

**Pathways to precision in
soil analysis: advancing
soil laboratories in Latin
America and the
Caribbean**

**Caminos hacia la
Precisión en el Análisis de
Suelos: avance de los
Laboratorios de Suelos
en América Latina y el
Caribe**

LATSOLAN
LATIN AMERICAN SOIL LABORATORY NETWORK

General Laboratory Safety

by Hanane Aroui-Boukbida

WORKSHOP
SANTIAGO - CHILLÁN | CHILE
8-11 APRIL 2024



**Institut de Recherche
pour le Développement**
FRANCE

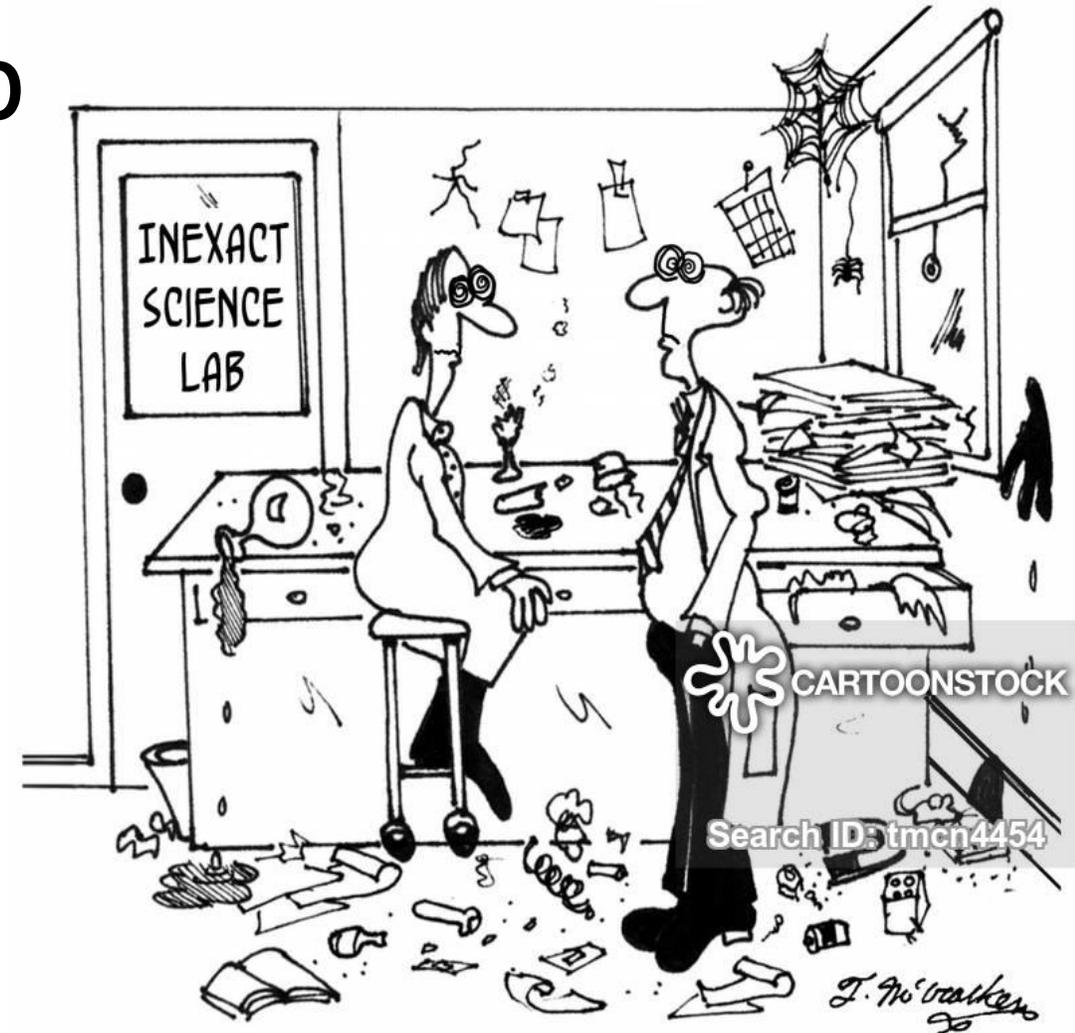


Health and Safety in the lab

Why does it matter?

Safe working protects :

- You
- Other lab workers
- Cleaners
- Visitors
- Your work



https://www.cartoonstock.com/directory/l/laboratory_accidents.asp

Health and Safety in the lab

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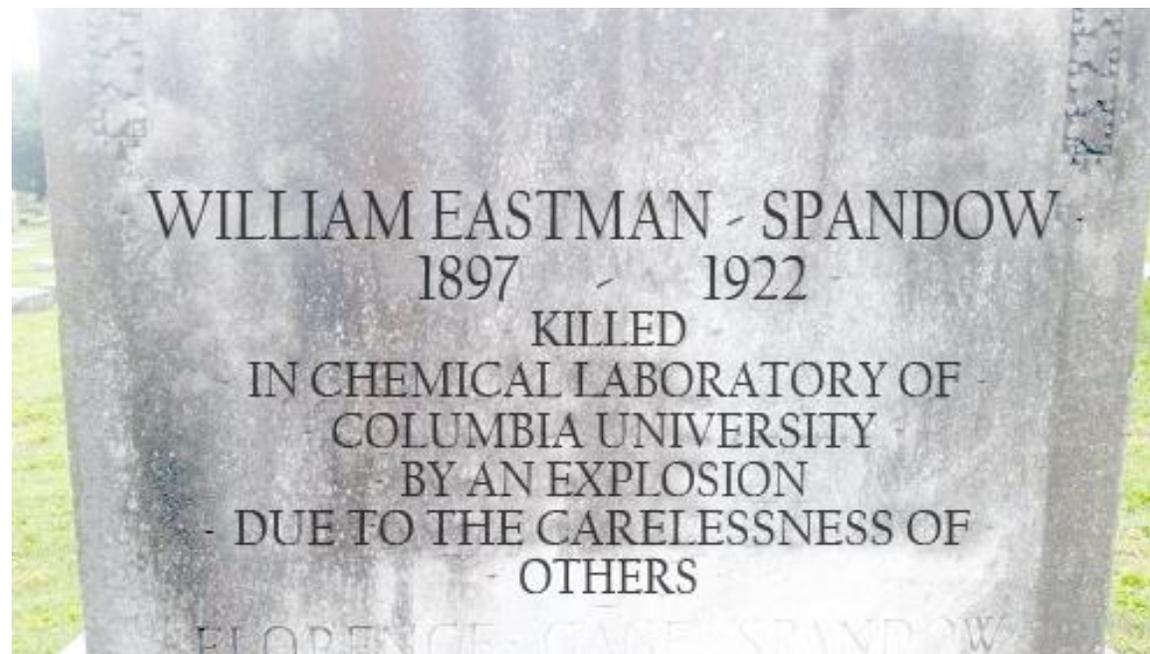
- You
- Other lab workers
- Cleaners
- Visitors
- Your work

Who is responsible ?

- **Every one**

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1922 Lab Explosion

<https://www.labsafety.org/1922-lab-explosion-with-clues-for-today>

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Hazard and Risk -- What's the difference?

Danger et risqué – Quelle est la différence?

- https://www.youtube.com/watch?v=_GwVTdsnN1E



Hazard and Risk -- What's the difference?

