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.

C05 Laboratory Chemical Safety Guidelines

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

C05 Laboratory Chemical Safety Guidelines

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, Dintrophenols, 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

C05 Laboratory Chemical Safety Guidelines

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 displaced on the box. The information can be referred to Occupational Safety and Health Ordinance (Cap.

509A) regarding first aid box requirements. The laboratory first aids 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.

C05 Laboratory Chemical Safety Guidelines

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.