

Personal Protective Equipment (PPE)

IAMC Toolkit

*Innovative Approaches for the Sound Management of
Chemicals and Chemical Waste*



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



Introduction

The presentation on personal protective equipment provides an overview of the different types of PPE. Safety rules, information and training sessions as well as monitoring are also addressed in the presentation.

The reader will learn to distinguish between different equipment protecting from different substances and exposure modes. Indications about the suitability of the equipment are given, including an example about spray varnishing and painting.

Hazard Management

1. Risk Identification and safety	2. Transport and storage	3. Fire and explosion protection	4. Emergency response
1.1 Chemical classification and labelling	2.1 Internal transport of chemicals	3.1 Fire protection	4.1 Emergency response plan
1.2 Risk assessment	2.2 Internal pedestrian routes	3.2 Fire protection in welding and cutting operations	
1.3 Safety rules	2.3 Storage	3.3 Explosion protection	
1.4 Personal protective equipment		3.4 Container cleaning	
1.5 Skin protection			
1.6 Emergency escape routes			
1.7 Solvents, acids, bases handling			
1.8 Safety in gas tank handling			



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1. Context
2. Types of Personal Protective Equipment
3. Responsibilities
4. Sources

Context

Definitions

- **Harm:** “Harm is a negative safety and health consequence (e.g. injury or ill health).”
- **Hazard:** “A hazard is anything that can cause harm (e.g. work materials, equipment, work methods and practices).”
- **Risk:** “The risk is the chance of harm being done (likelihood and extent of harm).”

Definitions from the European Agency for Safety and Health at Work (www.osha.europa.eu)



Context

- Personal Protective Equipment (PPE) has no influence on hazards and will not suppress them, however, it will reduce or even eliminate the negative impact on humans.

Corrosive substance



Source: Suva

Environment with toxic gas



Source: Suva

Welding sparks



Source: Suva

Context

- The introduction of PPE should always be preceded by an examination of possible prevention measures to avoid the risks.
- Before choosing the PPE, an evaluation of the workplaces should be undertaken (activities, types of risks, dangerous areas, safety data sheets).
- The specific conditions of each workplace should be assessed by specialists.
Examples:
 - ❑ Room temperature
 - ❑ Contact temperature
 - ❑ Thermal radiation
 - ❑ Noise
 - ❑ Dust emissions
 - ❑ Weather conditions
 - ❑ Nature of the substances and exposure time, etc.
- The staff should have the opportunity to express their experiences and needs in terms of PPE.



Types of Personal Protective Equipment (PPE)

Types of PPE



Source: Suva

Head Protection

- **Mandatory** for each **activity** with a risk of **head injury**
- **Hazards** to consider:
 - Mechanical hazards (e.g. falling object)
 - Thermal hazards (e.g. projections of molten metal, flames)
 - Electrical hazards (e.g. sparks induced by electric discharges)
 - Chemical hazards (e.g. acids, bases, solvents)
 - Lack of visibility (e.g. public works)
 - Machines in action (e.g. hair caught up by a machine)



Source: Suva

Head Protection: Examples



Helmet with jugular strap



Mountaineer helmet



Shock-proof cap



Helmet with breathing mask



Air-supplied helmet



Hair net

Source: Suva

Eye Protection

- Hazards to consider:
 - Mechanical hazards (dusts, swarf, shards, etc.)
 - Physical hazards (UV and IR radiation, laser beam, etc.)
 - Chemical hazards (acids, bases, vapours, dusts, etc.)
 - Thermal hazards (heat, cold, metal in fusion, etc.)
 - Special hazards (X-rays, electric arcs, biological hazards, etc.)
- Note: Prescription glasses and contact lenses are inadequate for protection!



Eye Protection: Examples



Goggles



Facial shield with eye protection



Safety glasses with lateral protection



Goggles

Source: Suva

Hearing Protection

- Hearing protection is essential to preserve the hearing of workers exposed to excessive sound levels (even for short periods).
- The sound pressure can cause damage to a person's hearing if the sound level is higher or equal to 85 dB(A).

Hearing Protection: Examples



Expanding foam earplugs



Plastic moulded hearing protectors



Custom-moulded hearing protectors



Earplugs with stirrups



Ear defenders

Source: Suva

Hand and Arm Protection

- Wearing hand and arm protection wear prevents **injuries** (cuts, burns, skin irritation, etc.) and **skin permeation** caused by dangerous substances.
- For each hazard under consideration, there is a specific type of gloves:
 - Mechanical hazards (sharp materials, etc.)
 - Thermal hazards (flames, heat, cold, etc.)
 - Chemical and biological hazards (toxic, infectious, corrosive or irritating substances, etc.)
 - Radiation
 - Fouling
 - Electrical hazards
- Safety data sheets provide information on the type of gloves/protection to be used.