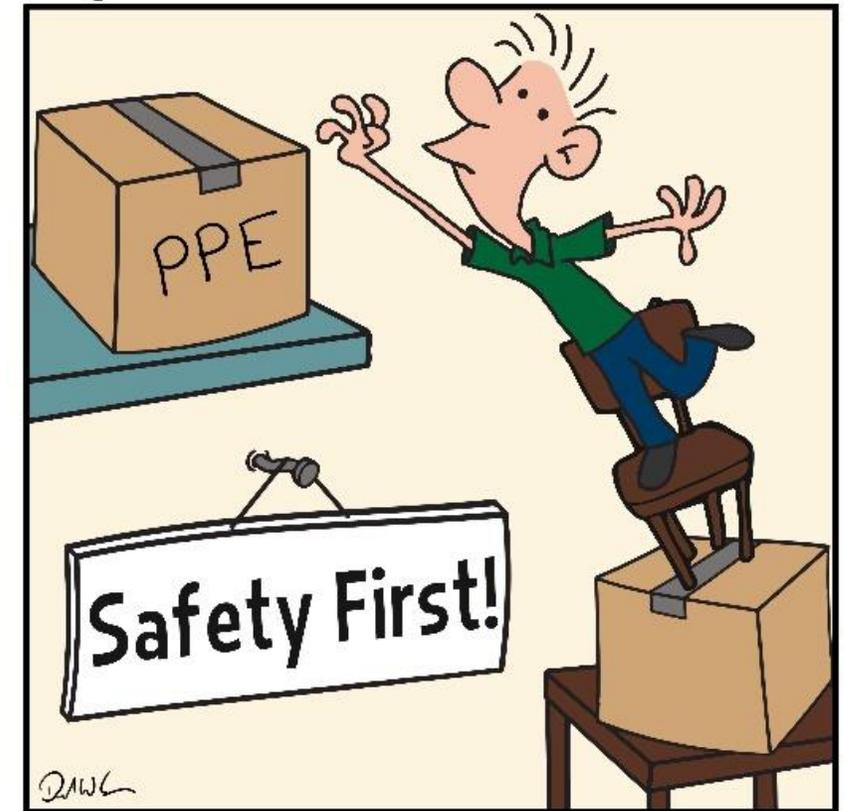
Danger et risqué – Quelle est la difference?

A *hazard* is **any source of potential damage or harm** to an individual's health or life under certain conditions.

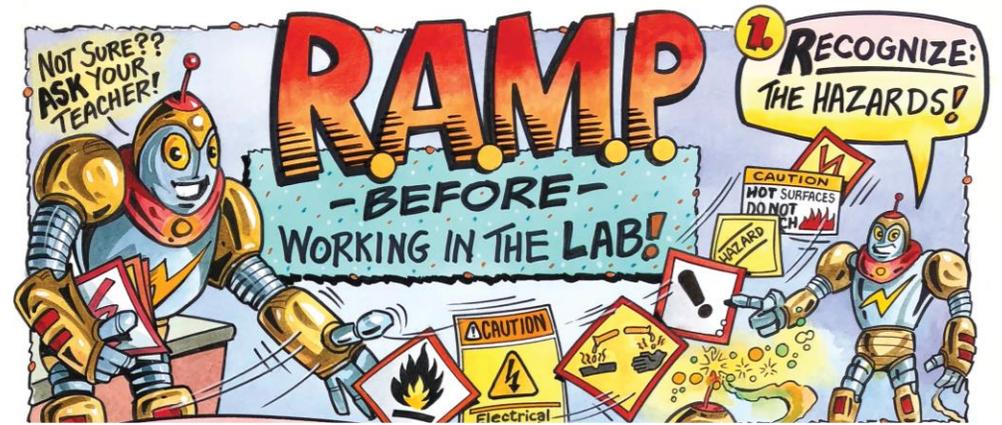


Risk is **the chance or probability of a person being harmed or experiencing** an adverse health effect if exposed to a hazard.

Enlightened EH&S



Risks can be reduced by taking measures to minimize or control the hazard.



1. Recognize the Hazards/Reconnaître le danger

Risks can be reduced by taking measures to minimize or control the hazard.

1. Recognize the Hazards
/Reconnaître le danger

2. Assess the Risks of the Hazards
/Evaluation des risques du danger

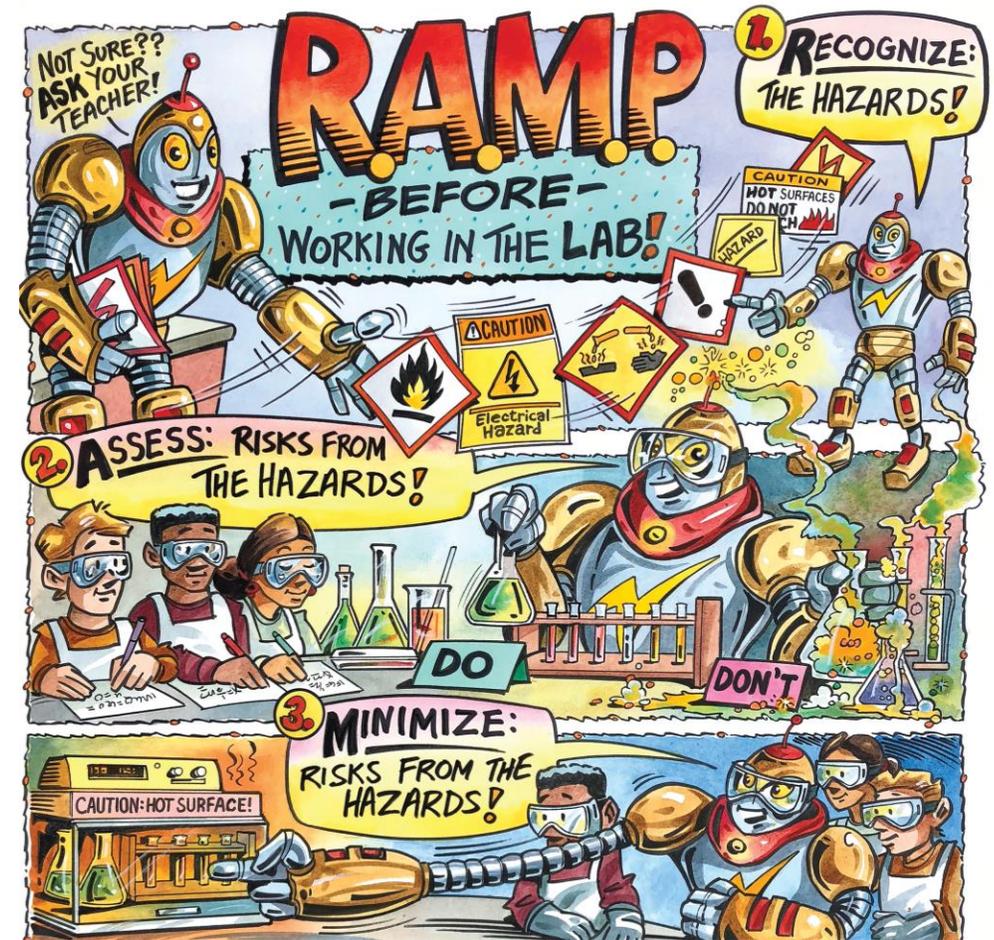


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3. Minimize the Risks of the Hazards
/Minimiser les risques du danger



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1. Recognize the Hazards
/Reconnaître le danger
2. Assess the Risks of the Hazards
/Evaluation des risques du danger
3. Minimize the Risks of the Hazards
/Minimiser les risques du danger
4. Prepare for Emergencies from Uncontrolled Hazards
/Se préparer pour les urgences des dangers incontrôlables



1. Recognize the Hazards

Know what hazards are present in your lab.

<https://interactivesolutions.co.uk/games/flashGames/labHazards.htm>

1. Recognize the Hazards

What are the general hazards in a laboratory?



- Fire
- Breakage of glassware
- Spillages
- Pressure equipment and gas cylinders
- Extremes of heat cold
- Chemical hazards
- Biological hazards
- Radiation

And many more!

