The University of Hong Kong

Laboratory Design Guide

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1. Scope and Objectives

a. The University of Hong Kong is committed to ensuring the health and safety of its staff and students during the course of their work and study. As some staff and students have to work in laboratories where a number of hazards may be encountered, safety of laboratory work is an important part of the University's Safety Policy. Laboratory safety depends on both the activities and the facilities. This Laboratory Design Guide attempts to provide safety guidelines on the design of laboratory so that laboratory facilities are built with safety factored into the design from the very beginning.

b. Hong Kong does not currently have a comprehensive set of legislation and local standards related to laboratory design. Unlike the US, UK and Australia who can readily base their designs on relevant local standards, this Guide adopts provisions in relevant international standards that are applicable to the Hong Kong situation. There are however times when our local situation may not allow the direct adoption of the common international standards. Among other local constraints, the shortage of space, which is not unique to HKU, is one crucial factor that may call for variation from common international standards. When the matter concerned is not safety-critical, variation may well be justified. However, such deviations can only be justified after a careful assessment of their impacts on safety.

c. This Guide applies to all new laboratories and those that undergo major renovation. The objective is to provide a consistent and harmonized reference across the campus for laboratory design and to progressively raise the safety standard of laboratories in HKU.

d. It should be borne in mind that despite the lack of local laboratory standards, relevant local building legislation and codes must be complied with. In the unlikely event that discrepancies arise between this Guide and the legislation, legal requirements should take priority.

2. General Design Principles

The design of laboratory should conform to the following general principles:

a. A Laboratory should contain the microbiological, chemical, radiological or physical hazard as far as possible so that associated areas and adjoining public space are not affected by its activities.

b. Sufficient unobstructed space for safe working, including adequate space around large pieces of equipment for maintenance personnel, should be provided inside the laboratory.

c. Open spaces between and under benches, cabinets and equipment should be accessible for cleaning.

d. Corridors and passages to the exits shall be clear of obstructions.

e. Suitable and adequate spaces should be provided for the safe and secure storage of chemicals and designated laboratory waste prior to disposal.

f. In designing ventilation for the laboratory, effective separation between potentially contaminated areas and other areas should be considered. If possible, each area should have an independent air-circulating system.

g. Each laboratory where hazardous materials are used shall contain a sink for hand washing.

h. Emergency shut off/isolating device for piped-in town gas shall be prominently labeled and readily accessible on an exit path.

i. Safety equipment such as emergency showers, eyewashes, first-aid kits and spill kits should be readily accessible.

j. Suitable fire protection and detection equipment shall be installed in a laboratory according to the fire risk.

k. Special facilities should be provided for the safe access and egress of disabled persons where applicable.

3. Design Phase Consultation

a. The prospective user of a new laboratory should carry out a risk assessment prior to the design of the laboratory to ensure that the necessary safety provisions are built into the design. These considerations should then be formally communicated to the Estates Office and where applicable the architect/consultant of the project.

b. The laboratory design shall comply with all relevant regulations and codes of practice. Sufficient time should be allowed to obtain the relevant licenses or government approval (e.g. use of radiation) if applicable.

c. Consultation with the Safety Office should be made once the initial design concept and layout of the laboratory are available. Formal meetings among all concerned

parties (user, Estates Office, architect and the Safety Office) are the most effective ways of coming to consensus on safety provisions.

d. The following information should be made available by the user for each laboratory:

i. Type & function of the laboratory
ii. Layout & containment level if any
iii. Details of hazards associated with the work e.g. the expected amounts and types of chemicals stored in the laboratory
iv. Contaminants that are likely to be generated by the operations e.g. chemical vapours, gases, mists, aerosols, or objectionable odours
v. Equipment and apparatus to be installed especially those requiring local exhaust ventilation
vi. Conditions that may necessitate structural requirements (e.g. heavy loads)
vii. Anti-vibration or insulation requirements or other special hazards such as fire, explosion or radiation
viii. Types and amounts of wastes including hazardous wastes
ix. Locations of bulky, fixed or movable items of equipment & furniture in relation to the circulation paths, emergency egress, disturbance of air flows and lighting
x. Possible future expansion needs
xi. Other matters that could affect the project in the construction phase

