

▶ Chemical exposures in the
world of work:
Preventative measures at the
workplace level



Session objectives

At the end of the session, you will be able to:

1. Provide an overview of different workplace level actions.
2. Describe the different components of a workplace programme.
3. Understand how to implement a workplace strategy.
4. Explain the Hierarchy of Controls.
5. Illustrate how the Hierarchy of Controls can be applied for different chemicals.



Introduction

Workplace prevention efforts must be implemented to complement policy level actions.

- ▶ **Implement a workplace programme for the sound management of chemicals:** To follow the ILO general blueprint for the sound management of chemicals in the workplace.
- ▶ **Implement a workplace level strategy:** This includes chemical identification and classification, risk assessment and identification of control measures.
- ▶ **Apply the Hierarchy of Controls:** Elimination, substitution, engineering controls, administrative controls and personal protective equipment (PPE).



Question:

Can you think of any ways that hazardous chemical exposures can be controlled in the workplace?





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Implement a workplace programme



▶ ILO blueprint of a workplace programme

- ▶ The ILO recommends a number of components that make a general blueprint for the sound management of chemicals in the workplace.
- ▶ National guidelines should be considered in the first instance.



Components of a workplace programme – an overview

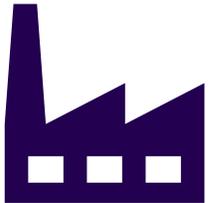
- ▶ General obligations, responsibilities and duties
- ▶ Classification and Labelling following the GHS
- ▶ Chemical Safety Data Sheets
- ▶ Operational Control Measures
- ▶ Design and Installation
- ▶ Work Systems and Practices
- ▶ Personal Protection
- ▶ Information and Training
- ▶ Maintenance of Engineering Controls
- ▶ Exposure Monitoring
- ▶ Medical and Health Surveillance
- ▶ Emergency Procedures and First Aid
- ▶ Investigation, Recording and Reporting of Accidents, Occupational Diseases and Other Incidents

General obligations, responsibilities and duties



Responsibilities of government

- ▶ Sick workers should have access to **medical care** and **sickness benefits**.
- ▶ Workers should be covered by schemes for **employment injury benefits**.
- ▶ Sick workers should receive **health care**.
- ▶ Dependent family members should have **compensation** and **funeral grants**.



Responsibilities of employers

- ▶ Ensure that workplaces are **safe**.
- ▶ Ensure that chemical substances are **without risk** to health.
- ▶ Ensure that workers are **trained in OSH**.
- ▶ Provide PPE and **emergency measures** for accidents.



Rights and responsibilities of workers

- ▶ Participate in adequate **OSH training**.
- ▶ **Remove themselves** from dangerous work situations.
- ▶ Comply with **OSH instructions**.
- ▶ **Report accidents**.

Classification and labelling following the GHS

Internationally agreed standard set up to create an internationally harmonized approach to classification and labelling of chemicals

- ▶ Designed to cover **all chemicals**, including mixtures.
- ▶ Developed to **inform and protect people** involved in chemical production, handling, transport, use and disposal.
- ▶ Workplace chemicals must be **appropriately labelled** using GHS.

GHS PICTOGRAMS		
Health Hazard Carcinogens, respiratory sensitisers, reproductive toxicity, target organ toxicity, germ cell mutagens 	Flame Flammable gases, liquids, & solids; self-reactives; pyrophorics; 	Exclamation Mark Irritant, dermal sensitiser, acute toxicity (harmful) 
Gas Cylinder Compressed gases; liquefied gases; dissolved gases 	Corrosion Skin corrosion; serious eye damage 	Exploding Bomb Explosives, self-reactives, organic peroxides 
Flame Over Circle Oxidisers gases, liquids and solids 	Environment Aquatic toxicity 	Skull & Crossbones Acute toxicity (severe) 

▶ Chemical safety data sheets (SDS)

- ▶ Comprehensive information on hazards.
- ▶ Training must also be provided.
- ▶ Includes harms and guidance on precautions needed.
- ▶ Content:
 - Identification: for product and supplier
 - Hazards: physical (fire, reactivity, corrosivity) and health
 - Prevention: steps to work safely, reduce or prevent exposure, or in an emergency
 - Response: in various situations (e.g., first-aid, fire, accidental release)



Chemical safety data sheets (SDS)



1. identification;
2. hazard identification;
3. composition/information on ingredients;
4. first aid measures;
5. fire-fighting measures;
6. accidental release measures;
7. handling and storage;
8. exposure controls/personal protection;
9. physical and chemical properties and safety characteristics;
10. stability and reactivity;
11. toxicological information;
12. ecological information;
13. disposal considerations;
14. transport information;
15. regulatory information;
16. other information.