1. Recognize the Hazards

Match the pictogram to the hazard

<https://www.safetyandhealthmagazine.com/articles/9561-match-the-pictogram-to-the-hazard?page=3>



1. Recognize the Hazards : Hazard Classes

Know the signs and meaning

Think safety

- Environmental Hazards
- Health Hazards
- Physical Hazards

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GHS Hazard Pictograms Globally Harmonized System

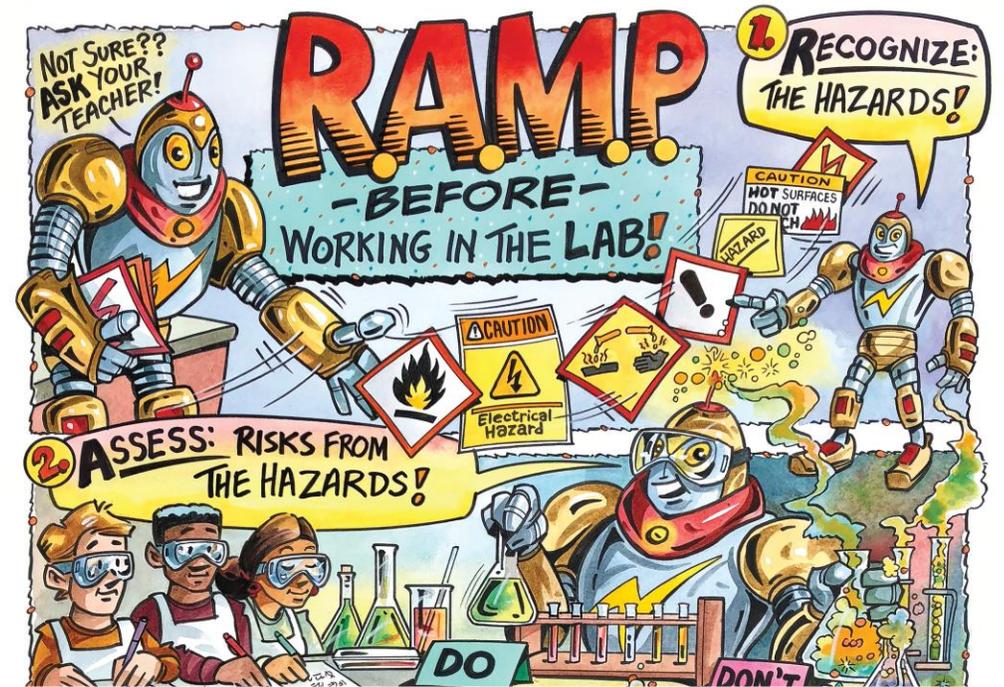
| | | |
|--|--|---|
|  Health Hazard Carcinogen Mutagenicity Reproductive Toxicity Respiratory Sensitizer Target Organ Toxicity Aspiration Toxicity |  Flammable Flammables Pyrophorics Self-Heating Emits Flammable Gas Self-Reactives Organic Peroxides |  Harmful Irritant (skin & eye) Skin Sensitizer Acute Toxicity (harmful) Narcotic Effects Respiratory Tract Irritant Hazardous to Ozone Layer (Non-Mandatory) |
|  Compressed Gas Gases Under Pressure |  Corrosive Skin Corrosion/Burns Eye Damage Corrosive to Metals |  Explosive Explosives Self-Reactives Organic Peroxides |
|  Environmental Aquatic Toxicity |  Toxic Acute Toxicity (fatal or toxic) |  Oxidizing Oxidizers |



Risks can be reduced by taking measures to minimize or control the hazard.

1. Recognize the Hazards

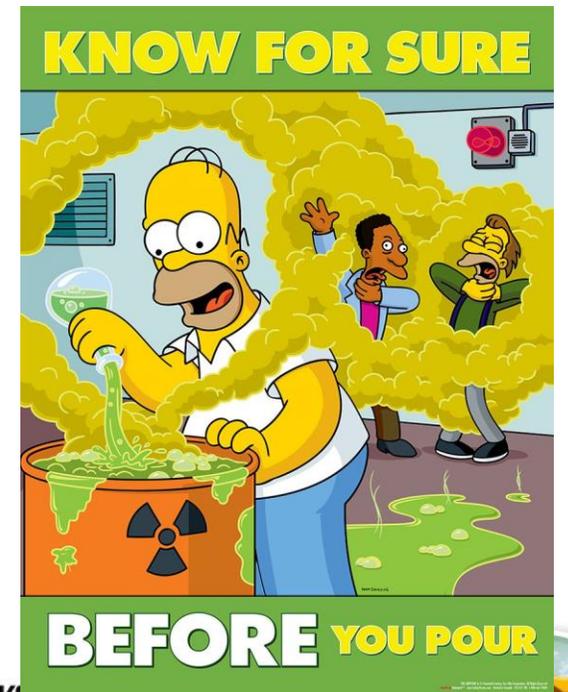
2. Assess the Risks of the Hazards



2. Assess the Risks of the Hazards

- *Risk assessment* : the process of estimating the probability of harm from a hazard, by considering the process or the laboratory procedure that will be used with the hazard.

When ? Before, during and after an Experiment.



2. Assess the Risks of the Hazards

How to do a Risk Assessment?

Risk assessment template : Determine hazards and evaluate risks

| What are the hazards? | Who might be harmed and how? | What are you already doing to control the risks? | What further action do you need to take to control the risks? | Who needs to carry out the action? | When is the action needed by? | Done |
|-----------------------|------------------------------|--|---|------------------------------------|-------------------------------|------|
| | | | | | | |

- Do it with your colleagues
- Agree it with your supervisor



What's Wrong With This Picture?

| What are the hazards? | Who might be harmed and how? | What are you already doing to control the risks? | What further action do you need to take to control the risks? | Who needs to carry out the action? | When is the action needed by? | Done |
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Mrs. Page, Kennedy Middle School/2002-2003

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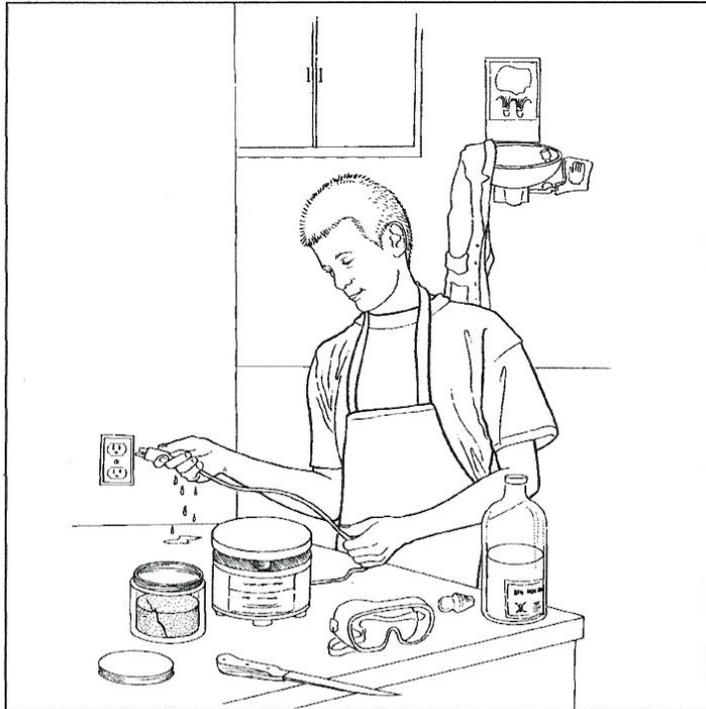
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17
GLOBAL SOIL
PARTNERSHIP

What's Wrong With This Picture?

