NUS National University of Singapore

RISK MANAGEMENT
For Laboratories

Office of Safety, Health and Environment

10 May 2012

Objectives

- **Conduct Risk Assessment by**
  - Identifying hazards in laboratories,
  - Evaluating risks, and
  - Recommending appropriate control measures
- **Execute Risk Management by**
  - Implementing and communicating control measures
  - Reviewing the effectiveness of control measures

Course Outline

- Overview of Risk Management
- Preparation Work
- Hazard Identification
- Risk Evaluation
- Risk Control
- Summary of RA Methodology
- Record Keeping
- Implementation & Review
- Effective Risk Management
- Hands-on Exercise
- Risk Assessment Assignment

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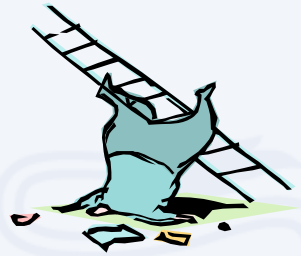
OVERVIEW OF RISK MANAGEMENT

Why Risk Assessment

We need to eliminate / control risk.

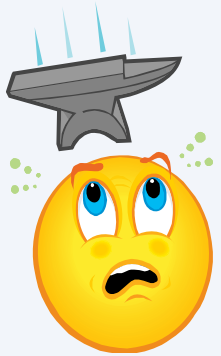
We think we are safe…



Things do happen!!!

We need to know where the concerns are, and set priority….

Why Risk Assessment



- **Protect Ourselves from injuries**
- **Prevent accidents and incidents**
- **Assess if a work process is safe to proceed**
- **Assess the adequacy of the existing control measures**
- **Compliance with legal requirements**

  -Workplace Safety and Health (Risk Management) Regulations

Common Misconception

- Accident can't be prevented.
- We don't have many accidents.
- Safety is expensive.
- We are insured anyway.
- There's no hazards in my jobs.
- We are experienced.

- **However, ……**

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Volume 83, Number 21
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FIGHTING LAB FIRES

Explosion and fire at an Ohio State University chemistry lab highlight safety issues in academia

DESTROYED Coleman's lab after the April 8 explosion and fire at Ohio State.

COURTESY OF OSU

WILLIAM G. SCHULZ, C&EN WASHINGTON

Friday evening, April 8, should have been routine for the chemistry graduate students finishing up a day's work in professor Robert S.

E-mail this article to a friend
Print this article
E-mail the editor

Consequence of safety lapses – Lab and research work destroyed!

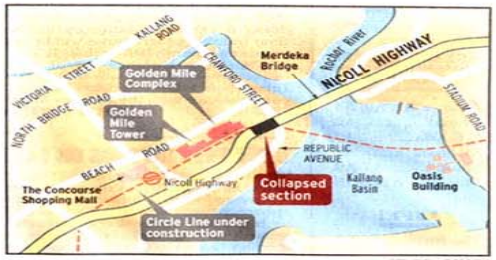
Internet

start Disconnected... ChBME prese... Presentation1 2 Microsoft ... 2 Microsoft ... C&EN: GOVE... 7:05 PM

However, ……

MRT worksite collapse wrecks Nicoll Highway

- One dead, three hurt, three missing
- Thousands of commuters hit
- Highway will stay closed for months



ST GRAPHICS

By SHARON LOH

A MASSIVE collapse of a Mass Rapid Transit (MRT) construction site yesterday afternoon wrecked a stretch of Nicoll Highway, which will now be closed for many months.

The mid-afternoon accident near the Merdeka Bridge killed one construction worker and injured three others. Three men were missing and feared dead.

By last night it appeared that the accident occurred after a temporary supporting wall for a tunnel of the MRT's Circle Line collapsed.

There might have been more casualties, except that most of the site workers were having their tea break when the tragedy happened.

While completion of the Circle Line now looks likely to be delayed, thousands of commuters must now use alternative routes into and out of the city, and put up with congestion for several months while the highway is repaired.

The volume of traffic disrupted is unprecedented, the Land Transport Authority (LTA) said.

Everything happened very quickly yesterday afternoon.

Thai construction worker Vehakul Somchia, 28, was bringing tools down to the site at about 3.30pm when he saw a crane and wall collapse.

He dumped his tools and ran.

"I just knew that I must get off this bridge or I would fall in and die," he said. "When the crane sank into the ground there was a man inside."

Within minutes, the surrounding area caved in, leaving a gaping ravine 30m deep strewn with twisted steel beams, rubble, cranes and excavators.

Motorists ground to a halt in time, as a 100m stretch of the highway collapsed.

Home Affairs Minister Wong Kan Seng arrived at the scene and assured the public: "There is no indication that this is foul play."

Transport Minister Yeo Cheow Tong, who came in the late afternoon, said the surrounding buildings were safe, and the top priority now was the search and rescue operations, involving some 75 firefighters and rescue dogs.

'THERE IS NO INDICATION THAT THIS IS FOUL PLAY.'
— Home Affairs Minister Wong Kan Seng

'JUDGING FROM THE SCALE OF THE IMPACT, IT WILL BE MANY MONTHS BEFORE WE CAN OPEN THE HIGHWAY.'
— Transport Minister Yeo Cheow Tong

The body of a Malaysian crane operator in his 40s, Mr Vadivil Nadason, was brought out at 6.15pm, while search teams worked on to find three others believed to have been driving machinery at the bottom of the site when the wall came down.

Three others were injured and taken to hospital. Two were later discharged from Tan Tock Seng Hospital — an Indian national, 25, and a Singaporean, 47, both with leg injuries.

A Thai worker, 21, with head injuries is still at the Singapore General Hospital.

Even as curious onlookers crowded the area, police cordoned off Merdeka Bridge and sealed all roads leading to Nicoll Highway.

The impact of the accident was felt far and wide.

As Nicoll Highway sank, gas, water and electricity cables snapped, causing power to go out for about 15,000 people and 700 businesses in the Marina and Suntec area.

Tenants and residents in the Golden Mile Complex, near the collapsed stretch, were also evacuated.

Several callers to The Straits Times said they heard an explosion, while others reported blackouts.

Though some eyewitnesses said they saw flames flash across Nicoll Highway, the LTA said it had no evidence of an explosion.

When leaking gas was detected, Power Gas shut off the supply to the severed pipe, said Mr Rajan Krishnan, LTA's director of projects, at a news conference last night.

The loud sound of the collapsing wall "might have sounded like an explosion", he said.

Electricity was restored at 3.50pm.

The huge boom which sounded at 3.30pm sent many office workers scurrying to their windows, to be stunned by what they saw.

From his 18th-floor office at Golden Mile Tower, Mr Vincent Chan, 28, said he heard a loud sound "like a huge aircraft approaching the building".

Rushing to the window, he saw a ball of fire on the far side of Nicoll Highway.

"Then the steel reinforcements lying horizontally across the road started to fall into the hole one by one, like dominoes," he said.

Others ran out of their buildings for safety.

Ms Sirirat, 48, a permanent resident from Thailand, was sewing in her shop on the first floor of the Golden Mile Complex when she heard a loud bang.

"I saw many women running out of their shops," she said. "They said: 'Gas explosion! Run for your life'. So I followed them. I thought it was a bomb."

Speaking to reporters yesterday, the Transport Minister said the LTA would now stabilise the ground and ensure the buildings in the area remained secure.

"Tunnelling has been going on for many years but this has never happened before," he said.

"LTA will do its utmost to repair the damage and the rest of the Circle Line project will continue."

The LTA said it could be six to nine months before Nicoll Highway might be opened again.

[More reports and pictures, HOME: H1-H3]


A 30m-deep ravine opened up within minutes of the first collapse, which has initially been blamed on a temporary supporting wall.
WONG KWAI CHOW

Straits Times, 21 April 2004

Workplace Safety & Health Act

Risk Assessment is a legal requirement under Workplace Safety and Health (Risk Management) Regulations 2006

- A subsidiary legislation of the **Workplace Safety & Health Act**
- came into operation on **1 September 2006**

Workplace Safety & Health Act

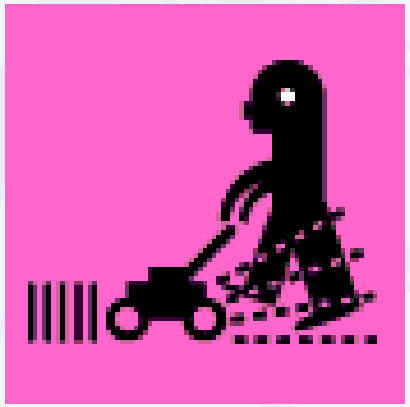
The WSH (Risk Management) Regulations require employers, the self-employed and principal (including contractor and sub-contractor) to conduct risk assessments for the purpose of identifying workplace safety and health risks and implementing measures to control the hazards and reducing the risks.

- **Compliance achieved via the NUS Risk Assessment System**
  - –Risk Assessment required for Teaching and Research work
  - –Moving towards a Lab (OH&S) Certification Scheme

What is hazard?

Anything with the potential to cause **bodily injury**, and includes any physical, chemical, biological, mechanical, electrical or ergonomic hazard.

WSH (Risk Mgt) Reg 2006.



What is Risk?

The Likelihood that a hazard will cause a specific bodily injury to any person.

WSH (Risk Mgt) Reg 2006.

Measured in terms of:
Severity and **Likelihood**

What is Risk?