Source: Suva

Hand and Arm Protection: Examples



Mittens

Source: Suva



Five-finger glove

Source: Suva



Three-finger glove

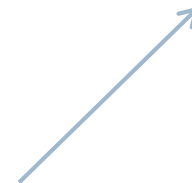
Source: Suva



Latex/chloroprene rubber/vinyl (PVC)/nitrile

Source: UNIDO

The material of the gloves should be **carefully selected** based on the chemical properties of the substances used. Latex gloves, for instance, cannot be used when handling hexane. Instead use vinyl (PVC) gloves.



Examples of Glove Types and Their Use

Glove type Chemical	Latex	Nitrile	Neoprene	Butyl rubber
Acetone	Very safe	Dangerous	Safe	Very safe
Benzene	Safe	Dangerous	Safe	Safe
Butyl acetate	Safe	Dangerous	Very safe	Safe
Phenol	Dangerous	Dangerous	Very safe	Very safe
Potassium hydroxide	Very safe	Very safe	Very safe	Very safe

Very safe
Safe
Dangerous

Foot Protection

- Foot protection should be chosen according to the **foreseeable hazards** and the **characteristics of the workplace**.
 - Example: The characteristics of the ground are important criteria:
 - Slippery ground: Use protective shoes with non-slip soles.
 - Uneven ground/earth: Use protective shoes providing good support.
- **Hazards to consider:**
 - Mechanical hazards (falling objects, sharp objects, swarf, shards, etc.)
 - Thermal hazards (heat, cold, liquid metal, vapours, etc.)
 - Chemical hazards (acids, bases, solvents, fuel, detergents, etc.)
 - Electrical hazards (static electricity, etc.)
 - Other hazards (slipping, stumbling, etc.)



Source: Suva

Foot Protection: Examples

- **Types of shoes:**
 - **Safety shoes:** shoes with a toecap withstanding energy shocks of 200 joules and a compression charge of 15 kN
 - **Protective shoes:** shoes with a toecap withstanding energy shocks of 100 joules and a compression charge of 10 kN
 - **Work shoes:** shoes with particular protection properties (e.g. anti-puncture material)



Respiratory Protection

- Protects from dusts, gases or mists containing dangerous substances or micro-organisms.
- Filtering devices should only be used:
 - If the oxygen concentration is higher than 17% and
 - If the concentration of the dangerous substances is lower than the maximum concentration allowed for the filter.

If these conditions cannot be guaranteed, the worker should wear autonomous respiratory protection equipment.



Source: Suva

Respiratory Protection

- Before purchasing respiratory protective equipment, a **risk analysis** should be undertaken to establish the following criteria:
 - **Characteristics** and **risks** of dangerous substances (see SDS)
 - Presence of dangerous substances in the ambient air
 - **Expected concentration** of the substances in the ambient air and maximum concentration authorized
 - **Work environment, duration, difficulty** of the task
- The staff should be trained in the **appropriate use, good care and maintenance** of the protective equipment they use.



Source: Suva

Respiratory Protection: Examples

Types of filters:

- Anti-gas filters contain carbon filtering material to absorb gases and vapours.
- Anti-dust filters protect against dusts, fumes and mists. They can be oil-resistant or oil-proof and are available in different categories (filters removing either 95%, 97% or 100% of one-micrometre particles).
- Combined filters include anti-gas and anti-dust filters.



Anti-dust half-mask



Half-mask with interchangeable filters



Mask with interchangeable filters



Filtering device with assisted ventilation



Self-contained breathing device

Source: Suva

Respiratory Protection: Examples

- **Choosing a respiratory mask:**

- The choice of a suitable mask depends on the toxic substances expected in the work environment.
- **Caution: Different gases might require different gas filter types.**

Substance	Type of filter
Acid gases	Anti-gas filter
Bleaches	Anti-dust filter
Dusts	Anti-dust filter
Fibres	Anti-dust filter
Organic vapours	Anti-gas filter
Paints	Anti-gas filter
Welding	Anti-dust filter

Gas	Type of filter*
Organic gases and vapours	A
SO ₂ , HCl and other acid gases	E
NH ₃ and ammoniac organic derivatives	K

The type of filter applied for HCl is different from the filter used for NH₃.

* According to the European standard EN 141



Respiratory Protection

- **Important considerations (1):**
 - Reusable particle filters must be replaced at the latest when a breathing resistance is noted.
 - Gas filters must be replaced as soon as the presence of dangerous substances is detected in the mask (e.g. smell).
 - The use of combined filters and gas filters is time-limited. They should be replaced after six months.