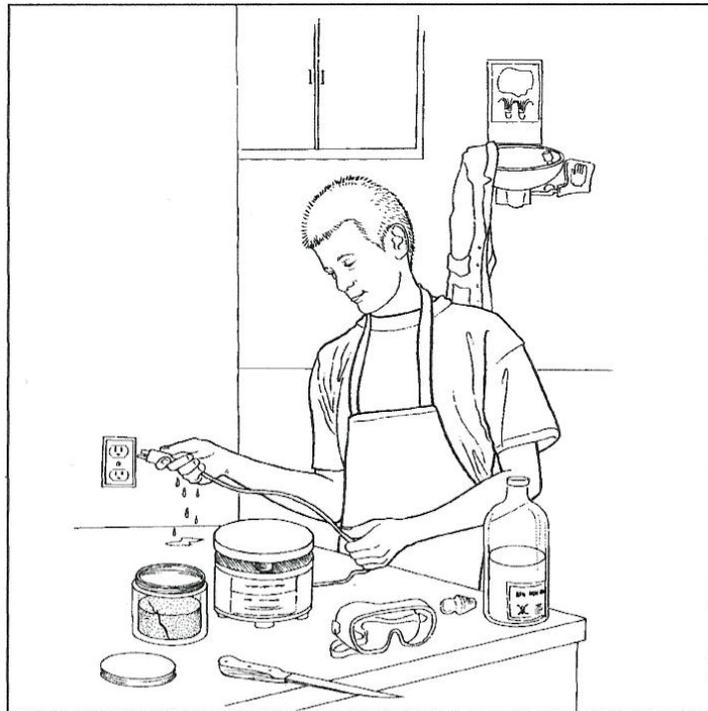
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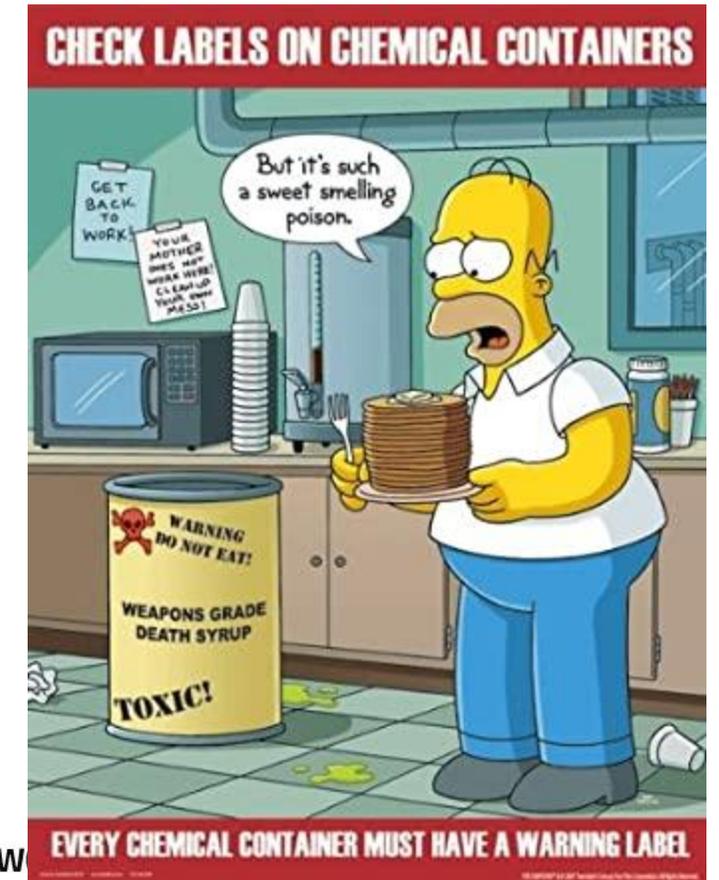
1. Recognize the Hazards
2. Assess the Risks of the Hazards
3. Minimize the Risks of the Hazards



3. Minimize (or control) the risks of the hazards

Use the safe practices

- Know details and location of the vital Laboratory Information.
- Labeling : It is important to know as much about a chemical as possible.



3. Minimize (or control) the risks of the hazards

Signs and Labeling



- Signs are a way of communicating important information. It is a way to heighten awareness about hazards that exist.



- The label should describe what the content is and also any precautions.



Escherichia coli

Precautions:

Must use Eye protection, lab coat, gloves
Only use under BSC

3. Minimize (or control) the risks of the hazards

Know the properties of chemicals and biological agents before you use or transport them

- Toxicity
- Flammability
- Reactivity/Incompatibilities
- Corrosive
- Unstable
- Radioactive
-

Spark from pressure gauge caused University of Hawaii explosion :Postdoc, who lost an arm in the incident, was using a gauge not specified for work with flammable



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<https://cen.acs.org/articles/94/web/2016/04/Spark-pressu>

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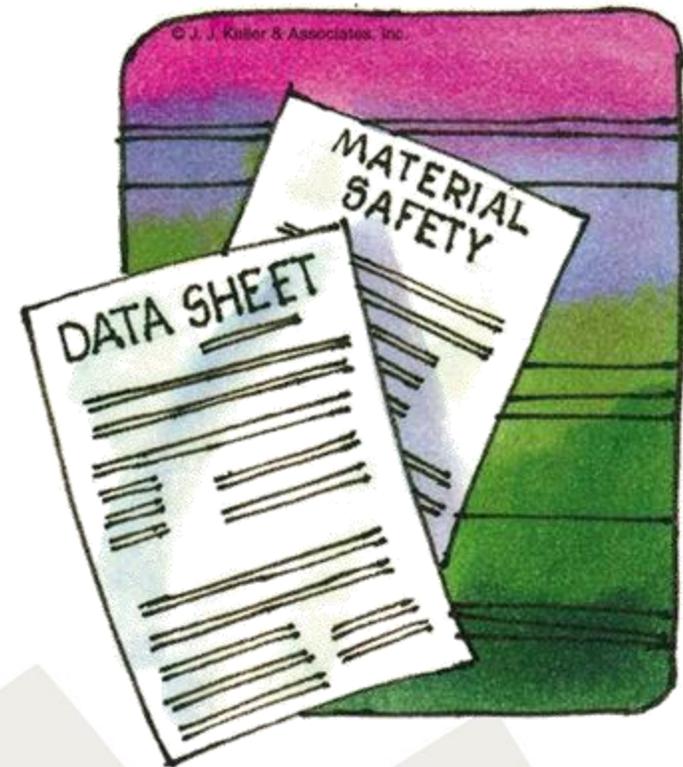


3. Minimize (or control) the risks of the hazards

MSDS: Material Safety Data Sheets

MSDS provide you with the following :

- Chemical and Physical properties
- Toxicity Information
- Computability/Incompatibility
- Appropriate spill and fire response
- **Information needed for first aid**
- ...



3. Minimize (or control) the risks of the hazards

Example : Use a less risky substance

1. Use a safer form of that substance (eg solution instead of powder)
2. Partially enclose the process (eg with a fume cupboard)
3. Ensure good general ventilation
4. Reduce exposure times, increase distance, reduce volumes
5. Personal Protective Equipment

3. Minimize (or control) the risks of the hazards

Protecting yourself and your colleagues

- Proper Use of Safety Equipment
- Proper Use of Personal Protective Equipment (PPE)



When using the safety device, remember to also use the proper personal protective equipment.

3. Minimize (or control) the risks of the hazards

Safety Equipment

- Fume hoods

Use Properly:

- keep sashes down
- don't store flammable liquids, equipment in hood
- limit traffic behind you



- Canopy and Snorkel

It is important to know when this equipment is to be used and how to properly use it.