▶ Operational control measures

- ▶ Establish criteria for the safe use of hazardous chemicals.
- ▶ After assessing risks, employers should take steps to limit exposure of workers (elimination or substitution preferable).
- ▶ Control measures for:
 - Chemicals hazardous to health
 - Flammable, dangerously reactive or explosive chemicals
 - Storage of hazardous chemicals
 - Transport of chemicals
 - Disposal and treatment of chemicals



► Design and installation

- Use **engineering control measures** to minimise risks of chemical exposure: These include:
 - **Changing a process** to reduce risk e.g. decrease the temperature so less vapour is released.
 - **Enclosed systems** where feasible to keep the hazard 'in' and the worker 'out' e.g. dust hoods and spray booths.
 - **Separate areas** for hazardous processes to limit exposures.
 - Practices and equipment that **minimize releases**.
 - Local exhaust **ventilation** and general ventilation.

▶ Workplace systems and practices

- ▶ Use **administrative control measures** to minimize risks of chemical exposure. These include:
 - **Organisational practices** e.g. rest breaks, work rotations.
 - **Safe work procedures** e.g. compliant with law, address all hazards.
 - **Cleaning and maintenance** of control equipment.
 - Provision of **safe storage** for hazardous chemicals e.g. safety signs, proper containers.
 - Personal **hygiene practices** and facilities e.g. washing facilities, drinking water.
 - Education, **training** and preparedness.
 - **Housekeeping** e.g. clean equipment and decluttered workspaces.

▶ Personal protection

- ▶ **Personal protective equipment** e.g. gloves, respirators, overalls.
- ▶ **Welfare facilities** and **personal hygiene** e.g. washing facilities, clean drinking water.
- ▶ Practices to **maintain** equipment and clothing as necessary e.g. proper storage and cleaning of PPE.
- ▶ **Training** on personal protection.



Information and training

- ▶ Workers should be given information about chemicals in the appropriate language (labels and safety data sheets).
- ▶ They should be trained on topics such as:
 - Types of chemical hazards in their work.
 - Risks to health.
 - How to handle chemicals safely.
 - What to do in an emergency.
 - How to obtain additional information.



▶ Maintenance of engineering controls

- ▶ Practices and procedures to keep engineering controls in good working order.
- ▶ Engineering control measures should be examined and **tested regularly**.
- ▶ The results of each thorough examination and test should be compared with the assessment of risks and control measures.
- ▶ A suitable **record of examinations** should be kept.



▶ Exposure monitoring

Surveillance programmes should include the monitoring of workers' exposure to hazardous chemicals.

- ▶ The main objectives of monitoring:
 - Identify real hazards.
 - Determine the level of workers' exposure to harmful agents.
 - Prove compliance with regulatory requirements.
 - Assess the need for control measures.
 - Ensure the efficiency of control measures in use.
- ▶ This can be done through occupational health surveys involving monitoring equipment.
- ▶ Where workers are exposed, the employer should limit exposures and assess monitor and record concentrations of substances.

▶ Medical and health surveillance

- ▶ Medical exams for exposed workers.
- ▶ Recordkeeping of exams and health results.
- ▶ Paid time off for affected workers, including paid sick leave.
- ▶ Employment protection for those harmed by chemicals.
- ▶ Transfer to alternative employment for pregnant/breast feeding workers.
- ▶ Proactive approach to workers' health promotion
 - Includes medical visits and specific testing/instrumental examinations.
 - Employer must ensure workers get medical services in compliance with the national law.
- ▶ Occupational medical records/data
 - Ensure confidentiality, safe data storage, workers' information, access to their own records and non-discrimination. Valuable for study/research/prevention.



▶ Emergency procedures and first aid

- ▶ Planning should be done to anticipate possible emergencies and have procedures to deal with them.
- ▶ First aid should be available on-site.
- ▶ Workers should be trained to raise the alarm, call for assistance and evacuate areas, as well as how to minimize incidents.
- ▶ Firefighting equipment should be provided and training given.