Severity (Consequences of accident or ill health)

Degree or **extent** of injury or harm caused by hazard, or as a result of an accident

Likelihood (probability of accident or ill-health)

The **probability** or **frequency** of an event occurring

What is Risk Assessment?

It is the process of

1.identifying safety and health hazards associated with work, (**Hazard Identification**)

2.assessing the level of risks involved, (**Risk Evaluation**)

3.prioritizing measures to control the hazards and reduce the risks (**Risk Control**)

A guide to WSH (Risk Mgt) Reg by MOM

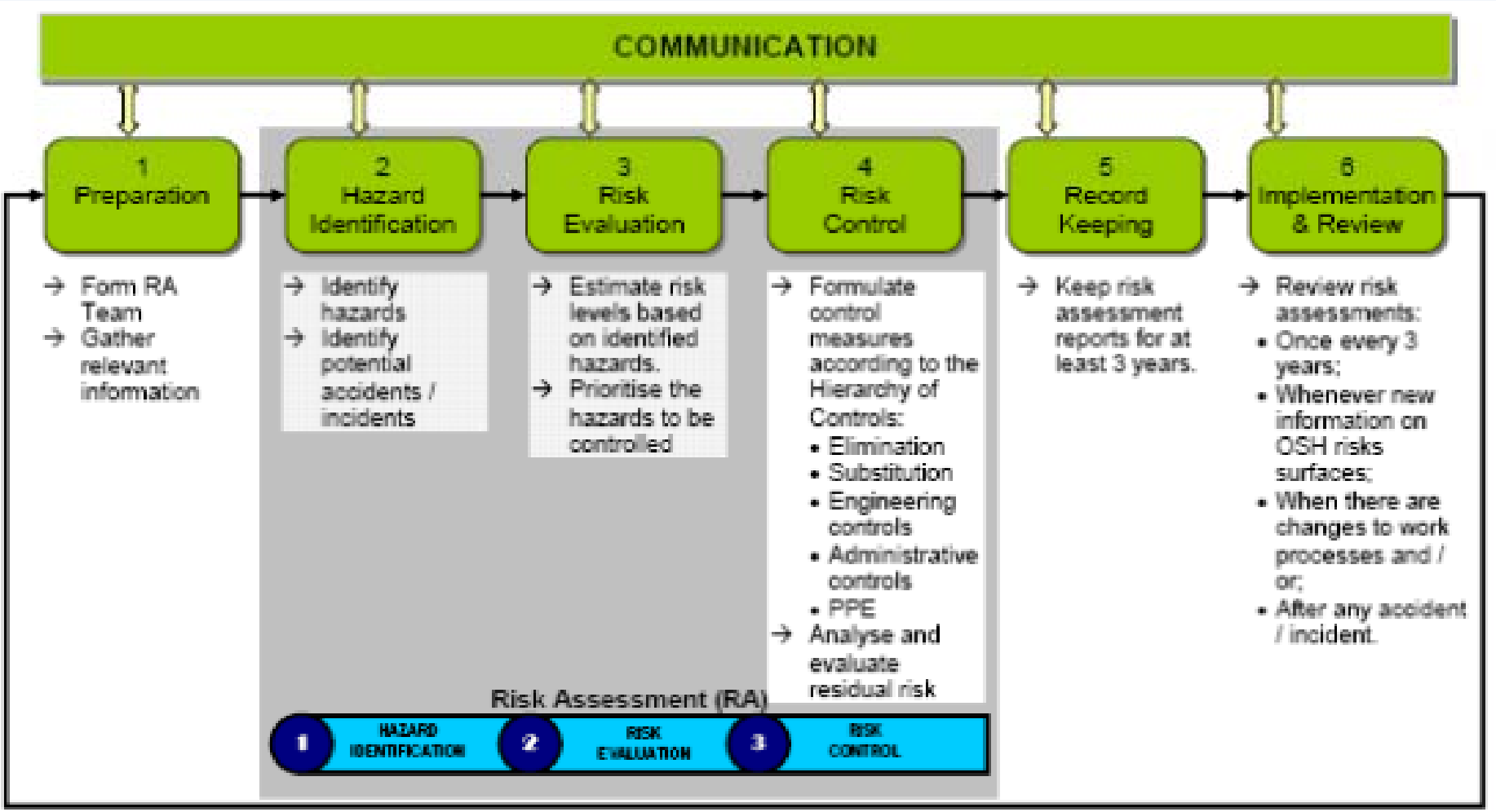
What is Risk Management?

It is a systematic approach to:

- **Assess** risks associated with any work activity (*Risk Assessment*)
- **Communicate** these risks to all persons involved
- **Control and monitor** such risks

Risk Assessment is an integral part of Risk Management.

Risk Management Process Flowchart



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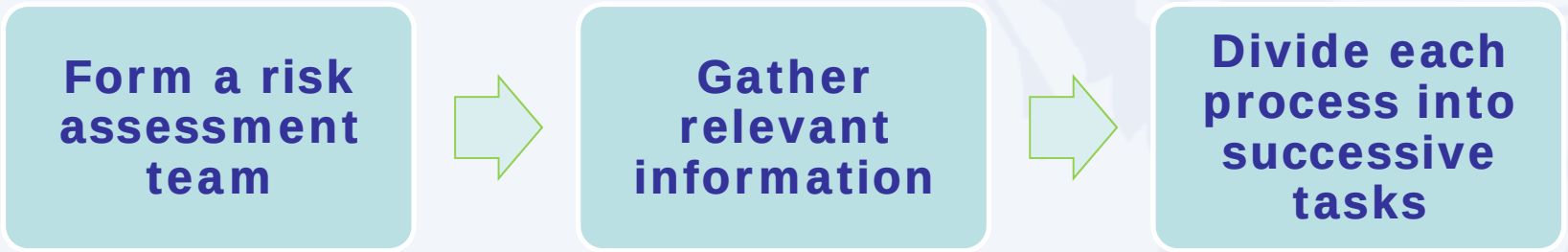
PREPARATION WORK

Preparation Work

Preparation work includes:

- **From a Risk Assessment Team** and appoint a team leader with roles and responsibilities clearly defined,
- **Gather relevant information**
- **Break down each process/procedure** into successive tasks



Risk Assessment Team

Risk Assessment should be conducted by

- the one who is **competent** of the hazards - **Principal Investigator**
- a team who have **thorough knowledge** of the work to be undertaken – **PI and his/her team**

Never a one man show!!!

Role of OSHE – Training & Guidelines

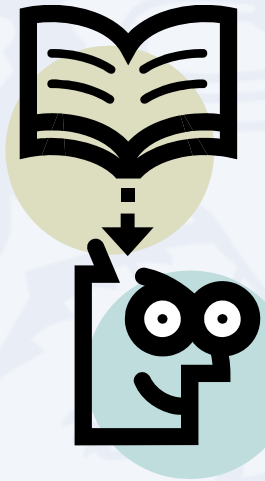
Review of RA - HOD, safety committees

Information Needed for Risk Assessment

- Laboratory layout plan
- Process flowchart
- List of work activities in the process
- List of chemicals, equipment, machinery, tools used
- Safety Data Sheets, Operation Manuals
- Records of past incidents and accidents
- Relevant legislation, codes of practice or specifications

Information Needed for Risk Assessment

- Observations and interviews
- Past inspection records & audit reports
- Details of existing risk controls & Safe work procedures (SWPs)
- previous risk assessments
- Feedback