4. Laboratory Space Utilization

a. Ideally, laboratories should be located on separate floors from offices. As a general principle, office areas should be separated from the laboratories. Access to offices or other non-laboratory areas should not require going through laboratory spaces. In the exceptional circumstances that it is not feasible to separate the two types of work areas, offices attached to a laboratory should be located near the exits of the laboratory.

b. Write-up areas provided in a laboratory shall be separated from areas where hazardous materials are used or hazardous processes are undertaken, and should not be used as a substitute for proper office areas. These write-up areas shall not be located right opposite a fume cupboard or biological safety cabinet, but should be located near the exit.

c. Sufficient floor space should be provided for refrigerators, freezers, incubators and large centrifuges. Furniture or equipment should not protrude into passage ways and exit routes of a laboratory.

d. Sufficient space and facilities should be allowed for the safe handling and storage of chemicals, compressed gas cylinders and other hazardous materials, etc. if they are to be used.

5. Support Area & Amenities

a. Space specifically for the storage of laboratory consumables and portable equipment, etc. should be provided in the design to help future housekeeping.

b. Support areas such as general stores and equipment rooms should be located strategically to facilitate services to the laboratories and to minimize transportation issues.

c. Rooms housing heat-producing and noisy equipment should be well air-conditioned and sound proofed if necessary. Doorways should be wide enough to allow delivery and removal of large equipment. Floor loading required by large equipment should be taken into account at the design stage.

d. Consideration should be given to the provision of a pantry or separate room for food & drink consumption to avoid eating & drinking in laboratories if a large enough laboratory working population is present.

e. Meeting or seminar areas should be separated from the laboratories.

f. Facilities for storage of street clothing and personal items of laboratory users should be provided outside the laboratory working areas.

g. Suitable hangers/cabinets should be provided near the laboratory exit for the hanging of the laboratory coats.

h. If other Personal Protective Equipment is used, suitable storage space shall be provided for those items.

6. Corridor and Aisle Clearance

a. Corridor widths and escape distances shall be maintained in accordance with the Building Codes of Hong Kong.

b. The minimum separation between benches and floor-positioned equipment should be according to the following:

No worker on either side	900mm
Workers on one side of the aisle, no through traffic	1000mm
Workers on one side of the aisle, plus through traffic	1000mm

Workers on both sides of the aisle, no through traffic	1400mm
Workers on both sides of the aisle, plus through traffic	1450mm

c. Widths may need to be increased to accommodate special equipment, access for disabled people, other requirements or hazards.

d. For clearance relating to Fume Cupboards and Biological Safety Cabinets, please refer to separate sections of this Guide.

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

7. Entries, Exits and Doors

a. Exit paths shall not be obstructed by furniture or equipment.

b. The number of exits required shall be in accordance with the relevant Building Codes.

c. Laboratory benches, other furniture and appliances such as chairs, stools, refrigerators, etc. must not impede emergency exit.

d. Laboratory access doors should be provided with self-closing mechanism and locks, and must be openable without the use of a key from inside at all times.

e. Doors should have viewing panels or alternative means of viewing the laboratory activities from outside.

f. Glass doors or panels should be made of tempered/toughened glass.

g. Doors should open into the laboratory; doors opening into the corridor should be recessed.

h. Exits shall be wide enough to allow routine transfer of laboratory equipment and gas cylinders where applicable; exits with double doors may be required.

8. Laboratory Surface Finishes and Materials

a. Flooring

i. The floor finish shall be smooth, impervious, easy to clean, slip- and wear-resistant and resistant to chemicals expected to be used in the laboratory and preferably of seamless construction.

ii. 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 should be considered.

iii. The floor surface shall be coved where it meets the walls and fixed benches

b. Walls

i. Wall surfaces should be free from cracks and unsealed penetration.

ii. Walls should be non-porous and painted with a durable, impervious finish to facilitate decontamination and cleaning.

iii. Corner guards and bumper rails should be provided to protect wall surfaces in high traffic or impact areas.

c. Ceilings

i. Ceiling heights should be sufficient to accommodate the safe installation of fume cupboards and Biological Safety Cabinets where applicable.

ii. Washable lay-in acoustic tiles should be provided for most 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.