▶ Investigating and reporting of accidents, occupational diseases and other incidents

- ▶ All incidents should be investigated to determine why they occurred, what failed in the workplace or in the emergency plan.
- ▶ The accident and dangerous incident book should be reviewed regularly to identify risky jobs and processes.
- ▶ Authorities should be notified as required by national laws.





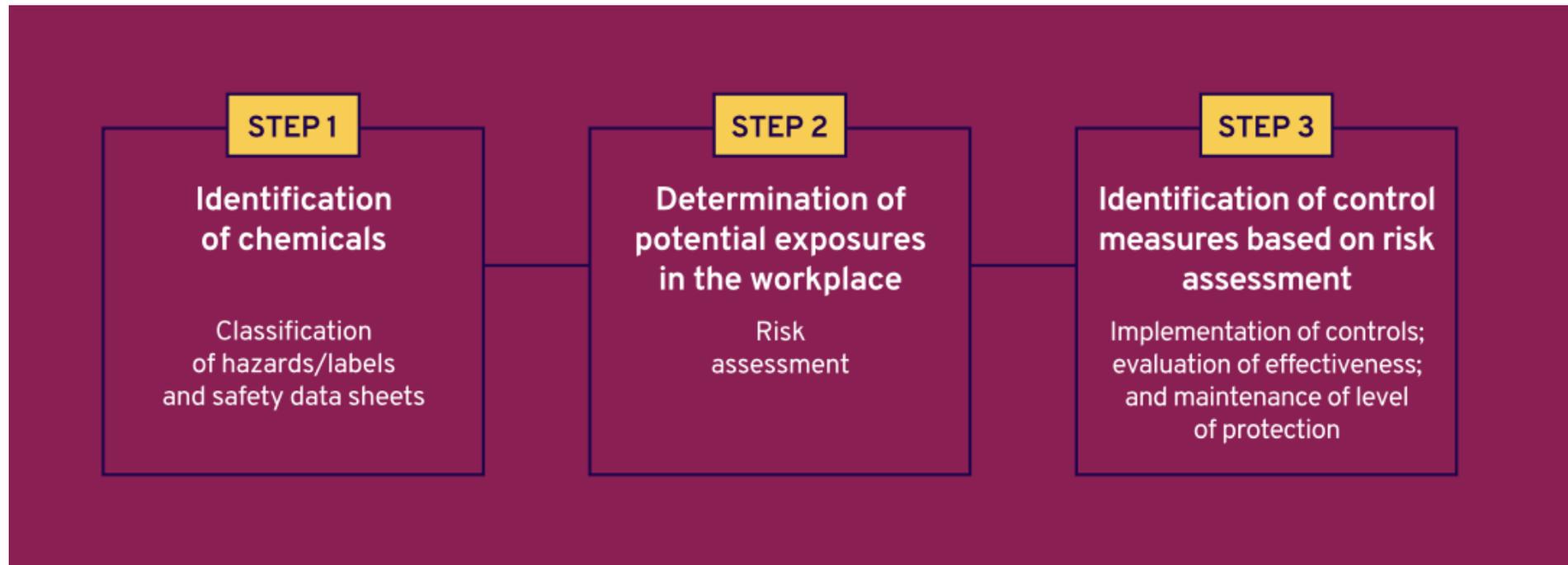
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**Implement a
workplace level
strategy**



► Implement a workplace level strategy

The overall strategy to achieve the sound management of mercury in the workplace and in protecting the general environment can be described in three steps:



▶ **Step 1: Identification of chemicals**

Classification of hazards, labels and safety data sheets

- ▶ Identify what chemicals are present.
- ▶ Ensure that they are classified as to their health, physical and environmental hazards.
- ▶ Labels and safety data sheets should be used to convey the hazards and associated protective measures.
- ▶ Information provides the underlying structure needed to achieve the sound management of chemicals.
- ▶ The information is needed to evaluate the impact of the chemicals and to determine appropriate preventive measures and controls.

Step 1: Identification of chemicals

1 — **2-Propanol**

2 — **DANGER**

3 —

- Highly flammable liquid and vapor.
- Causes mild skin irritation.
- Causes serious eye irritation.
- May cause drowsiness or dizziness.

4 —

Keep away from heat/sparks/open flames/hot surfaces. -No Smoking. Avoid breathing dust/fume/gas/mist/vapours/spray. **IF IN EYES:** Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. May be harmful if absorbed through skin. Causes skin irritation. causes eye irritation. may be harmful if swallowed.