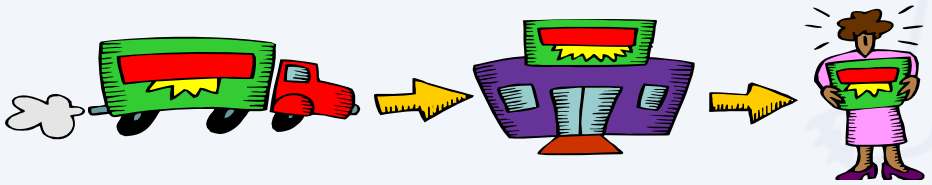


Break Down of Process

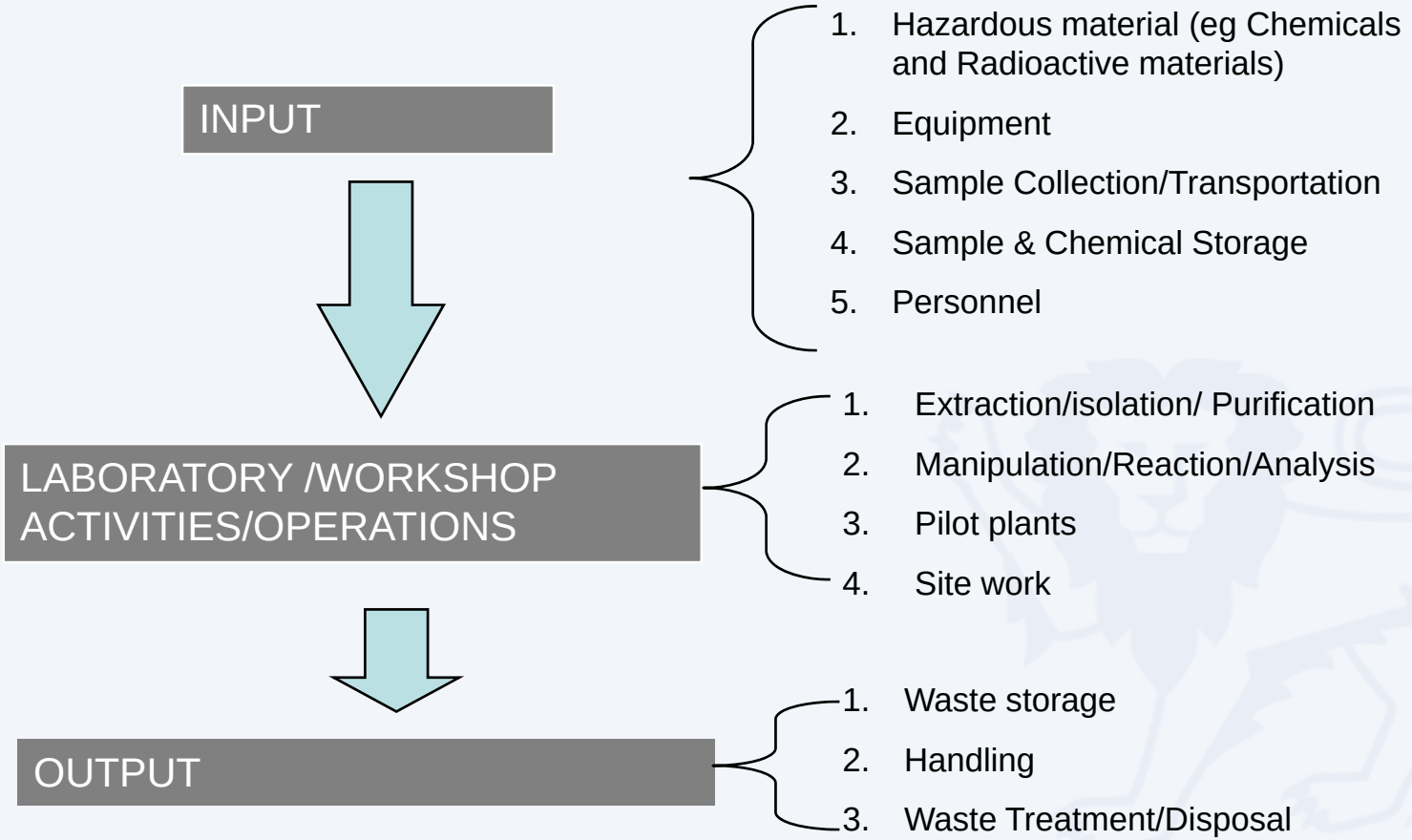
Break down each process/procedure into **successive tasks** as far as possible so that the hazards of each task can be identified for evaluation of safety & health risks.

If the tasks are made too general, specific operations and related hazards may be missed.
Too many tasks may make the Risk Assessment impractical.

Rule of Thumb: **Most experiments can be described in less than 10 tasks, normally 6 – 8 tasks.**



Break Down of Process



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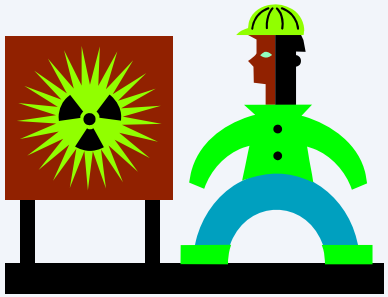
HAZARD IDENTIFICATION

Hazard Identification

Identifying hazard is the most important step in risk assessment, because *hazards can only be controlled if they are identified.*

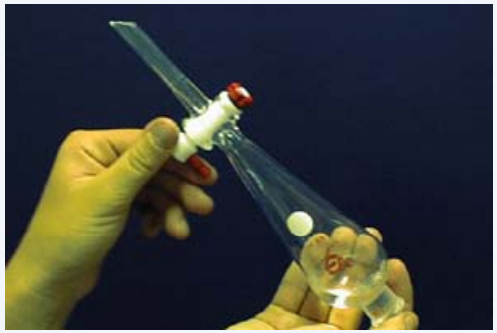


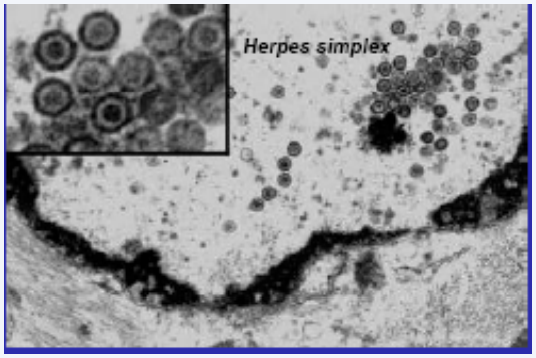
What to Identify?

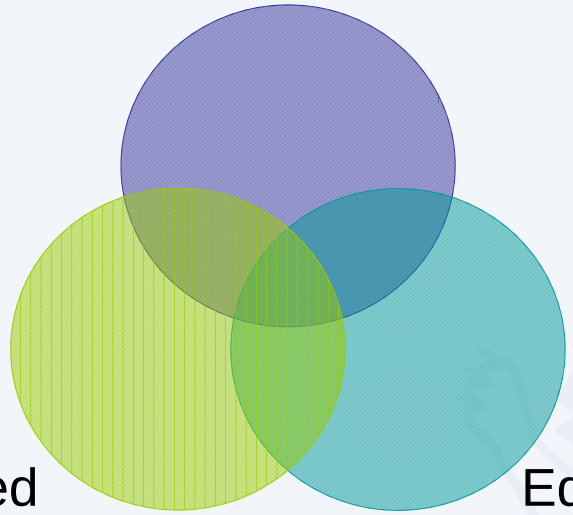
- The **hazard** associated with the activity of each process/procedure;
- all the possible types of **accidents**, **incidents** and/or **ill-health** that can occur due to the hazards; and
- identify potential **persons-at-risk**

Hazard Identification Methods

Procedural Based







Substance Based

Equipment Based

Scope of Hazard Identification

Should consider :

Routine / Non-routine Activities

Normal / Abnormal / Emergency Conditions

***Normal Condition*: situation whereby the outcome is within expectation without any deviation whatsoever**

***Abnormal Condition* : situation whereby the outcome is beyond expectation and can be normalized easily**

***Emergency Condition* : Situation with catastrophic effect and external parties are needed to normalize the situation**

What are the Hazards in a laboratory?

- Chemical
- Biological
- Radiation
- Mechanical
- Physical
- Environmental
- Energy
- Human factor

Chemical Hazards

- Flammability;
- Explosive nature;
- Toxicity;
- Carcinogenic;
- Teratogens;
- Mutagenic;
- Asphyxiant;
- Irritants

Where can such information be obtained?

Biological Hazards

- Animals (poisons vs physical wounds)
- Infection (pathogenic bacteria, viruses, molds)
- Health care facilities, waste treatment operations, normal field activities
- Sharps, biological equipment

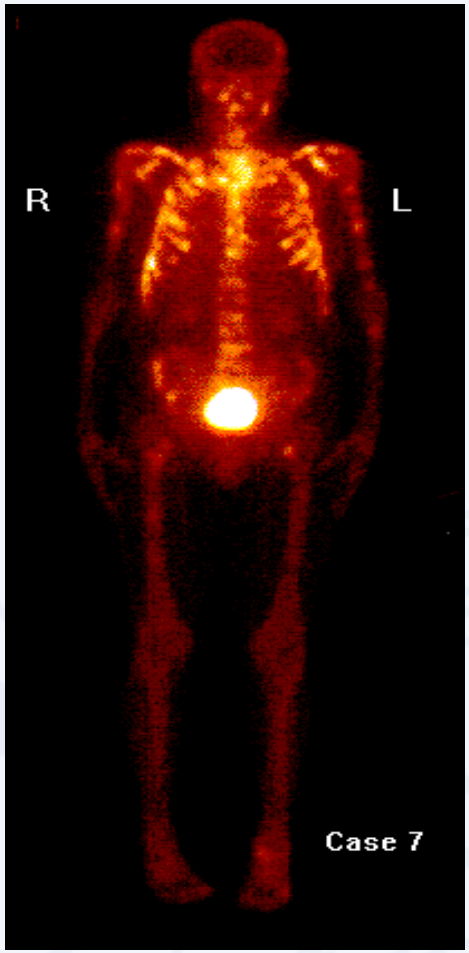
Radiation Hazards

Ionizing sources

- Alpha particles, beta particles, gamma rays, x-rays (Half life, quantity, type of radiation)

Non – Ionizing sources

- Sun lamps, arc welding, lasers (class of laser), sonicators



Mechanical Hazards

- Protrusion
- Sharp Edges
- Moving Parts/machinery
- Nipping or Pinch Points
- Acceleration (Inadvertent motion)
- Deceleration (Sudden stops)
- Vibration
- Falling weight

Physical & Environmental Hazards

- Weather
- Radiant heat (Furnace)
- Cold environment
- Noise
- Ventilation
- Vibration
- Lighting
- Poor housekeeping

Energy Hazards

- **Electrical**

  (Overloading, exposed wires, inadvertent activation, non-approve appliances)

- **Pressure**

  (Loose connection for hydraulic / pneumatic, residual energy)

- **Fire**

  (Non-compatible storage or activity, excessive flammable or combustible materials)

Human Factors

- Fatigue
- Stress
- Lack of concentration
- Lack of skills
- Not fit for job
- Attitude problem

Possible Accident / Ill-Health (Consequences)

- Minor injury
- Fatality
- Electrical shock
- Electrocution
- Poisoning
- LAI
- Chronic diseases
- Skin corrosion
- Skin cancer
- Lung burning
- Eye injury
- Cuts
- Hit by moving objects
- etc

