第二次及第三次沖洗的污水可經排水渠排走。污水流入排水渠時，請確保水一直在流動。
 - iii. 在沖洗不溶於水的物質前，必須使用適當的溶劑（例如乙醇或丙酮）預先沖洗容器。所有沖洗的溶劑應收集，並作為化學廢料處理。
 - iv. 如果化學物對環境有害，則必須收集三次沖洗過程的所有溶液；
 - v. 如果不確定該化學物的毒性，請參閱其物料安全資料表。
 - 移除或刪去原有的標籤，並標記為‘已沖洗’
 - 參照一般廢物處理程序棄置已沖洗的化學瓶
- c. 要了解更多，請參考《化學廢物管制指南》：
http://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/waste/guide_ref/files/guide_e.pdf

C33 受管制電器廢物管理

- a. 租戶/培育公司/承辦商應履行生產者對受管制電器處置的責任。受管制電器包括：空調機、雪櫃、洗衣機、電視機、電腦、打印機、掃描器及顯示器。
- b. 生產者應按照法例要求適當處置受管制電器：



- c. 不得在香港科技園共用/公共地方棄置受管制電器廢物。
- d. 要了解更多，請參考有關廢電器電子產品網站：

<https://weee.gov.hk/>

C34 食物安全及衛生

- a. 香港科技園內的餐飲營運商需確保其租借及營運範圍符合所有食品安全及衛生管理的法例要求及租賃要求。
- b. 餐飲營運商應定期安排外部測試實驗室對食品安全衛生進行獨立審核，並將審核報告結果交給香港科技園。
- c. 食品安全衛生審核報告應包括抽取樣本（體檢）及微生物測試，以及食品質素標準、衛生標準及所有貯存的商品及產品的質素。
- d. 應從餐飲營運商每一份餐食中提取食物、水及冰塊，以進行抽取樣本（體檢）及微生物測試。如果餐飲營運商每天提供的食物不同（早午晚餐），則應在每一份餐食中提取食物樣本。
- e. 若香港科技園對審核結果有任何不滿意的地方，餐飲營運商須自費即時糾正不合資格項目並進行相關審核。（重新審核的詳細資料可參閱香港科技園與營運商的租賃合約）。
- f. 餐飲營運商在營運期間排放的廢物（固態、液態及氣態廢物）必須符合所有法例要求。營運商應定期抽取廢水進行廢水質量測試。
- g. 餐飲營運商不得在任何香港科技園處所內排放有害物質和不合標準的廢水至排水渠中。
- h. 餐飲營運商須負責其區域廢水處理設施（例如隔油池）的運作和維修及滅蟲工作。香港科技園保留要求營運商提交其廢水處理設施的運作和維修記錄/時間表及廢水質量檢測報告的權利，以進行審查。
- i. 如果發現從餐飲營運商排放了不合標準的廢物，則該經營者將承擔因排放而產生的所有責任和費用。
- j. 要了解更多，請參考食物環境衛生局發佈的《食物衛生守則》：

https://www.fehd.gov.hk/english/publications/code/code_all.pdf

Appendix

Appendix 1 – 與安全及健康相關的聯絡資料

香港科技園公司 SHE Office

如對本文件或科技園公司的安全、健康及環保規定有任何查詢，可與 SHE Office 聯絡：

電子郵件：she_office@hkstp.org

電話：2629 6793

香港科學園設施管理處 / 實驗室設施管理處聯絡資料

香港科學園設施管理處：

客戶服務

設施管理處（香港科學園）

富城物業管理有限公司

香港科學園科技大道西 1 號核心大樓二座二樓 213 – 215 室

電話：2639 8008

實驗室設施管理處：

實驗室設施管理服務中心（香港科學園）

林德港氧有限公司

香港科學園科技大道西 1 號核心大樓二座三樓 317 室

電話：2639 8738 傳呼機：71163322 （傳呼 8410）

實驗室設施管理服務中心（香港科學園 17W & 19W）

MGI (Far East) Limited

香港科技園科技大道西 17 及 19 號 19W 大樓 GM 層

電話：2639 8827

創新中心設施管理處聯絡資料

創新中心設施管理處：
置邦物業管理有限公司
九龍九龍塘達之路 72 號創新中心管理處
電話：2778 7061 傳真：2778 4782

工業邨聯絡資料

將軍澳工業邨 / 大埔工業邨 / 元朗工業邨：

Mr. Alex Chan
電話：2623 9619 / 9491 0034

大埔工業邨 GMP 中心設施管理處：

Mr. Kwok Man Fai
富城物業管理有限公司
電話：2660 0165

大埔工業邨 PMC Building 設施管理處：

Mr. Ronnie Kwok
置邦物業管理有限公司
電話：2856 3178

Appendix 2 – 與安全及健康相關的法例

以下是香港與職業安全及健康有關的條例及規例：

1.	氣體安全條例	第 51 章
2.	鍋爐及壓力容器條例	第 56 章
3.	工廠及工業經營條例	第 59 章
4.	工廠及工業經營規例	第 59A 章
5.	工廠及工業經營(應呈報工場的急救設備)規例	第 59D 章
6.	工廠及工業經營(職業病呈報)規例	第 59E 章
7.	工廠及工業經營(木工機械)規例	第 59G 章
8.	建築地盤(安全)規例	第 59I 章
9.	工廠及工業經營(起重機械及起重裝置)規例	第 59J 章
10.	工廠及工業經營(砂輪)規例	第 59L 章
11.	工廠及工業經營(在壓縮空氣中工作)規例	第 59M 章
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