5 — Acme Chemical - 101 Main Street - Anywhere - USA

6 —

1 Product identifier / Ingredient Disclosure

2 Signal word

3 Hazard Statement

4 Precautionary Statements

5 Supplier Identification

6 Pictograms



▶ Step 2: Risk assessment

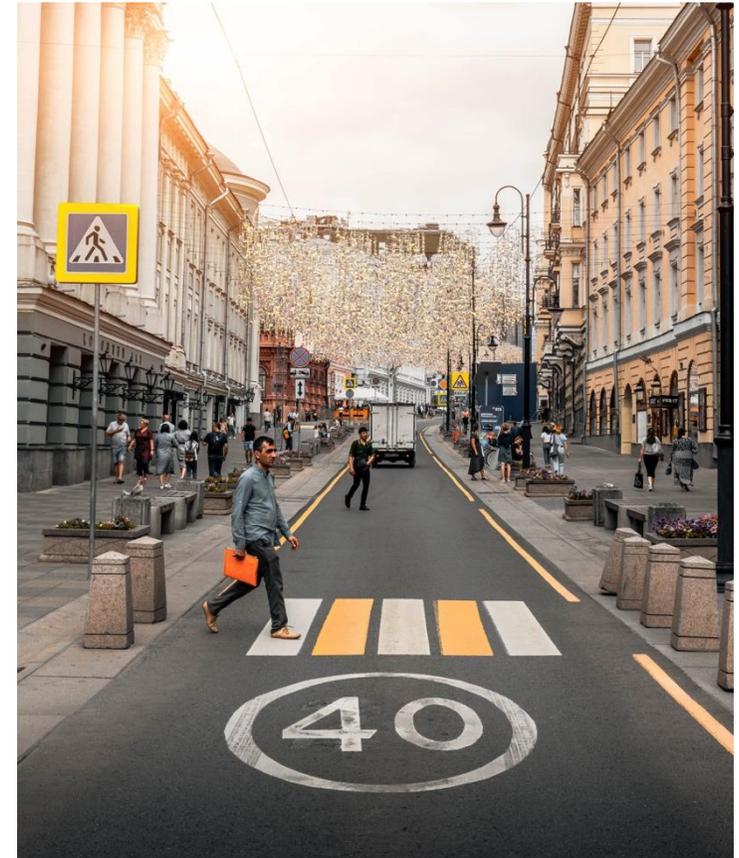
A preventative tool to ensure safer/healthier working conditions.

- ▶ Process used to determine the level of risk of injury or illness associated with each chemical.
- ▶ Evaluate how the identified and classified chemicals are used in the workplace
- ▶ Determine what exposures can result from this use.
- ▶ May be accomplished through exposure monitoring, or through application of tools that allow for estimation of exposures based on:
 - the quantity used
 - the potential for release given the conditions in the workplace
 - physical characteristics of the chemical

▶ Step 2: Risk assessment in everyday life

Example: Crossing a road

- ▶ Do I look both ways and then go?
- ▶ Should I use the zebra crossing?
- ▶ Do I use the crossing point?
- ▶ Same on every road?
 - Vehicle speed?
 - Is the road straight?



▶ Step 2: Risk assessment

The following stages are carried out in a risk assessment:

- A. Identification of chemical hazards (as described in Step 1).
- B. Identification of who might be harmed and how.
- C. An evaluation of the risks and how to control them.
- D. Recording the results of the assessment and setting priorities for improvement.
- E. Reviewing and updating the assessment as necessary.