Hazards & Consequences

Hazard Identification for Laser Alignment

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk
1	Turn on Class IV laser system	Contact with wet hands	Electrical shock
2	Perform alignment work	Accidentally hit by a stray beam	Permanent eye damage
			Skin sustain laser burn
3	Turn off Class IV laser system	Contact with wet hands	Electrical shock

Hazards & Consequences

Hazard Identification for Extraction of DNA from Human Cells

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk
1	Get vials from Liquid nitrogen	Possible Exposure to liquid nitrogen	Frostbite-damage skin & underlying tissue
2	Thawing of human cells (commercial - ATCC) stored in liquid nitrogen	Breakage/explosion of vial due to the temp difference	Eye injury due to explosion of vials
		Exposure to human bloodborne pathogens (BBP) - (e.g. HBV, HCV, HIV etc.) from human cells- (Risk Group 2)	Lab acquired infection-BBP
3	Centrifugation of cells	Exposure to aerosol	Infection-BBP
		Explosion of centrifuge if the rotor fails while in use	Bodily injury
4	Extraction of DNA from the cells using Phenol-Chloroform mixture	Exposure to chemicals-eg; Chloroform	1.Cause dermatitis 2. Cause reproductive damage 3. Carcinogen

Hazards & Consequences

Fabrication of Nanofibrous Scaffold by Electrospinning

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk
1	Preparation of solution by dissolving polymer materials into a solvent [such as HFP (1,1,1,3,3,3 hexafluoro-2-propanol)]	Chemical hazard-corrosive, irritant- accidental inhalation of HFP & skin contact by spilled solvent	Chemical burn, skin irritation, may produce severe irritation to respiratory tract
2	Grind the tip of needle in order to collect nanofiber	Mechanical hazard when grinding the sharp needle tip	Minor cuts on fingers due to needle prick
3	Set the parameters, pour solution into syringe and connect the circuit	Chemical hazard-corrosive, skin irritant, accidental inhalation of HFP & skin contact by spilled solvent	Chemical burn, skin irritation, may produce severe irritation to respiratory tract
4	Switch on high voltage and spinning the fiber	Electrical Hazard-Potential contact with live electricity	Electrocution, body burns
		Chemical hazard-Inhalation of solvent vapour	Respiratory problem
5	Stop spinning/collect fiber	Chemical hazard-exposure to solvents	Chemical burn, respiratory problem
6	Disposal of remaining solvent and syringe	Chemical hazard-exposure to solvent vapour & contact with spilled solvent	Chemical burn, skin irritation, Respiratory problem
		Human factor-Lack of concentration	Minor cuts on the hand due to being prick by the used needle syringes

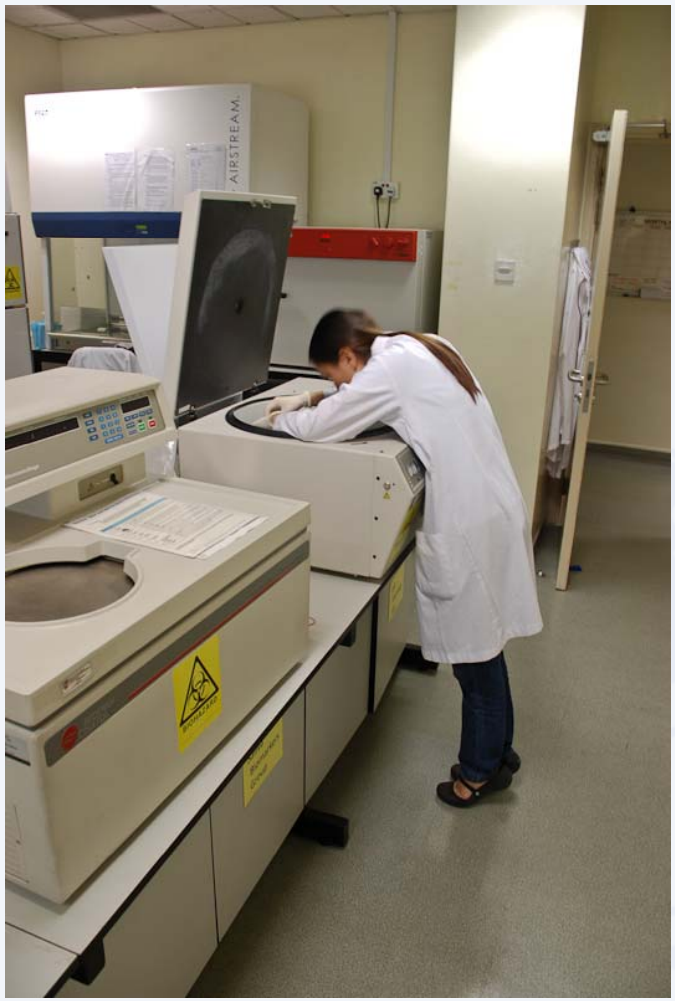
Person at Risk

- Persons directly involved in the experiment / operation
- Persons not directly involved in the experiment / operation
- Visitors
- Members of public

Involve all students, lab techs, professors, researchers, etc.

Hazard Identification – Exercise

Hazard Identification – Exercise



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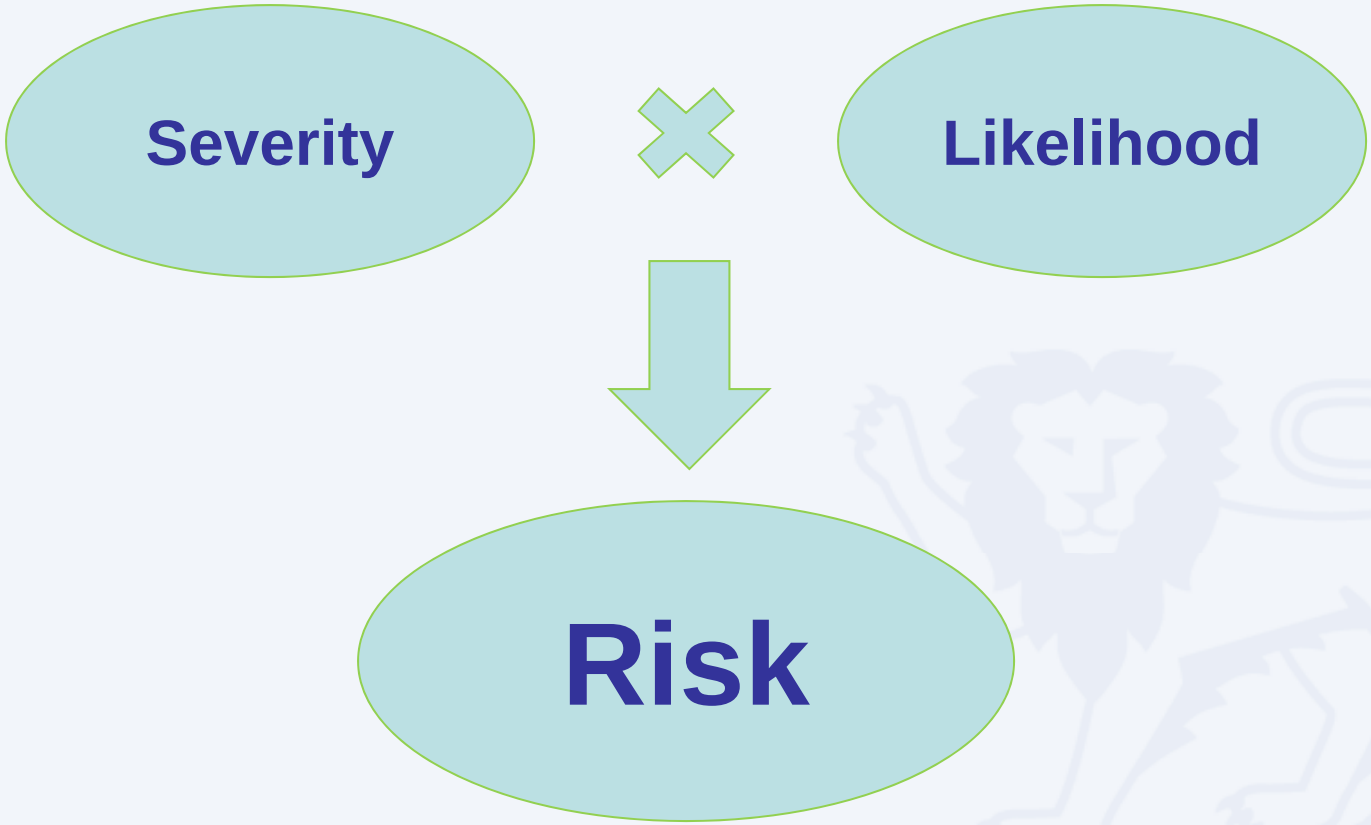
RISK EVALUATION

Risk Evaluation

1. Identifying the **existing control** measures
2. Assessing the potential **severity**
3. Assessing the **likelihood**
4. Determining the **risk level**

Risk Components



* ( ) – Term use by MOM

Assessing the Severity

Score	Severity	Description
1	**Low** (Minor)	No injury, injury or ill-health requiring first aid treatment only - includes minor cuts and bruises, irritation, ill-health with temporary discomfort
2	**Medium** (Moderate)	Injury requiring medical treatment or ill-health leading to disability, includes lacerations, burns, sprains, minor fractures, dermatitis, deafness, work-related upper limb disorders
3	**High** (Major)	Fatal, serious injury or life-threatening occupational disease, includes amputations, major fractures, multiple injuries, occupational cancer, acute poisoning and fatal diseases

*( ) – Term use by MOM

Severity normally will not change unless there is a physical change to the equipment or process.