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3. Minimize (or control) the risks of the hazards

Safety Equipment

Chemical Storage

- Ensure that all chemicals are stored according to compatibility. Acids are incompatible with bases, flammable solvents, oxidizers
- Water reactive materials should be stored separately.
- All chemical products must be dated when opened

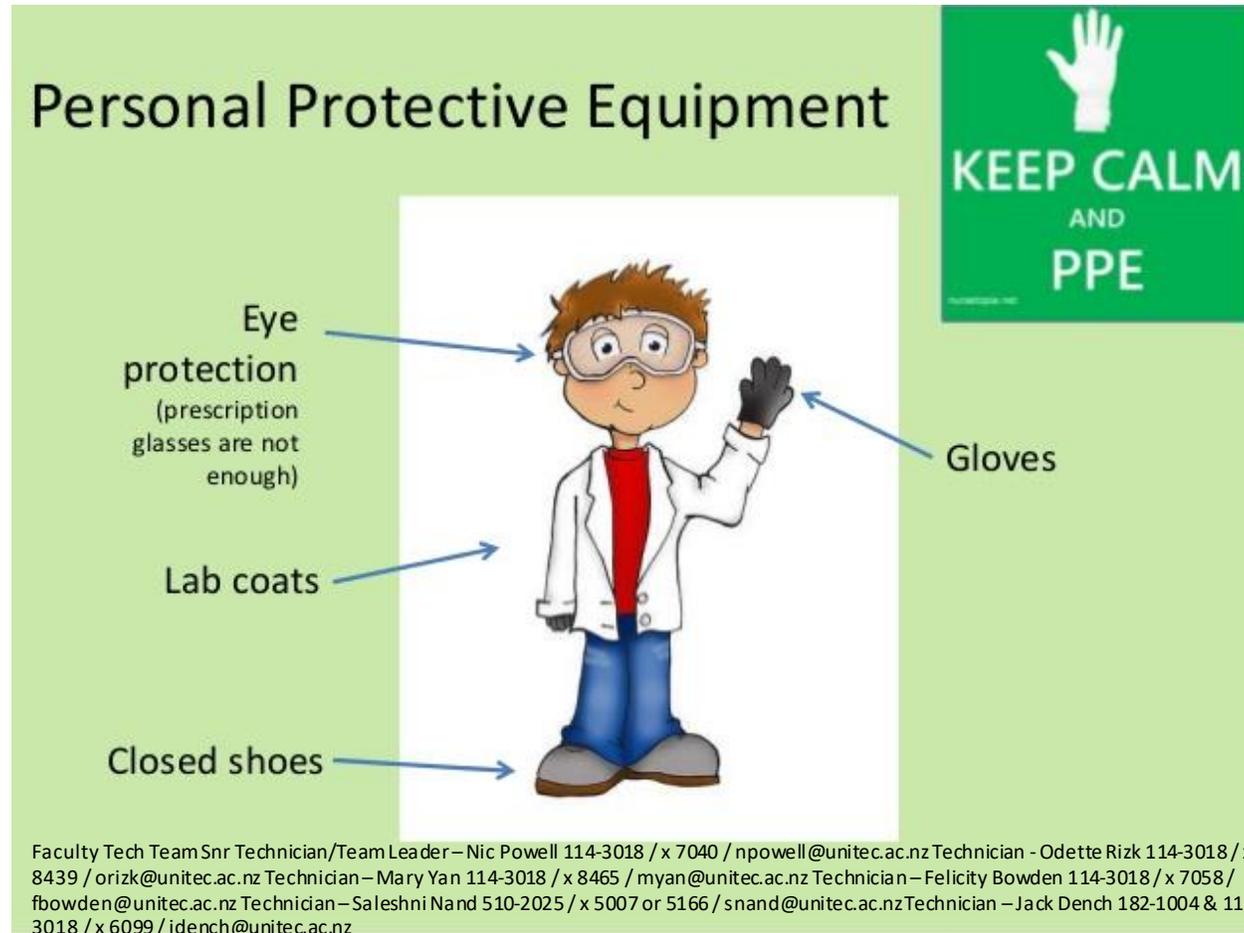


The storage area and cabinets should be labeled to identify the hazardous nature of the products stored within.

Food containers MUST NEVER BE USED for chemical storage.

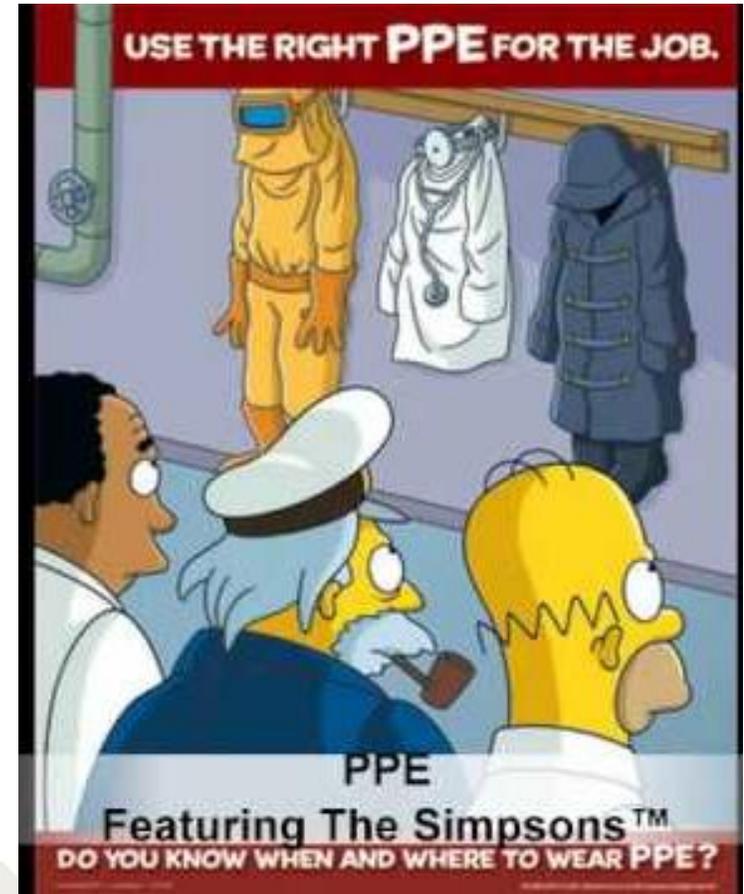
3. Minimize (or control) the risks of the hazards

Personal Protective Equipment (PPE)



3. Minimize (or control) the risks of the hazards

Personal Protective Equipment (PPE)



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Knowing **what to use and when to use** it is the key to properly protecting yourself.

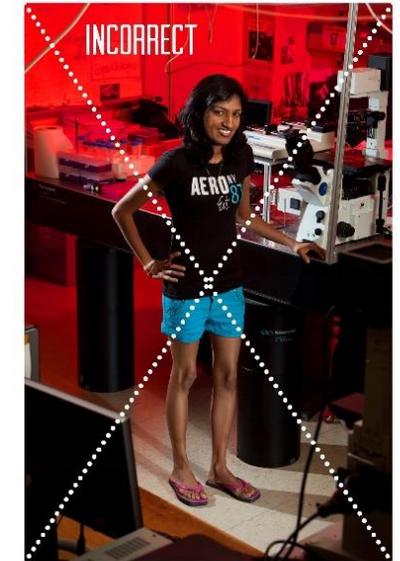
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3. Minimize (or control) the risks of the hazards

Personal Protective Equipment (PPE)

- Wear the clothing and protective wear identified in your risk assessment
- Laboratory coats must be kept fastened
- Don't wear sandals or open shoes
- Long hair must be tied back

NO PANTS, NO SHOES
NO SCIENCE



FOR MORE INFORMATION CONTACT ENVIRONMENTAL HEALTH AND SAFETY AT (806) 742-3876
WWW.EHS.TTU.EDU | WWW.SAFETY.TTU.EDU

SAFETY @ TTU

3. Minimize (or control) the risks of the hazards Personal Protective Equipment (PPE)

Example : gloves

- There are many different types of protective glove
- Use the correct ones for the job you will be doing : **CHEMICAL COMPATIBILITY**
- Remove your gloves before using instruments, telephone, and leaving the laboratory

| | | | |
|--|---|---|--|
| Light latex, vinyl or nitrile gloves |  | Disposable latex Powdered or un-powdered | Working with biological hazards (human blood, body fluids, tissues, blood-borne pathogens, specimens), BSL1, BSL2, BSL2+, BSL3 |
| |  | Disposable nitrile Puncture, abrasion resistant, protection from splash hazards | Working with biological hazards and chemical splash hazards |
| |  | Disposable vinyl! Economical, durable, similar to latex | Working with biological hazards, BSL1, BSL2, BSL2+, BSL3 |
| Light chemical resistant gloves |  | Natural rubber latex Chemical resistant, liquid-proof | Working with small volumes of corrosive liquids, organic solvents, flammable compounds |
| Light to heavy chemical resistant gloves |  | Nitrile Chemical resistant, good puncture, cut, and abrasion resistance | Using apparatus under pressure, air or water reactive chemicals |
| Heavy chemical resistant gloves |  | Butyl High permeation resistance to most chemicals | Working with large volumes of organic solvents; small to large volumes of dangerous solvents, acutely toxic or hazardous materials |
| |  | Viton® II High permeation resistance to most chemicals | Same as butyl gloves, plus hazardous material spills |

What's Wrong With This Picture?