Step 2: Risk assessment

What are the hazards?	Who may be harmed and how?	What are you already doing?	What further action is necessary?	Action by whom	Action by when	Done
Slips, trips and falls	Staff and others risk injuries such as fractures and bruising if they trip over objects, or slip on spillages or on wet floors, and fall.	<ul style="list-style-type: none"> ■ Good housekeeping at client company. ■ Warning cones placed in wet floor areas. ■ Client company instructs all staff to keep off wet floors. ■ Cleaners use electrical socket nearest to where they are working to reduce risk of tripping over leads. 	<ul style="list-style-type: none"> ■ To further reduce risk of slips, introduce two-mop system for cleaning hard floors (wet mopping followed by dry mopping). 	Manager	31/8/13	System introduced 8/8/13
			<ul style="list-style-type: none"> ■ Cleaners instructed to wear sensible shoes, e.g. flat shoes with a good grip. 	Manager	31/8/13	15/8/13
Contact with bleach and other cleaning chemicals	Staff risk getting skin problems such as dermatitis, and eye damage, from direct contact with bleach and other cleaning chemicals, e.g. solvents and detergents. Chemical vapour may cause breathing problems.	<ul style="list-style-type: none"> ■ Staff asked when they start if they suffer ill health, e.g. skin problems, when using cleaning chemicals. ■ Long-handled mops and brushes, and strong rubber gloves, are provided and staff trained in their use. ■ All staff trained in the risks, use and storage of cleaning chemicals. 	<ul style="list-style-type: none"> ■ Investigate replacing chemicals marked 'irritant' with milder alternatives. 	Manager	7/10/13	
			<ul style="list-style-type: none"> ■ Staff reminded to report any health problems they think may come from cleaning, and to check for dry, red or itchy skin on their hands. 	All staff	7/8/13	4/7/13
			<ul style="list-style-type: none"> ■ Staff reminded to wash gloves after use. 	Manager	7/8/13	4/7/13
Musculoskeletal disorders (MSDs) and injuries	Staff risk injuries such as back problems if they try to lift objects that are heavy and/or awkward to carry, such as cleaning machines or full mopping buckets, or if they are required to often work in awkward postures.	<ul style="list-style-type: none"> ■ Cleaning equipment provided for each floor. ■ Long-handled mops, brushes and dusters are provided to reduce need to stretch and stoop. ■ Staff do not overfill buckets. 	<ul style="list-style-type: none"> ■ Provide new mopping system – long-handled wringer, to reduce force needed to squeeze mop, and a bucket on wheels to reduce lifting and carrying (see 'slips, trips and falls'). 	Manager	1/11/13	
Work at height	Staff risk bruising and fracture injuries if they fall from any height.	<ul style="list-style-type: none"> ■ No need for staff work from stepladders etc. and they are instructed not to do so. ■ 'No standing on chairs' policy. ■ Staff trained in safe system of work for cleaning stairs. 	<ul style="list-style-type: none"> ■ None 			

▶ Step 2: Risk assessment

Many established methods and techniques for carrying out risk assessments.

- ▶ A numerical weighting system may be used to determine priorities for action for each hazard.
- ▶ Numerical values are assigned to:
 - The likelihood of the hazard causing harm
 - The severity of the consequences
- ▶ The level of risk is then determined:

Risk = likelihood x severity

Step 2: Risk assessment

Evaluating risks through risk matrices.



Probability (likelihood) of event happening	Potential Severity or consequences of the event		
	Slightly harmful	Moderately harmful	Very harmful
Low probability	Low risk	Low risk	Medium risk
Probable	Low risk	Medium risk	High risk
Highly probable	Medium risk	High risk	High risk

▶ **Step 3: Identification of control measures based on risk assessment**

Implementation of risk controls, evaluation of effectiveness and maintenance of protection levels.

- ▶ The information collected is used to design an appropriate preventive and protective programme for the workplace.
- ▶ The Hierarchy of Controls is used.
- ▶ Other provisions of a thorough programme that support and enhance these controls are exposure monitoring, information and training for exposed workers, recordkeeping; medical surveillance, emergency planning and disposal procedures.

▶ A positive safety culture is key

It is essential to create a preventative safety and health culture.

- ▶ **Prevention: stopping something from happening.**
 - Occupational accidents and ill health cause an intolerable burden, damaging reputation for good business and negatively impacting sustainable economic growth. In short, **prevention pays.**
- ▶ **A Preventative safety and health culture.**
 - Right to a safe and healthy working environment ensured by government, employers and workers through a system of defined rights, responsibilities and duties, where the principle of prevention is accorded the highest priority.

“An ounce of prevention is worth a pound of cure.”

▶ Actions for a positive safety culture

▶ At the national level:

- Commitment from government to build and maintain this culture.
- OSH must be a priority in the national agenda.
- Adequate means and resources must be allocated to increase OSH, awareness, knowledge of hazards and risks, and understanding of their prevention and control.
- Meaningful social dialogue and tripartite national commitment.

▶ At the workplace level:

- Compliance with OSH regulations and introduction of OSH management systems
- Culture change to achieve a positive OSH culture, which is valued and promoted by all.
- Workers should feel comfortable to raise OSH concerns.
- Open communication and dialogue built on trust and mutual respect.