Determining the Likelihood

Score	Likelihood	Description
1	**Unlikely** (Remote)	Not likely to occur (has not occurred in the PI's Lab or similar Lab setup)
2	**Possible** (Occasional)	Possible or Known to occur (has occurred in the PI's Lab or similar Lab setup)
3	**Likely** (Frequent)	Common or repeating occurrence (has occurred repetitively in the PI's Lab or similar Lab setup

*( ) – Term use by MOM

The team should rely upon their experience and consider realistic scenarios:

- Past experience / incidents
- Complexity of the activity
- Number of personnel involved in the activity (e.g. all personnel, a limited number of trained personnel, etc)
- Frequency of use or execution
- Degree of control (involvement of contractors)
- Strength/completeness of administrative controls
- Sufficiency/formality of training
- Other....

Evaluate Risk Level

Risk = Severity x Likelihood

Vary from 1 to 9

< 3 -Acceptable Residual Risk	- Low
3,4 -Consider Additional Risk Control	- Med
>4 - Additional Risk control Required	- High

		Likelihood		
		Likely (3)	Possibly (2)	Unlikely (1)
Severity	Low (1)	3	2	1
	Medium (2)	6	4	2
	High (3)	9	6	3

Risk Assessment Example 1

Risk Assessment for Laser Alignment

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control	S	L	RL
1	**Turn on Class IV laser system**	Contact with wet hands	Electrical shock	Period check of equipment	1	1	1
2	**Perform alignment work**	Accidentally hit by a stray beam	Permanent eye damage	Laser curtain Access control Protective eye wear	3	1	3
			Skin sustain laser burn	Laser curtain Access control	2	1	2
4	**Turn off Class IV laser system**	Contact with wet hands	Electrical shock	Period check of equipment	1	1	1

Risk Assessment Example 2

Risk Assessment for Extraction of DNA from Human Cells

No	Description / Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control	S	L	R L	Additional control
1	Get vials from Liquid nitrogen	Possible Exposure to liquid nitrogen	Frostbite-damage skin & underlying tissue	Use cryogloves & face shields	2	1	2	
2	Thawing of human cells (commercial-ATCC) stored in liquid nitrogen	Breakage/explosion of vial due to the temp difference	Eye injury due to explosion of vials	Use cryogloves, face shield & lab coats when handling frozen vials.	3	1	3	
		Exposure to human bloodborne pathogens (BBP)- (eg; HBV, HCV, HIV etc.) from human cells- (Risk Group 2)	Lab acquired infection-BBP	Work in a BSL-2 lab, Use Biosafety cabinet (BSC) –class II, goggles & lab coat	3	2	6	Hepatitis B vaccination (occupational health programme)

Continued…

Risk Assessment Example 2

Risk Assessment for Extraction of DNA from Human Cells

No	Description / Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control	S	L	RL	Additional control
3	Centrifugation of cells	Exposure to aerosol	Infection-BBP	Loading & unloading of centrifugation tubes inside BSC, use centrifugation safety cups	2	1	2	
		Explosion of centrifuge if the rotor fails while in use & loads are not evenly balanced	Bodily injury	Balance the centrifuge cup, Refer to centrifuge SOP for the use	3	1	3	proper training on the use & maintenance of centrifuge
4	Extraction of DNA from the cells using Phenol-Chloroform mixture	Exposure to chemicals-eg; Chloroform	1. Cause dermatitis 2. Cause reproductive damage 3. Carcinogen	Use safety glasses & gloves, Handle inside a Fume-hood	2 3 3	1 1 1	2 3 3	

Risk Assessment Example 3

Fabrication of Nanofibrous Scaffold by Electrospinning

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health	Existing Risk Control	S	L	RL
1	Preparation of solution by dissolving polymer materials into a solvent [such as HFP (1,1,1,3,3,3 hexafluoro-2-propanol)]	Chemical hazard-corrosive, irritant-accidental inhalation of HFP & skin contact by spilled solvent	Chemical burn, skin irritation, may produce severe irritation to respiratory tract	Handle in Fume hood; usage of PPE (e.g. goggles, gloves, mask, lab coat); Training,	2	1	2
2	Grind the tip of needle in order to collect nanofiber	Mechanical hazard when grinding the sharp needle tip	Minor cuts on fingers due to needle prick	Training; maintenance of the grinding machine; and usage of PPE and sharp container	2	1	2
3	Set the parameters, pour solution into syringe and connect the circuit	Chemical hazard-corrosive, Skin irritant, accidental inhalation of HFP & skin contact by spilled solvent	Chemical burn, skin irritation, may produce severe irritation to respiratory tract	Handle in Fume hood and Usage of PPE like mask or respirator	2	1	1

Risk Assessment Example 3

Fabrication of Nanofibrous Scaffold by Electrospinning

No	Activity	Hazards	Possible Accident / Ill Health	Existing Risk Control	S	L	RL
4	Switch on high voltage and spinning the fiber	Electrical Hazard-Potential contact with live electricity	Electrocution, body burns	Regular maintenance of the equipment; Attach warning sign near or on the equipment to remind people of the hazard.	3	1	3
		Chemical hazard-Inhalation of solvent vapour	Respiratory problem	Handle in Fume hood; usage of PPE like mask or respirator	2	1	2
5	Stop spinning/collect fiber	Chemical hazard-exposure to solvents	Chemical burn, respiratory problem	Usage of PPE; Leaving it in the fume hood for 20mins before collecting the fiber	2	1	2
6	Disposal of remaining solvent and syringe	Chemical hazard-exposure to solvent vapour & contact with spilled solvent	Chemical burn, skin irritation, Respiratory problem	Usage of PPE, Leaving it in the fume hood overnight; store in special container; disposal is later done by licensed collector	2	1	2
		Human factor-Lack of concentration	Minor cuts on the hand due to being prick by the used needle syringes	Stored used syringe in special container until final disposal	1	2	2

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RISK CONTROL

Risk Control

1. **Identify** all reasonably practicable measures by eliminating or reducing the risk level.
2. **Implement** the control measures.
3. Review continually to **ensure their effectiveness**.

Reasonably Practicable

- ✓ An action is considered to be **practicable** when it is capable of being done.
- ✓ Whether it is also **reasonable** takes into account:
  - Severity of injury/harm/ill-health
  - Degree of risk (or likelihood)
  - Knowledge of hazard and the ways of eliminating, reducing or controlling it
  - Availability, suitability and cost of safeguards.

Risk Control

- Based on the risk level, select additional risk control measures to **reduce the risk level to an acceptable level**.

- When the risk level is High, implement effective and practicable risk control to bring down the "High Risk" to at least "Medium Risk".

Acceptability of Risk

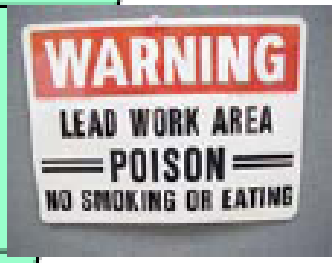
Risk Level	Risk Acceptability	Recommended Actions
Low Risk <3	Acceptable	No additional risk control measures may be needed. However, frequent review may be needed to ensure that the risk level assigned is accurate and does not increase over time.
Medium Risk 3, 4	Moderately acceptable	A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as is practicable within a defined time period. Interim risk control measures, such as administrative controls, may be implemented. Management attention is required.
High Risk >4	Not acceptable	High Risk level must be reduced to at least Medium Risk before work commences. There should not be any interim risk control measures and risk control measures should not be overly dependent on personal protective equipment or appliances. If need be, the hazard should be eliminated before work commences. Immediate management intervention is required before work commences.

Hierarchy of Controls

Eliminate / Substitute

Engineering Controls

Administrative Measures



PPE

Most preferred

Least preferred

Elimination

- Removes the source of the hazard from the work area;
- Most effective measure because the risk is eliminated;
- A permanent solution – should be attempted first.

  - Choose different process;
  - Modify an existing process by changing the energy type;
  - Modify or change equipment or tool;
  - Remove a radiation source from common lab area to a proper store;
  - Moving flammable solvents from common lab area into a flammable cabinet in a solvent store.

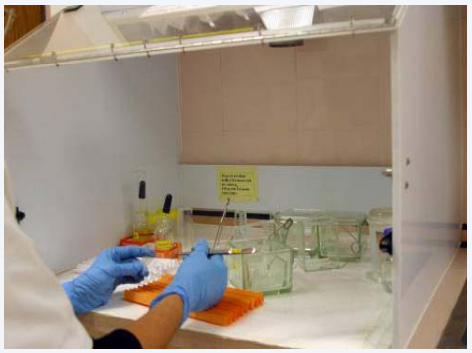
Substitution

- Replaces the hazardous work process or material with a less hazardous one.
- Very effective, especially for hazardous substance.
  - Replace solvent by water-based solution
  - Use a chemical of higher LD50 or PEL;
  - Micro-scale experiments / Computer simulation;
  - Substitute vapor heating by electric heating;
  - Use electronic control instead of pneumatic one;
  - Use a non-sparking hammer in a flammable atmosphere instead of a steel hammer;
  - Replace Benzene with Toluene;
  - Use a biological agent of lower risk group.

Engineering Control

Engineering controls are physical means that limit the hazard.