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Fake picture and situation

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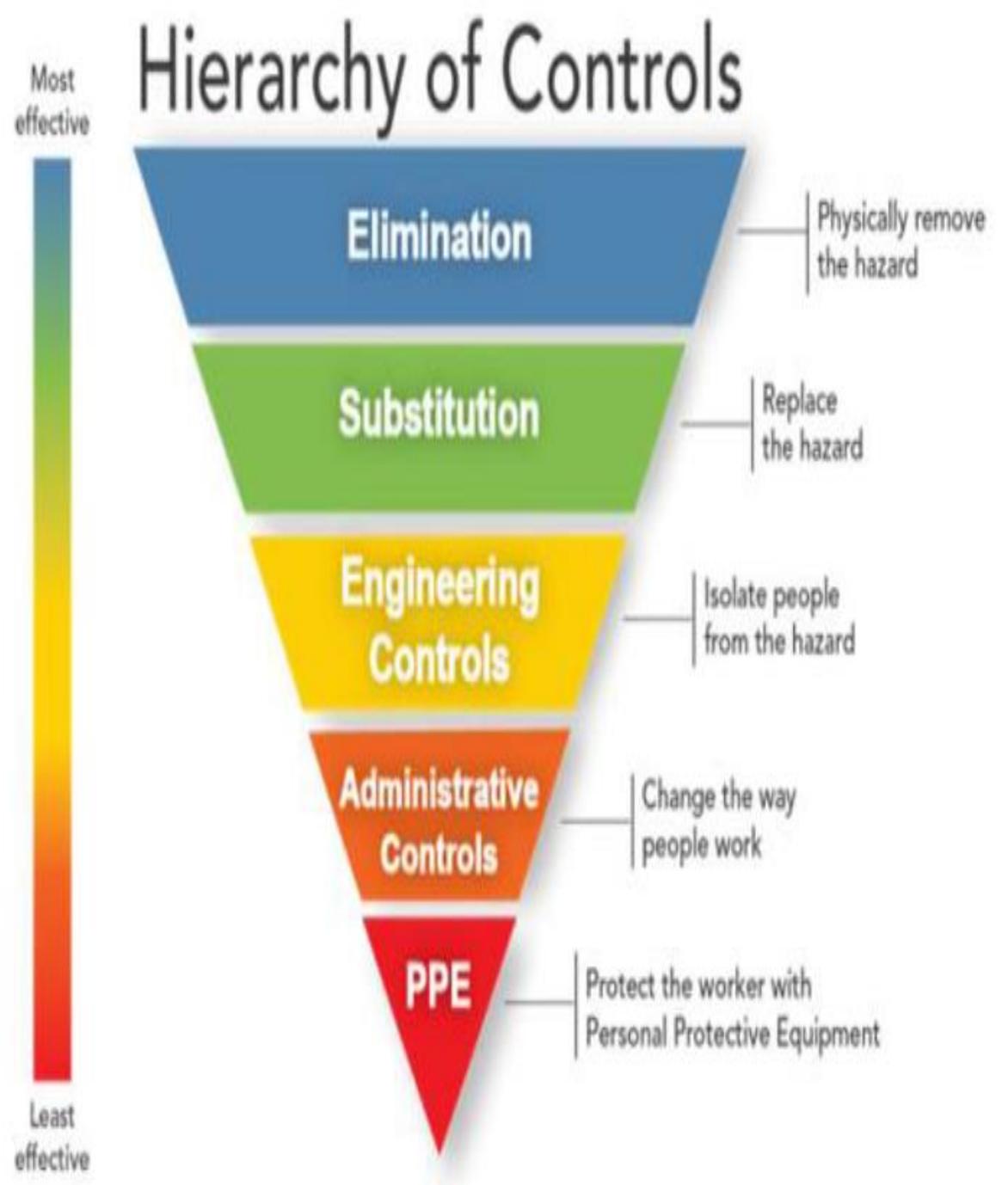


| Quantitative Likelihood |
|---|
| Has occurred on an annual basis in this organization in the past or circumstances are in the train that will cause it to happen |
| Has occurred in the last few years in this organization or has occurred recently in other similar organizations or circumstances have occurred that will cause it to happen in the near few years |
| Has occurred at least once in the history of this organization or is considered to have a 5% chance of occurring in the near few years |
| Has never occurred in this organization but has occurred infrequently in other similar organizations or is considered to have a 1% chance of occurring in the next few years |
| Is possible but has not occurred to date in any similar organization and is considered to have very much less than a 1% chance of occurring in the next few years |

| | | consequences | | | | |
|------------|------------------|-------------------------------------|--|--|--|--|
| People | | Minor skills impact | Minor impact to capability | Unavailability of core skills affecting services | Unavailability of critical skills or personnel | Protracted unavailability of critical skills /people |
| | | Minor injury or first aid treatment | Injury requiring treatment by medical practitioner | Major injury/hospitalization | Single death or multiple major injuries | Multiple deaths |
| | | Insignificant 1 | Negligible 2 | Moderate 3 | Extensive 4 | Significant 5 |
| Likelihood | Almost Certain 5 | | | | | |
| | Likely 4 | | | | | |
| | Possible 3 | | | | | |
| | Unlikely 2 | | | | | |
| | Rare 1 | | | | | |

| Interpreting the results sheet | Insignificant 1 | Negligible 2 | Moderate 3 | Extensive 4 | Significant 5 | | | |
|--------------------------------|--------------------|-----------------|---------------|----------------|------------------|--|--|------------|
| Almost certain 5 | 5 | 10 | 15 | 20 | 25 | | | Acceptable |
| Likely 4 | 4 | 8 | 12 | 16 | 20 | | | Low |
| Possible 3 | 3 | 6 | 9 | 12 | 15 | | | Medium |
| Unlikely 2 | 2 | 4 | 6 | 8 | 10 | | | High |
| Rare 1 | 1 | 2 | 3 | 4 | 5 | | | Very high |

| | Insignificant 1 | Negligible 2 | Moderate 3 | Extensive 4 | Significant 5 |
|---------------------|--------------------|-----------------|---------------|----------------|------------------|
| Almost Certain 5 | 5 | 10 | 15 | 20 | 25 |
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| Possible 3 | 3 | 6 | 9 | 12 | 15 |
| Unlikely 2 | 2 | 4 | 6 | 8 | 10 |
| Rare 1 | 1 | 2 | 3 | 4 | 5 |



3. Minimize (or control) the risks of the hazards

Laboratory hygiene

- Keep your workplace tidy
- Clear up waste, deal with washing up and put things away as you finish with them
- Make sure everything is safe before you leave things unattended

A Cluttered Lab is a Dangerous Lab! Keep your lab clean!



<https://lab-training.com/2015/12/05/laboratory-accidents-prevention-your-top-priority/>



<https://www.greelane.com/fr/science-technologie-math%C3%A9matiques/science/important-lab-safety-rules-608156/>

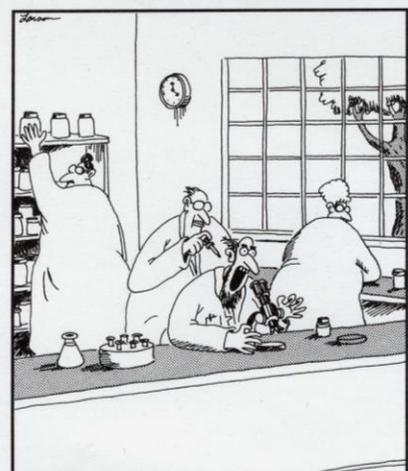
3. Minimize (or control) the risks of the hazards

Laboratory hygiene

- Never eat, drink or smoke in a laboratory
- Never apply cosmetics
- Never touch your face, mouth or eyes
- Never suck pens or chew pencils
- ...