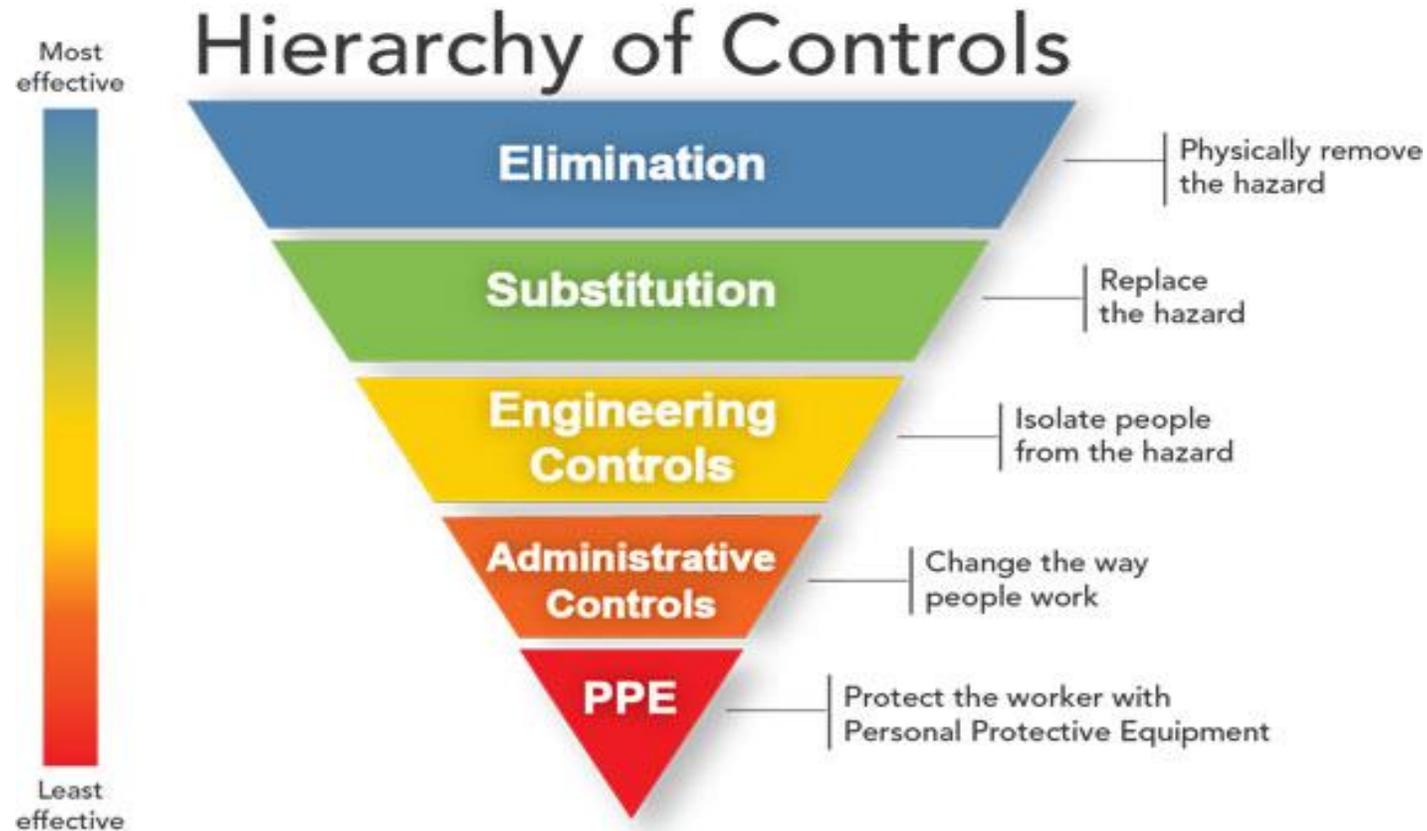
Promotional Framework for
Occupational Safety and Health
Convention, 2006 (No. 187):

“culture in which the right to a safe and healthy working environment is respected at all levels, where governments, employers and workers actively participate in securing a safe and healthy working environment through a system of defined rights, responsibilities and duties, and where the principle of prevention is accorded the highest priority.”

Apply the Hierarchy of Controls



What is the Hierarchy of Controls?



▶ Elimination

Completely remove the hazardous substance or work practice.

- ▶ Example: Stopping the use of a toxic pesticide.
- ▶ This is the most effective action to take because you remove the risk!
- ▶ It is also the most difficult (and costly).
- ▶ Major changes in equipment and procedures may be required to eliminate a hazard.
- ▶ May be simpler and cheaper if carried out during the design or development stage.