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

9. Laboratory Furniture

a. Benches

i. All work surfaces shall be impervious to chemicals and materials used in the laboratory.

ii. Materials used should be of low emission of formaldehyde.

iii. Bench tops should be of seamless design. If the bench top is against a wall, it shall be coved or have a backsplash against the wall.

iv. Bench height should depend on the working position of the laboratory users. Typical bench is about 900mm high for standing work. A slightly lower bench top may be required for the use of tall apparatus.

v. Typical bench depth is in the range of 600 to 900 mm for ease of access to the rear of the bench. Deeper worktop may be required for specific and large equipment where access to back of the worktop from the front is not normally required.

vi. Sufficient leg/knee clearance shall be left under the bench top for persons who use the bench top as a working/write-up area.

b. Shelving

i. Shelves should be secured to walls or benches to prevent toppling.

ii. Shelves should be installed at a height that allows safe retrieval of items without overstretching.

iii. Double sided shelves should have a central partition to prevent items from being pushed through from one side to another.

iv. Shelves should be fitted with raised lips or guards along the outer edges to prevent containers from falling.

v. Shelves/hanging cabinets should allow for sufficient clearance from fire service installations in accordance with the fire codes or regulations.

vi. Shelves should be fitted where possible with doors to prevent settling of dust and aerosols inside.

vii. The use of glass doors in hanging cabinets should be avoided as far as possible. If glass doors have to be used, consider the use of toughened /tempered glass.

c. Laboratory stools and chairs

i. In wet laboratories, the upholstery of chairs and stools should be vinyl or other suitable impervious materials to prevent spills from going into the cushioning materials, and to facilitate cleaning.

ii. Stools should be ergonomically suited to the task, with adjustable height, back-rest and footrest. A 5-star base with glides is preferred, casters are not recommended for hazardous works.

iii. Task chair for computer workstations located in a laboratory should have the same features as office chairs but with non-absorbing fabric for a laboratory chair.

d. Sinks

i. Each laboratory where hazardous materials are used should have a sink for hand washing. A separate hand-washing basin should be provided for a biosafety level 2 or higher containment laboratories.

ii. Hand wash facilities should be provided close to the exit of the laboratory for hand washing immediately before leaving the laboratory.

iii. Taps in biosafety level 2, radiation and other high containment laboratories should be of hand-free operation e.g. elbow-, foot- or sensor- operated to prevent direct hand contact.

iv. Drainage systems must be provided with adequate seals or traps to prevent the escape of vapours or gases from the drainage system. Over provision of sinks should be avoided as infrequently used sinks may have their traps drying out over time thus creating odour problems.

10. Emergency Showers and Eyewashes

a. Laboratories handling hazardous substances that are corrosive, irritant, or toxic must have at least a safety shower and an eyewash.

b. Safety shower and eyewash equipment shall comply with appropriate international standards.

c. They shall be located in unobstructed and accessible locations.

d. The safety shower and eyewash should be located as close to the hazard as possible and be accessible within 10 seconds along an unobstructed pathway.

e. They 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.

f. The clearance between the shower head and the nearest obstruction (wall, vertical supply pipe or similar) shall be a minimum radius of 400 mm. There should also be no protrusions or sharp objects in this area.

g. Electrical apparatus, telephones, thermostats, electrical control panels, or power sockets should not be located within 0.5 m of the emergency shower or eyewash or within any area that may be considered as a splash or flood zone.

h. The emergency facilities should be clearly signposted to be easily recognized.

11. Laboratory Signposting

a. Each laboratory shall be identified clearly at each entrance. Emergency exits shall be marked so accordingly.

b. A Health and Safety Placard should be posted on the door of each laboratory indicating accurately the hazards that are present in the laboratory, personal protection required and the emergency contacts.