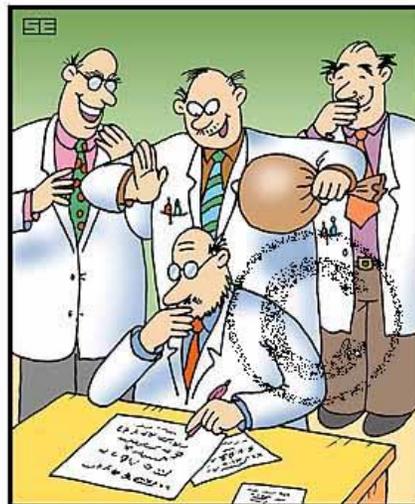
<https://www.the-scientist.com/technology-profile/an-accident-waiting-to-happen-52199>



Professor Glickman, the lab practical joker, deftly places a single drop of hydrochloric acid on the back of Professor Bingham's neck.

analysis

Análisis



The favourite practical joke amongst Big Bang theorists.

Never Engage in practical jokes

America and the Caribbean

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3. Minimize (or control) the risks of the hazards

Waste Management



Hazardous and biohazardous waste has special guidelines for proper disposal. It is important to properly dispose of waste to ensure human and environmental health.

Waste can be classified as either hazardous or biohazardous.

How to Properly Dispose of Chemical Waste

| Aqueous Waste (<40% Organic Chemicals) | Organic (>40% Organic Chemicals) | Solid Waste | Special Cases |
|--|---|---|--|
|  <ol style="list-style-type: none"> Acidic (pH < 4) Neutral (pH ~4-10) Basic (pH > 10) |  <ol style="list-style-type: none"> Non-chlorinated (e.g. THF, ethyl acetate, hexanes, toluene, methanol, etc.) Chlorinated (e.g. DCM, chloroform, chlorobenzene, etc.) Chemicals in a commercial bottle <u>Undamaged bottle:</u> Dispose in original bottle (no label necessary) <u>Damaged bottle:</u> Arrange disposal with Chem Stores | <ol style="list-style-type: none"> Lightly Contaminated <ul style="list-style-type: none"> No visible loose powders Collect in unlabeled green pails Empty into the solid waste drums on the 7th floor <u>Examples:</u> Gloves, Kimwipes, paper towels, empty vials/centrifuge tubes, etc. Chemical <ul style="list-style-type: none"> Loose powders Heavily contaminated solid materials <u>Examples:</u> Used filter paper, unwanted samples, heavily contaminated gloves/kimwipes/paper towels, etc. Silica gel <ul style="list-style-type: none"> Dispose in separate container May not be combined with other types of chemical wastes Chemicals in a commercial bottle <u>Undamaged bottle:</u> Dispose in original bottle (no label necessary) <u>Damaged bottle:</u> Place in secondary container with a waste label | <ol style="list-style-type: none"> Sharps (e.g. needles, razor blades, etc.) Inorganic Oxidizing <ul style="list-style-type: none"> Place in a container with a disposal label <u>Examples:</u> Peroxides, chromates, etc. Violently Reactive <ul style="list-style-type: none"> Contact Ken Greaves and Mike Dymarski <u>Examples:</u> LAH, nBu-Li, HF, Piranha, etc. Mercury Thermometers <ul style="list-style-type: none"> Labeled separate puncture resistant container Any uranium, thorium or mercury containing compounds <ul style="list-style-type: none"> Contact Ken Greaves and Mike Dymarski |
| A Note on Labeling: <ul style="list-style-type: none"> Indicate the content in the disposal container. Write out all chemical names. If the content is a mixture of chemicals, indicate the major components and list the most hazardous component[s]. | | | |
| <small>This document was created by Green Chemistry Initiative (GCI) in partnership with Environmental Health and Safety (EHS).</small> | | | |

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1. Recognize the Hazards
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4. Prepare for Emergencies from Uncontrolled Hazards



4. Prepare for Emergencies from Uncontrolled Hazards

What to do???

The best measure to take in order to protect yourself and your colleagues is to be prepared. There should be Standard Operating Procedures (SOP) for this type of situation in your lab.

- Recommended Safety Equipment
- Exits and Emergency Drills
- Emergency Response



4. Prepare for Emergencies from Uncontrolled Hazards

In case of an emergency...

Know the locations of:

- fire extinguisher
- fire blanket
- body shower
- eyewash station
- first aid kit



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Know Your Surroundings

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4. Prepare for Emergencies from Uncontrolled Hazards

Special Considerations

- Fires
- Spills
- Gas cylinders
- Electrical equipment





4. Prepare for Emergencies from Uncontrolled

Hazards : Fire

1. Avoiding Fires

Flammable substances :

- Use minimum quantity
- Store in special storage cabinet
- Use temperature-controlled heating sources



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KNOW HOW TO USE A FIRE EXTINGUISHER
FOLLOW THE ***P*A*S*S** WORD
***PULL *AIM *SQUEEZE *SWEEP**



4. Prepare for Emergencies from Uncontrolled Hazards : Fire

1. Avoiding Fires

Flammable substances :

- Use minimum quantity
- Store in special storage cabinet
- Use temperature-controlled heating sources

2. Fire Safety

Make sure that you know what to do :

- If you have a fire
- If you hear a fire alarm
- A member of staff must attend fire training annually



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3. Emergency Response

- If your clothing catches on fire, drop and roll to put out the flames
- Immediately notify your supervisor of the incident and report it

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KNOW HOW TO USE A FIRE EXTINGUISHER
FOLLOW THE ***P*A*S*S** WORD
***PULL *AIM *SQUEEZE *SWEEP**

4. Prepare for Emergencies from Uncontrolled Hazards : **Spillages**



- The first response to a spill should be to evacuate the immediate area until the scope of the hazard has been addressed.
- Allow sufficient time for the aerosol to settle before considering entering the room.
- You will already have determined how to do this as part of your risk assessment

Emergency Response

- Chemical spill on clothing
- Chemical splashes to the eye
- Burns
- ...



4. Prepare for Emergencies from Uncontrolled Hazards : Gas cylinders

Compressed gases may pose a physical and/or health hazard depending on the gas being used (MSD).

- Never use without formal training
- Minimise the number in a laboratory
- Store externally whenever possible
- Cylinders are heavy and can do serious damage to you if they fall
- Ensure that they are chained when in use
- Move only with a cylinder trolley
- Use regulators control equipment suitable for the gas concerned
- Consider the consequences if your cylinder leaks



The explosion knocked down ceiling panels, broke light fixtures, and scattered debris throughout the lab.

Credit: Honolulu Fire Department



The explosion caused damage in the hallway outside of the lab.

Credit: Honolulu Fire Department

4. Prepare for Emergencies from Uncontrolled Hazards : Gas cylinders

Compressed gases may pose a physical and/or health hazard depending on the gas being used (MSD).

<https://www.youtube.com/watch?v=IOUj6rGXuW4>



4. Prepare for Emergencies from Uncontrolled Hazards : **Electrical Equipment**

- Always do a visual check on electrical equipment before use, looking for obvious wear or defects
- NEVER use defective equipment



4. Prepare for Emergencies from Uncontrolled Hazards :

Report it!!!

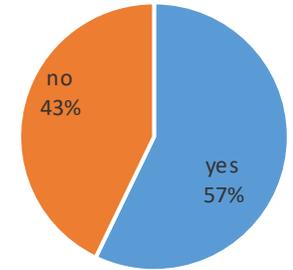


When a accident occurs, it must be recorded **in the lab register**. The main purpose of the register is to track an exposure in case of future illness/injury, and report it to your supervisor.

Last, not Least.....

Create a Laboratory Safety Manual

Laboratory Safety Manual



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Last, not Least..... Create a Laboratory Safety Manual

Writing a clear and concise policy regarding all lab rules and best practices

New staff members read the manual and ask that they sign it

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"They hate it when you carry the testtubes that way."