Whenever possible, the best way to eliminate the risk is to completely remove the hazardous item or substance or work practice



▶ Substitution

Replace the hazardous substance with a less hazardous one. It also works for processes (choosing a safer process).

- ▶ Example: Replacing solvent-based substances with water-based.
- ▶ It is important that the new choice does not create unexpected new dangers.
- ▶ Major changes in equipment and procedures may be required to substitute a hazard.

If it is impossible to get rid of a hazard completely, the most effective control option to minimize the risk is to substitute the hazardous substance, process or work practice with a safer, harmless alternative



▶ Engineering controls

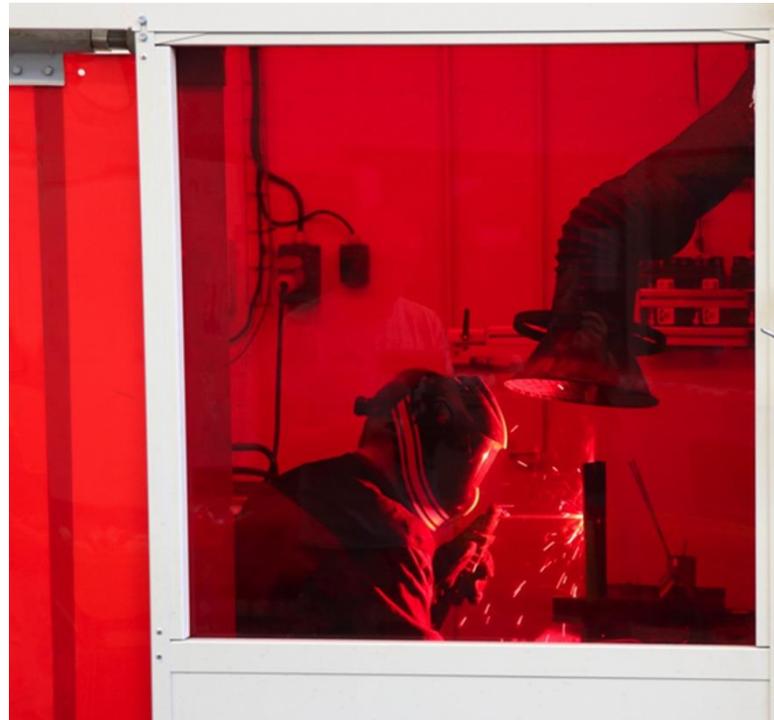
Remove the hazard at the source, before it comes in contact with the worker.

- ▶ Example: Ventilation systems or safety guards.
- ▶ Isolation involves enclosing the hazardous chemical to prevent it reaching the worker.
- ▶ Ideally, these should be implemented during the plant design phase.
- ▶ Can be highly effective at protecting workers.
- ▶ Initial costs can be higher, but over the longer term, operating costs are frequently lower.

Where the elimination or substitution of hazardous substances is not practicable, technical measures should be applied to prevent access to the hazard by enclosing it completely to prevent the hazard from reaching the worker



Engineering controls



▶ Case study: Engineering controls for silica exposure

- ▶ A study by Meeker et al (2009) in the USA evaluated the performance of commercially available engineering controls used in dusty construction tasks commonly performed by bricklayers.
- ▶ **Local exhaust ventilation (LEV) controls** for a portable abrasive cutter and for tuckpointing grinders were examined at a bricklayers' training centre, as were **two stationary wet saws**.
- ▶ Personal breathing zone air samples were collected with and without the use of LEV or water suppression during simulated concrete block cutting, brick cutting and tuckpointing.
- ▶ **Significant reductions in respirable quartz concentrations** in workers' breathing zones were seen for both the portable LEV unit and stationary wet saws (between **91% and 96%** for the different tasks).
- ▶ This shows that commercially available off-the-shelf tools are effective engineering control interventions to reduce crystalline silica exposures in construction.

▶ **Administrative controls**

Development safe work methods, to be used at all times, to minimise the exposure of workers to a hazard.

- ▶ Example: In-depth training on safe asbestos removal.
- ▶ Aims to change the way people work.