12. Physical Environment of Laboratory

a. Lighting

i. Each laboratory shall be naturally or artificially illuminated to a level that is optimal for safe working. Special colour-corrected lamps may be required where the correct identification of colour is important.

ii. 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.

iii. Benches located near windows should be protected from direct sunlight with the use of window blinds or protective film.

iv. Work surfaces should have a matt surface to minimize reflective glare.

v. Glare and distracting reflections should be minimized from other surfaces.

vi. Sudden changes in lighting intensity within work areas or at entrances and exits should be avoided.

vii. Supplementary lighting should be provided for equipment or work area if the main room lighting is not sufficient.

viii. When shelf-mounted task lighting is used, they should have protective diffusive covers to prevent glare.

b. Temperature

i. Any equipment generating excessive heat or chill should be isolated from the general workspace.

ii. Ambient temperature should be controlled as far as possible to a level compatible with laboratory workers' comfort when appropriate protective clothing is worn.

c. Noise

i. Selection and siting of equipment should take into account the noise generated by individual piece of equipment and their contribution to the cumulative noise levels in the work place.

ii. High noise-generating equipment should be segregated from the general work area.

13. Laboratory Ventilation

a. The general ventilation of a laboratory shall comply with relevant international standards for fresh air supply and thermal comfort.

b. Ventilation should be designed to provide sufficient fresh air, appropriate working temperature & relative humidity for the comfort of the occupants; to provide adequate air movement to remove airborne contaminants; and to provide sufficient make up air for the operation of the fume cupboards or other local exhaust equipment.

c. Ventilation should 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 contaminated areas.

d. Laboratory ventilation systems shall be totally separate from non-laboratory systems.

e. Air exhausted from a laboratory should not be re-circulated to other laboratories or non-laboratory areas.

f. 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.

g. Exhaust grilles and registers shall be located away from supply air diffusers in a manner that creates uniform, low velocity airflow across the room. The effectiveness of the supply or exhaust air should not be blocked by cabinetry, equipment, storage or other structures.

h. The 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.

i. 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.

j. Heat generated by appliances and activities in the laboratories should be factored into the design of the air conditioning system.

k. Laboratory ventilation ductworks shall not be internally insulated.

14. Relative Room Pressure Differentials

a. 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.

b. Laboratories in general should be maintained at a negative pressure relative to the corridors and non-laboratory spaces to prevent the escape of contaminants from the laboratories.

c. Office areas in laboratory buildings shall always be positive with respect to corridors and laboratories.

d. Special laboratories such as genome processing rooms, tissue culture laboratories, clean rooms, etc., may require positive pressure in relation to adjacent spaces. The users should be consulted at the design stage.

e. 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.

15. Emergency Exhaust/Ventilation

a. An emergency exhaust system should be installed in laboratories where hazardous chemicals 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.

b. A clearly labeled emergency exhaust button should be installed near the exit of the laboratory for activating the system.

c. The fume cupboards and other local exhaust systems should continue to operate after activation of the button unless manually shut down.

d. 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 maintenance system (BMS) if possible. Where such connection is impracticable, alternative means of direct communication with the building management staff should be established.

16. Local Exhaust Systems

a. Local exhaust systems should be installed to contain and exhaust locally generated air contaminants from specific equipment and processes, e.g. gas chromatographs, vacuum pumps, excimer lasers, AA spectrophotometers, etc.

b. Heat, steam, and odour generated by autoclaves/sterilizers should also be extracted and vented outside the building via local exhaust systems.

c. Local exhaust systems should be designed by professional engineers in consultation with the laboratory users in order to achieve the best efficiency.

d. Exhaust air containing toxic or nuisance contaminants 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 to render it safe before discharge.