- Biological Safety Cabinet, Local Exhaust ventilation, Fume cupboard, etc
- Centrifuges – safety cups
- Interlocks
- Safety Guards
- Primary barrier to prevent exposure by containment
- Electrical Leakage Circuit Breaker (ELCB)
- Safety Alarms



Special Rack is used

Administrative Controls

Administrative controls reduce or eliminate exposure to a hazard by adherence to procedures or instructions.

- Standard Operating Procedures, signage, etc
- Survey/Wipe tests – verification tests, hygiene monitoring
- Occupational Health – vaccinations/immunizations
- Training and Education
- Labeling
- Inspections and Audits
- Maintenance of Equipment

Personal Protective Equipment (PPE)

- PPE may be required to reduce the risk of exposure of a staff or student by contact, inhalation or ingestion of an infectious agent, toxic substance, or radioactive material.
- Provide a barrier against hazards to protect laboratory workers from injury risk
- PPE is the last line of defense

Examples of Common PPEs

1. Lab coat
2. Gloves
3. Covered shoes
4. Safety Glasses
5. Safety Goggles
6. Face Shields
7. Respirators

Residual Risk

- Residual risk are the **remaining risk** for which the planned risk controls are not able to effectively remove or control.
- All **reasonably practicable measures** must be taken to further reduce the residual risks, e.g. training (administrative control).
- The risk assessment team should highlight the residual risks for each of the controls.
- The lower the control in the hierarchy is selected, the higher is residual risk.

Summary

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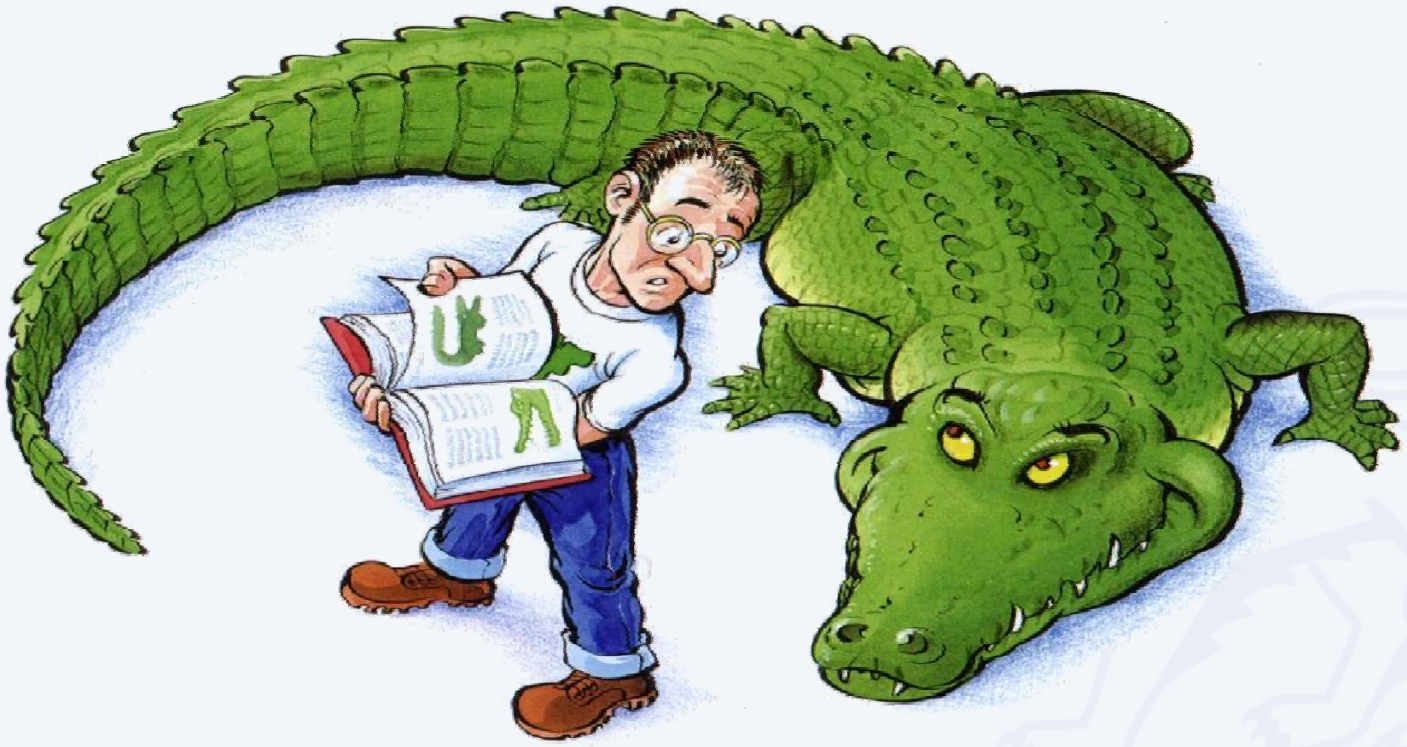
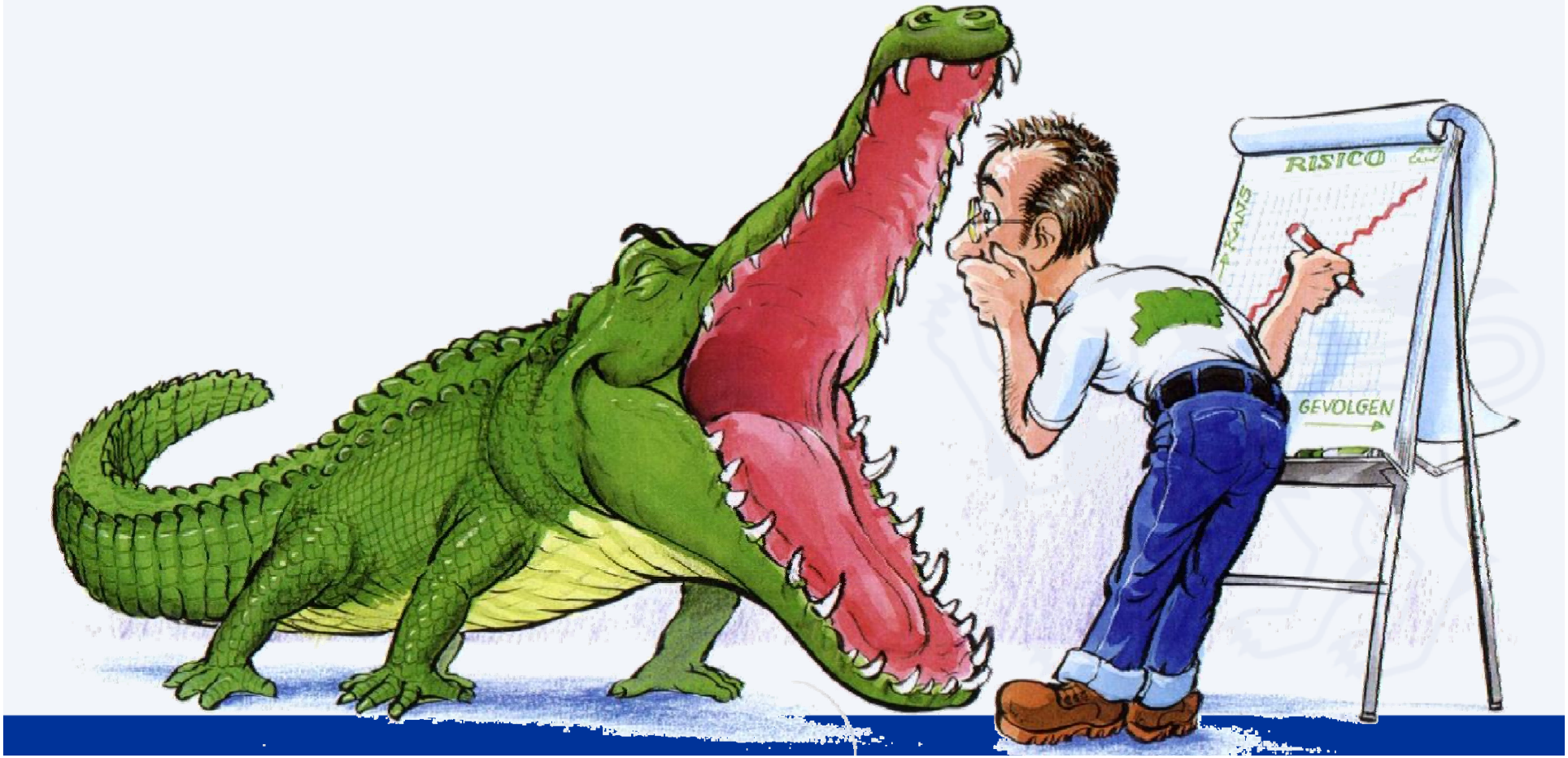
Principle of Crocodile

