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

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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					
	Severity of Consequences				
Likelihood of Occurrence	**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, 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)

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.

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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 Cryogens

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 cryogens such as liquid nitrogen	• Wear goggles, face shield and cryogenic gloves when handling cryogens. • Transport cryogens carefully in appropriate dewar flasks or containers.
Asphyxiation caused by accumulation of cryogenic gases	• Handle cryogens 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 cryogens.	• 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.