17. Fume Cupboards

a. Fume cupboards shall be provided where laboratory work involves the generation of hazardous vapours, gases, mists or fumes etc.

b. Fume cupboards shall meet one of the following relevant international standards - BS14175, AS/NZS 2243.8 or ASHRAE 110.

c. The proper operation of fume cupboards shall be tested on site by the supplier/contractor after installation according to recognized international standards in the presence of staff of Safety Office.

d. 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.

e. All fume cupboards shall be equipped with a sash stop to limit the sash opening and equipped with an alarm to indicate opening beyond the sash stop.

f. An airflow indicator visible from the front of the fume cupboard with audio & visual alarms shall be provided for each fume cupboard.

g. Electrical outlets, valves, and switches for utilities shall be placed at readily accessible locations outside the fume cupboard. Vacuum lines should go through the sides of the fume cupboard and not the bench top.

i. Fume cupboards should be located away from high traffic areas, air supply diffusers, doors, operable windows and other sources of air disturbance:

- There shall 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.
- Any bench opposite it should be at least 1.8 m from the sash of fume cupboard.
- There should be no opposing wall or other large obstruction within 1.8 m of the sash.
- A fume cupboard should not be located with either side closer than 300 mm to a wall or similar obstruction that extends past the line of the face of the fume cupboard.
- Doorways should not be within 1.5 m of the sash or within 1 m of the side of a fume cupboard.

j. A fume cupboard should not be located adjacent to an exit, particularly when there is only one single exit from the laboratory.

k. Fume cupboards should not be installed face to face or opposite a biological safety cabinet as far as possible.

l. Workstations where personnel will spend much of their working day, such as desks or microscope benches should not be located opposite the front openings of fume cupboards as materials splattered or forced out of a hood may present a risk to them.

m. Perchloric acid fume cupboards

Heating of perchloric acid shall only be done in a specially designed fume cupboard – "Perchloric Acid Fume Cupboard". The user and the Estates Office should consult the Safety Office on the appropriate design and standard of this type of fume cupboards.

n. Radioisotope fume cupboards

Radioisotopes shall only be handled in a specially designed fume cupboard – "Radioisotope Fume Cupboard". The user and the Estates Office should consult the

Safety Office on the appropriate design and standard of this type of fume cupboards.

o. Perchloric acid and radioisotope fume cupboards must be properly labeled and specifically designed for the use.

p. Exhaust ducts and fans

- Ductwork should have no pockets where airborne gases or particles can be trapped.
- Fan motors and controls should be located outside the air stream of exhaust systems, unless they are specifically designed to handle the exhaust air.
- Exhaust should normally be ducted to the roof top level.
- 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.
- 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 should be arranged so that shutting down one fume cupboard will not reduce or affect the exhaust capacity of other cupboards manifolded to the same system.
- 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.
- Automatic fire dampers shall not be used in laboratory hood exhaust systems.
- Exhaust of fume cupboards and other contaminated sources shall not be re-circulated into the building air supply including adjacent buildings.
- The exhaust stack outlet should be at least 3 meters above the roof. If parapet walls are present, stacks should be further extended.
- Exhaust from fume cupboards shall be located as far away from air intakes of buildings as possible.
- 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.
- Exhaust fans should be located outside the building at the point of final discharge so that the ductwork through the building is under negative pressure.
- Fans should be installed so they are readily accessible for maintenance and inspection.
- The exhaust fan & duct system should be labeled to show their connection to the fume cupboards in the laboratories.

18. Biological Safety Cabinets

a. Biological Safety Cabinets shall be provided in laboratories where work involves infectious biological agents or cell culture etc. There are three main classes of biological safety cabinets. Laboratory users and the Estates Office should consult the Safety Office on the most appropriate class to be used if in doubt.

b. A cytotoxic drug cabinet should be used if such drugs are handled. A biological safety cabinet is not a substitute for a cytotoxic drug cabinet.

c. Biological safety cabinets must be certified after installation by the supplier according to international standards (e.g. BS5726, AS2647) in the presence of staff of Safety Office.

d. Biological safety cabinets should be located out of the traffic flow, away from doors, openable windows, air supply registers, fume cupboards or laboratory equipment that creates air movement affecting the containment. The following should be observed:

- The distance from the sash to any traffic route shall be at least 1 m so as to preserve an undisturbed zone in front of the biological safety cabinet.
- The distance between the sash and any bench opposite it should be at least 1.5 m where occasional traffic only is anticipated.
- There should be no opposing wall or other large obstruction within 2 m of the sash.
- The distance to the aperture of an opposing safety cabinet, fume cupboard or the edge of a local exhaust ventilation outlet should not be less than 3.0 m
- A 300mm clearance should be provided on each side of the cabinet. Clearance on top of the cabinet should preferably be 600mm to allow free airflow and room for testing and maintenance of the HEPA filter.
- Doorways should not be within 1.5 m of the aperture or within 1 m of the side of a biological safety cabinet.
- Any room air supply diffuser should not be within 1.5 m of the front aperture.

e. There should be sufficient make up air if they are exhausted to outdoors.

f. When the cabinet exhaust is ducted to outdoors, the cabinet shall be fitted with an automatic anti-blowback device downstream of the filter to prevent air flowing back into the cabinet.

g. The discharge of a biological safety cabinet should be sited in consideration of the airflow pattern around the building and should be away from open windows or air intakes of the same and neighbouring buildings.

h. Where biological safety cabinets are directly (hard) connected to the exhaust system, an audible and visual alarm system indicating the loss of exhaust flow in the external duct shall be provided.

19. Air Cleaning for Laboratory Exhaust Systems

a. Room HVAC systems generally do not require air cleaning prior to release to the environment except for high containment laboratories.

b. In case where filters are installed, the flow rate through the filters shall be maintained at design specifications and shall not exceed the rated flow capacity of the filters.

c. The filtration media used for the cleaning of gases and vapours shall be clearly specified for its intended use.

d. Main filters shall be protected by pre-filters to minimize the cost and hazards associated with frequent replacement.

e. Appropriate alert system should be installed to indicate when filters should be replaced.

f. Filtering systems shall be designed in such a way that will allow filter testing and replacement in a safe manner in future.

20. Electrical Services

a. General power outlets should be above the bench height. Ceiling-mounted, pendent drop or floor-mounted receptacles should be provided as needed for laboratories where equipment will be located away from walls to avoid trailing cables on the floors.

b. Electrical socket outlets, outlets for telecommunication appliances and outlets for computer networks should not be positioned near water sources.

c. Electrical outlets should also be positioned as far as possible from valves for flammable gases.

d. All socket outlets shall be fitted with residual current protection devices.

e. Specialized essential equipment such as fume cupboards, biological safety cabinets, incubators, freezers, etc. may require uninterrupted power supply for safety or other reasons. They should be taken into consideration in designing the laboratory power supply system.

f. Emergency lighting and illuminated exit signs shall be provided to facilitate emergency evacuation in the event of power failure.

g. Splash-proof or water proof sockets should be provided for some special applications e.g. aquarium.

21. Compressed Air and Vacuum Systems

a. Compressed air or vacuum system can be in form of a piped-in service from a central compressor/ vacuum system or from a laboratory fitted compressor/vacuum unit.

b. Compressor units must be registered and inspected in accordance with the Boilers and Pressure Vessels Ordinance of Hong Kong.

c. Vacuum systems must be fitted with in-line filters and drain traps at accessible locations, and should be discharged outside the building at a location away from outdoor air intakes.

22. Gas Cylinders

a. Gas cylinders should be stored in well ventilated and cool places and protected from direct sunlight or other direct sources of heat.

b. Gas cylinders should be located away from traffic zones; not in any common passageways, stairways or doorways.

c. Infrequently used cylinders should be stored outside the laboratory, in the University's Dangerous Goods Stores or returned to the gas supplier where possible.

d. 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.

e. Exposed pipe work for other gases should be protected from accidental damage and marked clearly.

f. Adequate space should be provided for the segregation of gases by hazard class (e.g., flammable, oxidizing, toxic or corrosive).

g. Enclosed storage area for gas cylinders should be ventilated to prevent the potential build-up of leaked gases.

h. 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.