Identify the risk



Principle of Crocodile

Evaluate the risk

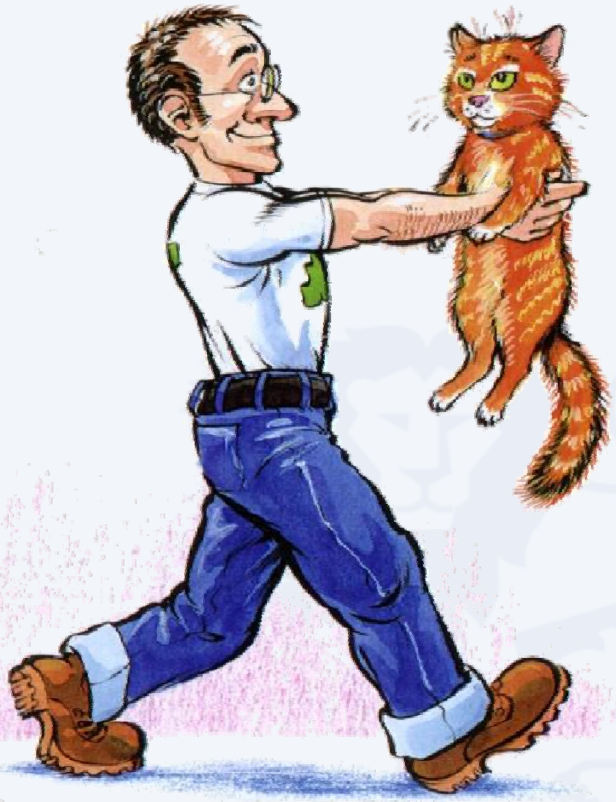


Principle of Crocodile

Eliminate the risk

Principle of Crocodile

Substitute the risk

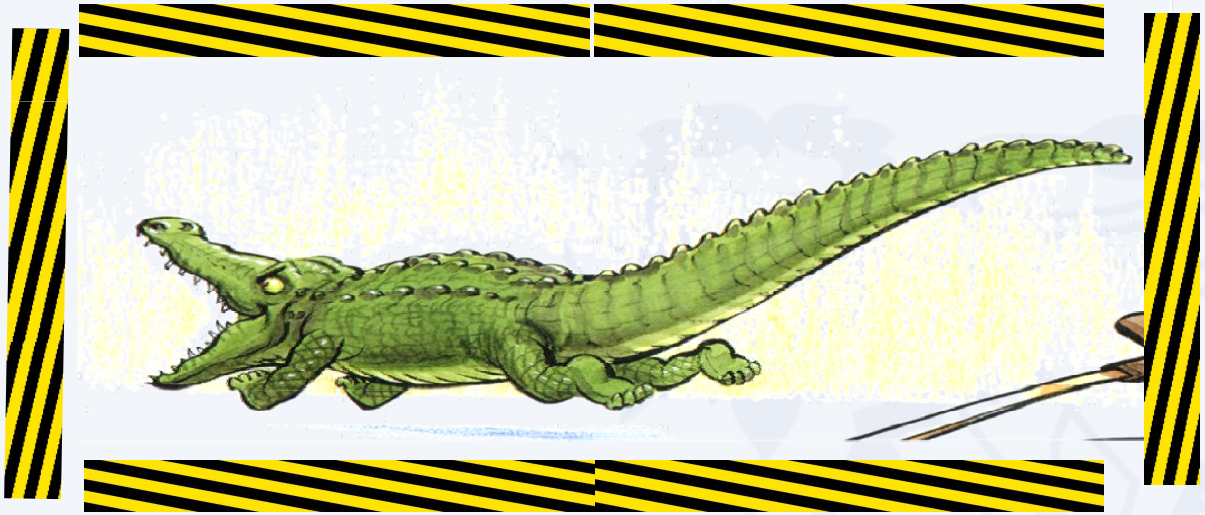


Principle of Crocodile

Isolate the risk (Engineering Controls)

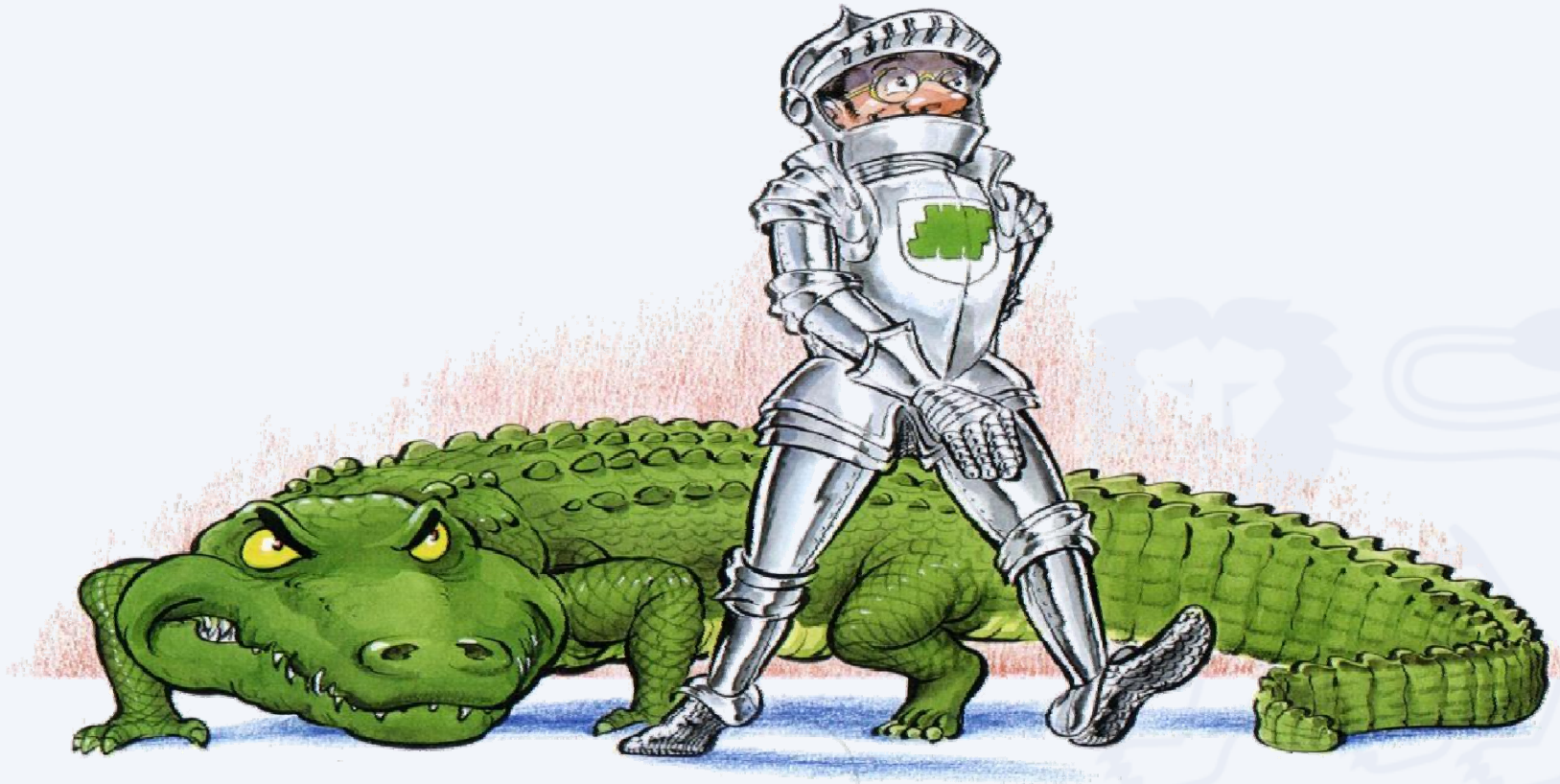
Principle of Crocodile

Implement administrative controls



Principle of Crocodile

Use Personal Protective Equipment



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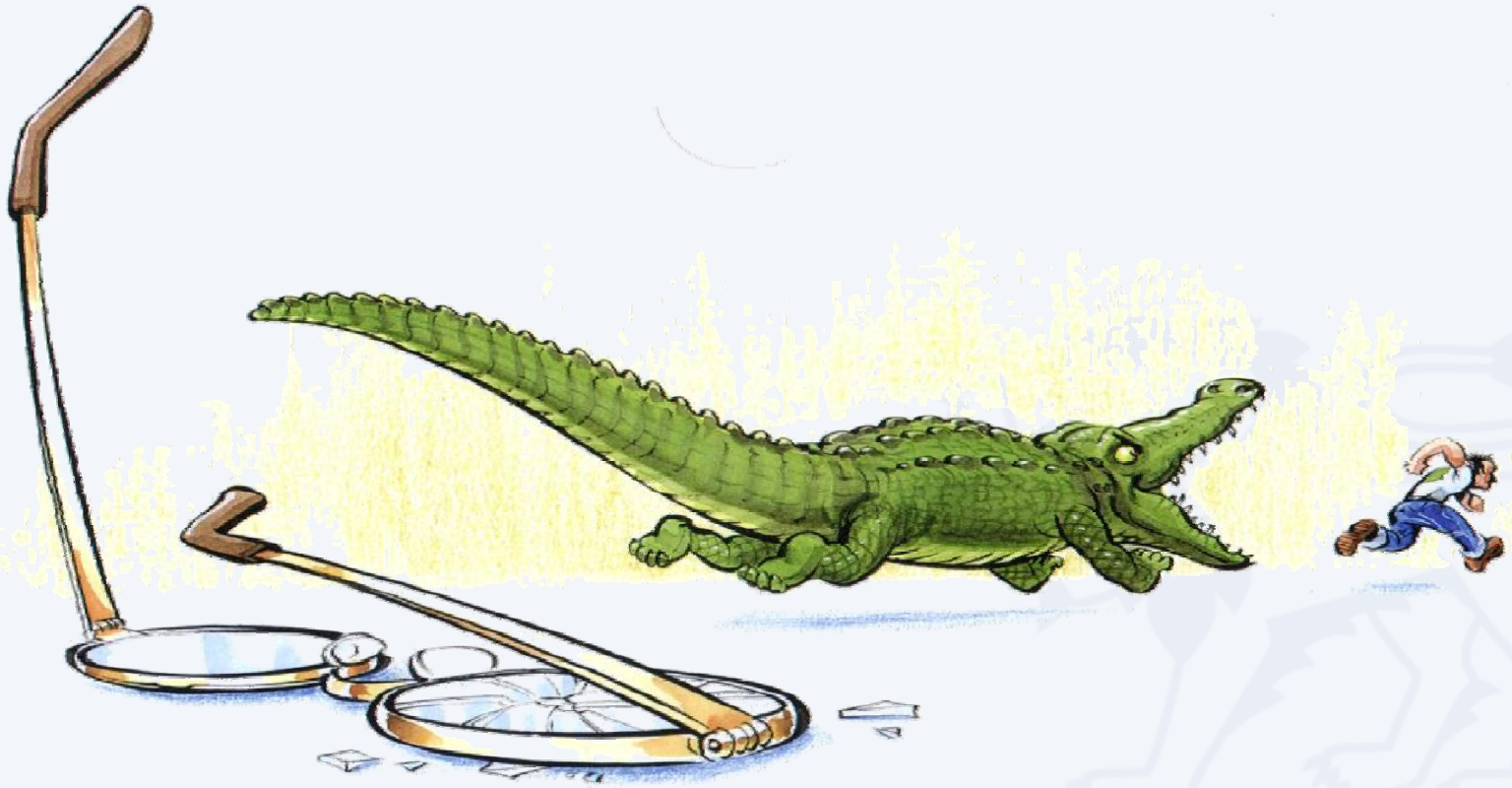
Principle of Crocodile