Developing and enforcing safe work methods and practices to minimize exposure to a hazard and hence to reduce the risk of injury or harm



▶ **Administrative controls: Types**

- ▶ Organizational practices e.g. proper breaks, job rotation, relief workers
- ▶ Safe work procedures e.g. compliant with laws, workplace hazards addressed
- ▶ Housekeeping e.g. clean equipment, tidy factory, stored chemicals
- ▶ Personal hygiene practices and facilities e.g. safe drinking water, washing facilities
- ▶ Education, training and preparedness e.g. mandatory, skills, promote OSH
- ▶ Keeping equipment well maintained e.g. planned preventative maintenance

▶ Personal Protective Equipment (PPE)

Wear PPE when handling or in contact with chemicals

- ▶ Should be used as a last resort or for short-term purposes (maintenance).
- ▶ Frequently used where hazards are not particularly well controlled.
- ▶ Relatively inexpensive to establish, but can be very costly to sustain long term.
- ▶ Less effective than other measures and requires significant effort by the workers.
- ▶ PPE can be bulky and uncomfortable, leading to misuse by workers.

Covering and protecting a worker's body from hazards. Important limitation of PPE: wearing an armour (PPE) won't stop the crocodile (hazard) from attacking you, it will just reduce the severity of injury!



▶ Personal Protective Equipment (PPE)



Question:

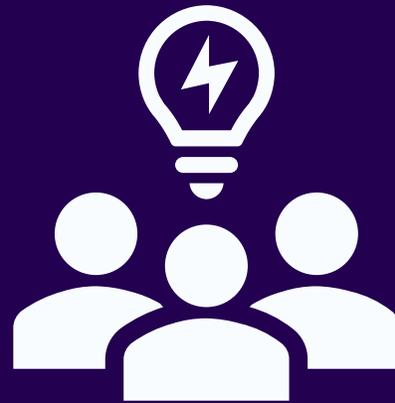
Which gloves are most suitable for handling chemicals?



▶ Case study: PPE and polycyclic aromatic hydrocarbon (PAH) exposure

- ▶ Quinlan et al. (1995) evaluated the effectiveness of a PPE intervention on exposure to polycyclic aromatic hydrocarbons (PAH) in coal liquefaction workers.
- ▶ The cross-over design study compared the use of intervention wear (new coverall, shirt, trousers, underwear, socks, and boots) compared to control wear (personal clothing beneath a coverall).
- ▶ Excretion of urinary 1-hydroxypyrene (1-OHP) and skin pad deposition of pyrene were used to compare intervention and control wear.
- ▶ After two weeks, the intervention wear resulted in significant reductions in workers' absorption and deposition of PAHs.
- ▶ As a consequence of the study, an improved workwear policy was implemented at the factory.

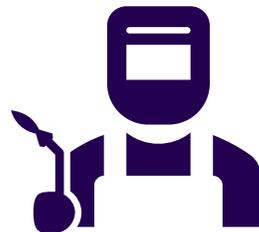
End of session activity



Group work

▶ Group work

You and your group have been appointed as the OSH managers for a new welding branch within a large production facility for automotive parts.



▶ Group work instructions

- ▶ There have been complaints of workers suffering from metal fume fever because of the use of zinc welding components.
- ▶ So far there has been no review of the materials used, engineering controls, administrative controls or otherwise.
- ▶ **ASSIGNMENT:** Use the Hierarchy of Controls to design an intervention for the workplace

Overview of the Hierarchy of Controls

Step	Example
Elimination	Physically remove the hazard.
Substitution	Replace the hazard.
Engineering controls	Isolate the worker from the hazard.
Administrative controls	Change the way people work.
Personal Protective Equipment	Last resort – protect workers with PPE.

Key ILO resources

- ▶ [ILO A 5 step guide for employers, workers and their representatives on conducting workplace risk assessments.](#)
- ▶ [Exposure to hazardous chemicals at work and resulting health impacts: A global review \(2021\).](#)
- ▶ [The GHS in the world of work: Mapping synergies between ILO Instruments and the Globally Harmonized System of Classification and Labelling of Chemicals \(GHS\).](#)
- ▶ [ILO Instruments on Chemical Safety – Analysis and synergies with other international frameworks on the sound management of chemicals \(2020\).](#)
- ▶ [The Sound Management of Chemicals and Waste in the World of Work \(2019\).](#)
- ▶ [Guidelines on occupational safety and health management systems \(2001\).](#)
- ▶ [Major hazard control: A practical manual \(1993\).](#)
- ▶ [Safety in the use of chemicals at work: code of practice \(1991\).](#)
- ▶ [Prevention of major industrial accidents: code of practice \(1991\).](#)
- ▶ [ILO indicators of progress in implementing SAICM \(2021\).](#)