Lab Safety



Always wear safety goggles when working in the lab.





Never wear open-toed shoes in the lab.



No food or drinks in the lab.



Always wear safety gloves when working in the lab.



Always discard any broken glass in the broken glass container.



If chemicals get in your eyes, use the eyewash station to clean them.





LABORATORY SAFETY GUIDELINES

WHAT is this for?

- SAFETY IN THE LAB
- PREVENTING AND REDUCING THE RISK OF ACCIDENTS BETWEEN HAZARDOUS AND NON-HAZARDOUS
- REDUCING THE RISK OF EXPOSURE TO HAZARDOUS SUBSTANCES
- REDUCING THE RISK OF INJURY TO PERSONS
- REDUCING THE RISK OF DAMAGE TO THE LAB
- REDUCING THE RISK OF DAMAGE TO THE ENVIRONMENT
- REDUCING THE RISK OF DAMAGE TO THE RESEARCH
- REDUCING THE RISK OF DAMAGE TO THE RESEARCHER

WHEN is this for?

- SAFETY
- BEFORE ALL THE RESEARCH ACTIVITIES

WHO is this for?

- ALL PERSONS WHO ARE INVOLVED IN THE LAB
- ALL PERSONS WHO ARE INVOLVED IN THE RESEARCH
- ALL PERSONS WHO ARE INVOLVED IN THE RESEARCH

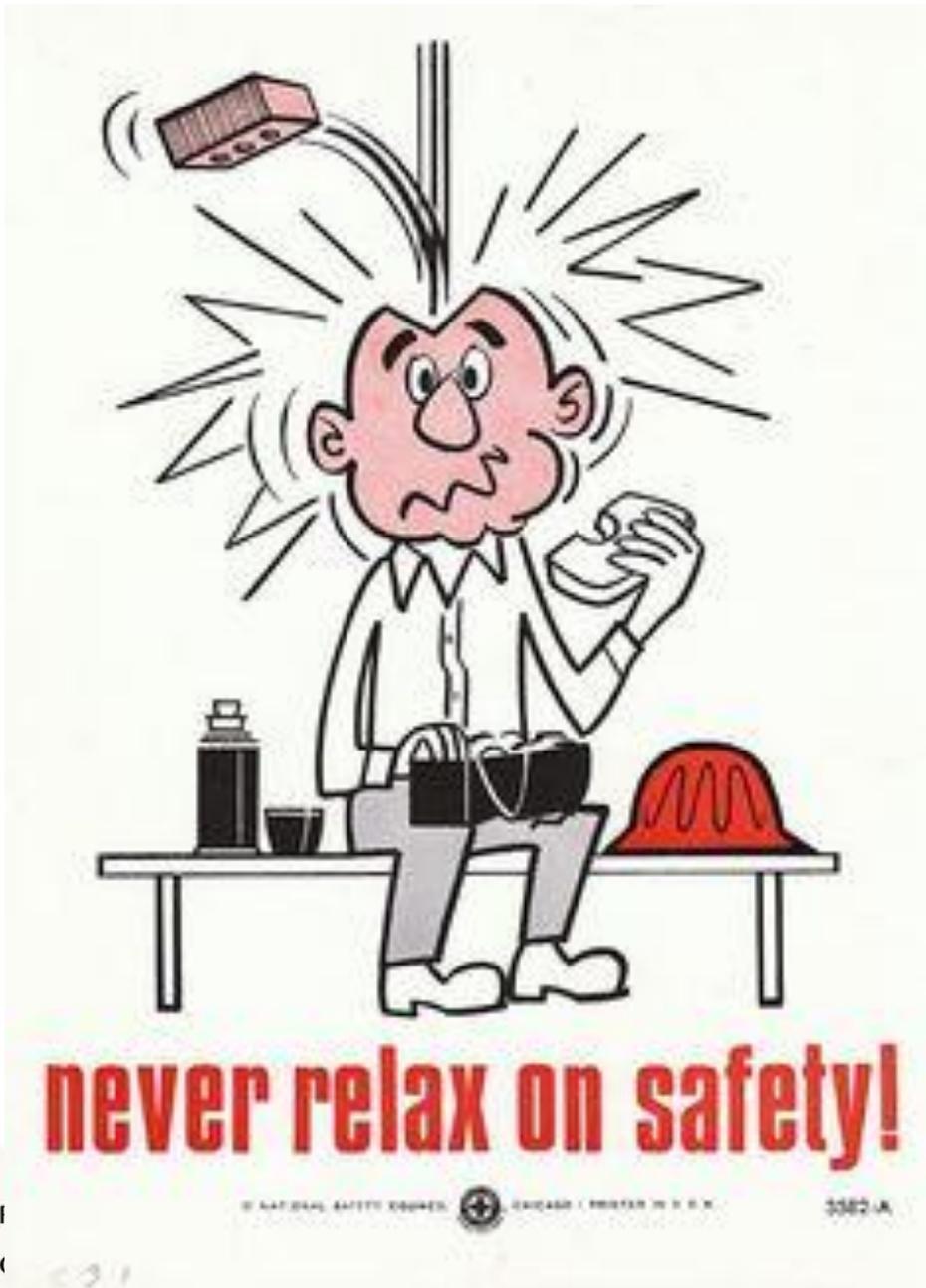
WHY do I need to know this?

- TO PREVENT ACCIDENTS
- TO PREVENT INJURY TO PERSONS
- TO PREVENT DAMAGE TO THE LAB
- TO PREVENT DAMAGE TO THE ENVIRONMENT
- TO PREVENT DAMAGE TO THE RESEARCH
- TO PREVENT DAMAGE TO THE RESEARCHER

HOW can I prepare my surroundings and myself?

- 1. Recognize the risks and the hazards**
- 2. Assess them**
- 3. Minimize or control the risk**
- 4. Prepare yourself for any potential emergency**

el Caribe



Thank you

Merci

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Internet Sources for Chemical Hazard Information

- American Chemical Society (ACS)
<http://dchas.cehs.siu.edu>
- Howard Hughes Institute
- American Biological Safety Association
- National Institute of Occupational Safety and Health (NIOSH)
- Center for Disease Control (CDC)

3. Prepare for Emergencies from Uncontrolled Hazards

Glassware

- Use correct techniques for the insertion of tubing onto glassware
- Never use glassware under pressure or vacuum unless it is designed for the job and suitably shielded
- Dispose of chipped or broken glassware it is a risk to you and others
- Always dispose of broken glass in a glass bin or sharps bin and not in a general waste bin

Tips

- <https://www.youtube.com/watch?v=RhIOYhOvCsQ>
- <https://www.youtube.com/watch?v=5W3cMaowR-c>
- <https://www.youtube.com/watch?v=gi3DeFY0cfw>
- <https://www.youtube.com/watch?v=1rcqxMURmhl> French



Terrifying statistics

- <https://www.labsafety.org/lab-safety-terrifying-statistics>

An explosion at University of Hawaii

- <https://cen.acs.org/articles/94/web/2016/04/Spark-pressure-gauge-caused-University.html>

quiz

- <https://www.highspeedtraining.co.uk/hub/health-safety-quiz/>
- <https://www.proprofs.com/quiz-school/quizshow.php?title=Lab-Safety-Practice-Quiz&q=2>
- <http://hsct2.free.fr/quiz/quiz3.php> : French
- <https://www.sens-ludique.com/conception-jeu/prevention-des-risques-par-le-jeu/> French (team game)

What's Wrong With These Statements?

- Hal says that his teacher is solely responsible for preventing laboratory accidents.
- Keshia started the lab activity before reading it through completely.
- Ricardo decided to do a lab activity that he read about in a library book before the teacher came into the classroom.
- Stephanie says that the safety goggles mess up her hair and give her raccoon eyes. She refuses to wear them.
- Barbie and Ken accidentally break a beaker full of some chemical. Instead of risking getting in trouble they quickly clean up the mess with paper towel and throw it in the garbage.



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Thank you