i. Suitable gas detectors should be installed for early detection of possible leaks from the toxic or flammable gas cylinders where ventilation is limited.

j. 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. The Safety Office should be consulted on the details if in doubt.

k. 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.

l. All gas cylinders must be individually restrained. Each individual restraint should be 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.

m. Storage and use of cylinders of highly toxic gases shall be within ventilated gas cabinets with the following features:

- Gas cabinets shall be operated at negative pressure and be connected to a non-recirculating exhaust ventilation. Air inside the cabinet shall be vented both at the top and bottom level to ensure adequate purging from minor gas leakage.
- With the doors closed, extraction rate should be at least 10 air changes per hour when using flammable and fire supporting gases, and at least 120 air changes per hour when using highly toxic gases. The pressure drop shall not exceed 150 Pa.
- Gas cabinets shall be fitted internally with sensors with audible alarms to notify personnel in the event of a leak or a system failure.
- Each gas cabinet shall contain no more than 3 gas cylinders.
- The cabinet should be constructed in such a way that cylinders can be moved in and out with minimal difficulty.
- Restraining devices should be installed within the cabinet for securing cylinders.

23. Hazardous Material Storage in Laboratory

a. Hazardous chemicals (at least corrosives, flammables and highly toxics) should be stored in purpose-made storage cabinets.

b. Incompatible classes of chemicals should be stored in separate cabinets.

c. Lockable cabinets or other means of limiting access should be designed for specifically regulated materials.

d. The maximum quantities of chemicals stored in any laboratory should be kept to a minimum and should not exceed the exempted quantities specified in the Dangerous Goods (general) Regulation. The Safety Office should be consulted on the details if in doubt.

e. The shelving inside storage cabinets should be designed to contain spillage of the stored contents.

f. Metal cabinets should not be used for the storage of corrosive materials unless the materials are specifically treated to be corrosion-resistant.

g. Flammable liquids must not be stored in hanging cabinets.

h. Flammable storage cabinets should not be located near exits, doorways or at locations that would impede egress.

i. The doors of flammable storage cabinets should be self-closing.

j. Metal storage containers for flammable liquids shall be properly earthed to avoid static charge.

g. If chemical storage cabinets are vented, they should 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 or through a flame arrestor to a fume cupboard exhaust system. If they are not vented, the vent openings should be sealed by the manufacturer.

h. Flammable liquids that require refrigeration shall be stored only in “explosion-safe” non-spark refrigerators. Domestic refrigerators shall not be used for this purpose.

24. Chemical Stores

a. Chemical store rooms may be built next to laboratories for storing sufficient stocks of chemicals to cater for the short-term needs of teaching and research. Amounts

of chemicals stored should not exceed the exempted quantities specified in the Dangerous Goods (general) Regulation. Larger amounts should be stored in the University's licensed Dangerous Goods Stores. The Safety Office should be consulted on the details if in doubt.

b. Chemical stores should be provided with sufficient natural or mechanical ventilation to prevent the build-up of gases or vapours emanating from the chemicals in storage.

c. A chemical resistant impervious coating shall be applied to the walls and floor to make it easier to clean up.

d. The storage area shall be designed to contain any accidental spill. A curb around the area, secondary containment trays or shelving, etc. should be provided for the purpose. The area should be thoroughly caulked and sealed to minimize pest harborage and exclude pests.

e. Emergency safety shower and eye wash should be provided either at the entrance or at a nearby location.

f. The store should be located at an easily accessible area to facilitate deliveries and collections.

g. For stores built specifically for flammable liquids, the exhaust fans, lighting, electrical installations and power outlets should be spark-proof. The entrance should bears a conspicuous warning sign indicating that the store contains flammable liquids.

25. Hazardous Waste Stores

a. Suitable areas shall be provided for the safe temporary storage of solid or liquid hazardous wastes (biological, chemical or radioactive) collected from laboratories.

b. Storage areas should be designed to contain any spills that may occur during handling of the waste.

c. These areas should have access control but be accessible to both the laboratory personnel and approved waste collector.

d. Different types of hazardous wastes have different requirements. Consult the Safety Office on the designs of storage areas if necessary.