Or else……Run away !



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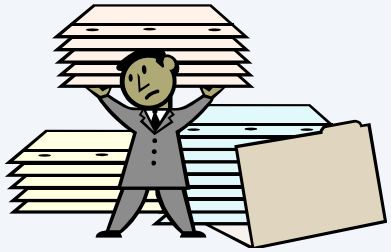
RECORD KEEPING

Record Keeping

- All Risk Assessments should be properly recorded in a **Risk Assessment Form**.
- All relevant information must be made **available for inspection**.
- Keep record for at least **3 years**.



Record Keeping

Records should be concise and include the following information:

1) Members of the Risk Assessment team,
2) Processed/procedures/tasks/activities involved,
3) Hazard identification and possible accident/ill-health and person at risk,
4) Existing risk control measures,
5) Risk level of each hazard,
6) Recommendation on additional risk control measures,
7) Persons responsible to implement the measures & completion date,
8) Signature, date & designation of persons conducting the Risk Assessment;
9) Signature, date & designation of management approving or endorsing the Risk Assessment.

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Risk Assessment Form

Experiment-Based Risk Assessment Form

Name of Department _____ Location of Lab _____

Name of Laboratory _____ Name of PI _____

Name of Researcher/LO _____ Name of Activity/Experiment _____

No	Description/Details of Steps in Activity	Hazards	Possible Accident / Ill Health & Persons-at-Risk	Existing Risk Control (Mitigation)	Severity	Likelihood (Probability)	Risk Level	Additional Risk Control	Person Responsible	By (Date)
1							0			
2							0			
3							0			
4							0			
5							0			
6							0			
7							0			
8							0			
9							0			
10							0			

Conducted By _____

_____

_____

_____

Approved By

Name _____

Signature _____

Approval date _____ Next Revision date _____ (Maximum 3 years)

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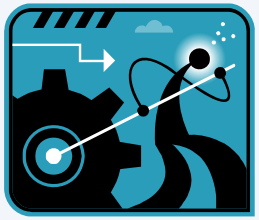
IMPLEMENTATION & REVIEW

Implementation

- The results of Risk Assessment should be **approved and endorsed by PI**.
- The PI should **implement the recommended risk control measures** without undue delay, as far as it is practicable.
- Implement the risk controls by apply **ALARP** concept and the **hierarchy of controls**.
- **Train the affected staff/students** on the Risk Assessment findings and the controls to minimize the risk of injury and ill-health with their awareness and support.
- Establish an implementation **schedule** to ensure that the risk control measures are implemented in due time.



Mandatory Review

Review or revise the Risk Assessment:

- At least **once in every 3 years**
- After any **accident or serious incident** occurs
- When there are **changes** in the Laboratory (Management of Change)

Review after Accident or Serious Incident

- **Reportable cases to MOM**
  - Workplace accident
  - Dangerous occurrence
  - Occupational disease
- **OSHE list of accident/incident categories link**: https://staffweb.nus.edu.sg/oshe/category.htm

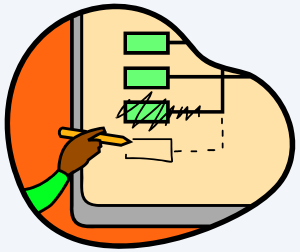
Review after Accident or Serious Incident

- **Other indicators for review:**
  - MC given by Doctor
  - Property damage
  - Environmental non-compliance
- **Risk levels should be reviewed taking into consideration the resulting severity:**
  - No. of days of MC
  - Extend of property damage
  - Extend of environmental pollution

Management of Change

Review and revise Risk Assessment when:

- **new equipment / materials / chemicals / agents** are brought into your lab;
- **parameters are changed**, e.g. change of equipment setting, change of concentration/volume of chemicals, etc;
- **new or revised processes / procedures / working practices** are implemented in your lab;
- When **new persons** join your lab / **change of competency**;
- your lab is **relocated**;
- **additional risk control measures** are introduced;
- **risk control measures are changed / revised**.
- Etc.

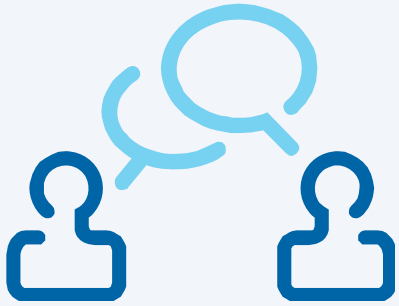


Communication

Staff/students or any other persons in the lab who may be **exposed to the risk** should be informed of:

- **The nature of the risk** involved,
- The **measures implemented to control the risk**,
- Applicable **SWP/SOP**,

Whenever the **risk assessment is revised**, or when there is a **significant change** in work practices or procedures, the staff/students or other persons who may be at risk must be informed accordingly.



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EFFECTIVE RISK MANAGEMENT

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Risk Management Success Factors

- Select Suitable Risk Assessment Team
- Risk Treatment
- Communication
- Record Keeping
- Training
- Technology Support
- Integrate into Existing Process
- Regular Monitor & Audit

Risk Management Success Factors

Select Suitable Risk Assessment Team

- PI
- Lab Sup / Tech
- Researchers
- Students
- Competent
- Experienced
- Trained

Risk Management Success Factors

Communication

- Appropriate approach
- Intranet
- Induction
- Communicate risks and control measures
- Address concerns of the persons at risk

Risk Management Success Factors

Training

- Training plan
- Departmental training
- SSTS
- SMS training

Risk Management Success Factors

Integrate into Existing Process

- Existing Policy / SOP
- Training procedure
- Incident/Accident investigation
- Audit

Risk Management Success Factors

Risk Treatment

- Risk Control
- Risk Mitigation

To consider:

- Effective and efficient internal controls
- Compliance with laws and regulations
- Cost effective

Risk Management Success Factors

Record Keeping

- Ease the documentation process
- Working paper as records
- Softcopies
- Filing system

Risk Management Success Factors

Technology Support

- Equipment with in-built safety features
- Less hazardous materials
- Software application

Risk Management Success Factors

Regular Monitor & Audit

- Review structure & process
- Provide updated information
- Improve knowledge
- Provide assurance

Conclusion

Benefits of effective Risk Management:

- Safer laboratory
- Effective & efficient research
- Quality working environment
- Highly motivated staff & students

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HANDS-ON EXERCISE

Hands-on Exercise

- Use the Risk Assessment Form
- Determine an experiment/procedure to work on.
- Identify the hazards and evaluate the risk level.
- Determine additional control measures, if necessary, and indicate responsible person and completion date.
- Present your Risk Assessment result.

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ASSIGNMENT

Risk Assessment Assignment

- **Form a team** of not more than 4 persons.
- Use the **Risk Assessment Assignment Form** (http://www.nus.edu.sg/osh/training/download.htm).
- **Determine an experiment / procedure** to work on (choose a **different one from the hands-on exercise**).
- **Identify the hazards** and **evaluate the risk** level.
- Determine **additional control measures**, if necessary, and indicate **responsible person** and **completion date**.
- Please use the **softcopy** to complete.
- You may **attach a short description** of the Risk Assessment.
- Submit to OSHE **within 2 weeks** via **Email**.

Marking Criteria

- **Complete identification: (25 marks)**
  The list of break down of process/ procedure/ experiment and hazard identification are complete. The process/ procedure/ experiment should be broken down into 6-8 tasks, not less than 4 tasks.
- **Clear description: (25 marks)**
  The description of “Hazard” and “Possible Accident/ Ill-Health & Person-at-Risk” is clear and easy to understand.
- **Correct scoring: (25 marks)**
  Scoring of “severity” and “likelihood” and calculation of risk level are correct.
- **Adequate & effective additional controls**: **(25 marks)**
  Additional control measures suggested are adequate and effective, if necessary.
  - **Passing Marks: 75 marks.**

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Thank You