26. Liquid Nitrogen and Other Cryogenic Liquids

a. Areas for storage of liquid nitrogen and other cryogenic liquids should have good and sufficient ventilation to prevent the build-up of nitrogen gas.

b. Regularly calibrated oxygen deficiency detectors should be installed for those storage areas where the ventilation is limited or doubtful.

c. If large tanks of cryogenic liquids are to be stored and handled, sufficient room and facilities should be allowed for their manipulation.

d. Means of transport of liquid nitrogen tanks to and from the laboratories should be considered at the design stage e.g. service lifts. Paths of transport of such tanks should be separate from heavily used public thoroughfare.

27. Cold Rooms & Specialty Rooms

a. Cold rooms used for laboratory work should be provided with sufficient ventilation and fresh air during period of occupancy.

b. Cold rooms must be provided with doors that are openable from inside without the use of a key to allow emergency escape.

c. 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.

d. Emergency lighting should be provided in cold rooms to prevent blackout.

e. Doors of walk-in specialty rooms must have viewing windows and external light switches in addition to the internal switches.

28. Biological Laboratories

a. In addition to the relevant design features outlined in the above sections, all laboratories involving the use of biological materials should comply with the design specifications of WHO Laboratory Biosafety Manual.

b. For Biological Safety Level (BSL) 2 laboratories, the following on top of the general laboratory features are required:

i. Limited/Authorised access should be factored into the design. The doors should be self-closing and lockable.

ii. A dedicated hand-washing basin in the laboratory, preferably near the exit, should be provided. Taps should be elbow-, foot- or sensor-operated.
iii. Emergency shower and eyewash facilities should be provided in each laboratory.
iv. An appropriate number of biological safety cabinets should be provided.
v. The ventilation system should provide an inward flow of air from the corridor and does not recirculate air into other areas.
vi. An autoclave or other means of decontamination should be provided in an appropriate location inside or close to the laboratory.
vii. Essential equipment such as biological safety cabinets, freezers, ventilated animal cages etc. should be on emergency electricity supply.

29. Radiation Laboratories

a. The laboratory design should comply with separate guidelines on "Controlled" or "Supervised" Areas stipulated by Safety Office.

b. The Safety Office should be consulted on the laboratory design prior to construction.

c. The laboratory and its equipment must be inspected and tested by the Safety Office to ensure compliance with the requirements before work starts.

30. Laboratories with High Power Lasers

a. The design should conform to a separate "Code of Practice on the Use of High Power Lasers" issued by the Safety Office.

b. The Safety Office should be consulted on the laboratory design prior to construction.

31. Laboratories with Static Magnetic Fields

a. As part of the design process, the static magnetic fields in the facility shall be mathematically modeled to identify where pacemaker hazards (>5G) and kinetic energy hazards (>30G) will exist. Places where excessive whole-body exposures (>600G) could occur shall also be identified and provisions to prevent access to these places shall be made in the design

b. Provisions shall be made for laboratory personnel to securely store their metallic items such as key, wristwatches, and other ferrous-alloy tools before entering areas where the magnetic field exceeds 30G.

c. Appropriate discharge mechanism shall be provided to exhaust cryogenic gases from quenched superconducting magnets to outside to avoid creating an oxygen-deficient atmosphere. Doors of laboratories that may be subjected to the effects of gases during a quench shall open outwards to ensure that they are still operable during pressurization.

d. Readily visible warning signs for persons with cardiac pacemakers as well as other prosthetic devices shall be posted on laboratory doors to identify such areas.

32. Laboratories with UV Radiation

a. Provisions should be made to restrict access to authorized persons only.

b. The entrance door and operation of UV lights should be interlocked to prevent accidental exposure.

c. Special warnings should be posted for locations where irradiance could exceed Maximum Permissible Exposure Levels. The Safety Office should be consulted if in doubt.

d. All glass panels, windows, or visible access to the area should be covered with UV-rated material for the particular wavelength of the UV source.

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