Source: Suva

Respiratory Protection

- **Important considerations (2):**
 - Gas filters must **not** be used to protect from odourless gases since the saturation of the filter cannot be detected. **Danger of death!**
 - Humidity can reduce filter efficiency.
 - Filters do not effectively protect from natural gas, liquefied gases, carbon dioxide and some halogenated hydrocarbons.



Source: Suva

Body Protection

- Some tasks imply a great number of risks for the human body. For these tasks, **protective clothing** should be worn.
- **Hazards to consider:**
 - Mechanical hazards (sharp objects, elements in movement, etc.)
 - Chemical hazards (acids, bases, solvents, dusts, oils, etc.)
 - Biological hazards (bacteria, viruses, mushrooms, etc.)
 - Thermal hazards (thermal radiation, burning surfaces, incandescent elements, projections from metal in fusion, flames, electrical arcs, etc.)
 - Physical hazards (radiation, humidity, dusts, etc.)
 - Electrical hazards (sparks, etc.)
 - Lack of visibility (public works, etc.)



Source: Suva

Body Protection: Examples

- Types of body protection:
 - Protection against chemical substances
 - Protection against fire and heat
 - Protection against cold
 - Protection for welders
 - Protection against radiation
 - Weatherproof protection
 - High-visibility garment



Source: Suva

Protection against dangerous
chemical substances



Source: Suva

Protection against heat

Protection Against Falls

- Whatever the height, falls often have serious consequences and can cause severe injuries.
- The planning of interventions requiring protection against falls must only be assigned to adequately qualified workers.
- Risks to consider:
 - Work on buildings, roofs, façades
 - Work on cranes
 - Work on high installations
 - Work on vehicles (buses, trucks, etc.)
 - Work on pylons and overhead electrical lines
 - Work on ladders, in trees, silos, pipes, etc.

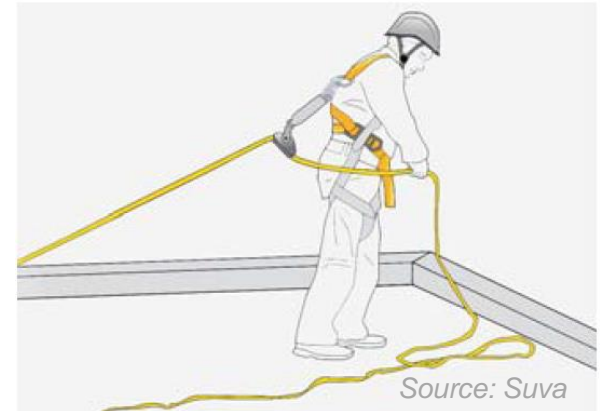


Source: Suva

Protection Against Falls: Examples

■ Protection systems:

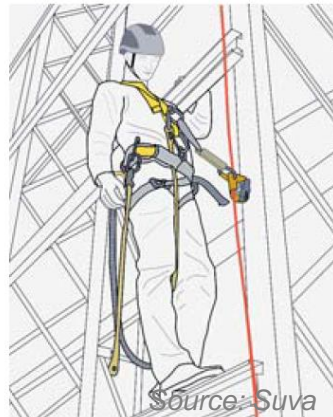
- **Restraint system:** keeps the worker away from risky zones
- **Work positioning lanyards:** allow the worker to safely position himself on the intervention zone, work hands-free and prevent a potential free-fall
- **Fall arrest system:** retains the worker in case of a fall and limits the impact of the shock



Restraint system



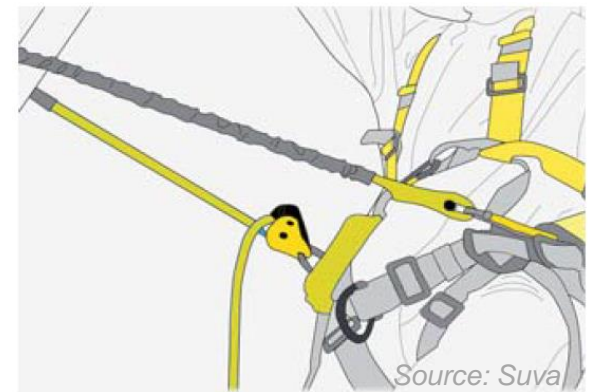
Harness kit



Works on a pylon



Fall arrest system



Work positioning lanyard

Spray Varnishing and Painting

Practical Exercise



Spray Varnishing and Painting: Context and Hazards

- Spray varnishing and painting produce **very fine aerosol mists** with **high concentrations** of varnish/paint components.
- Polyurethane varnishes and paints generally contain **isocyanates** (toxic substances that may lead to **serious chronic effects**, such as allergies, asthma, etc.).
- **Main hazards:**
 - Diseases
 - Intoxication
 - Explosions
 - Irritations

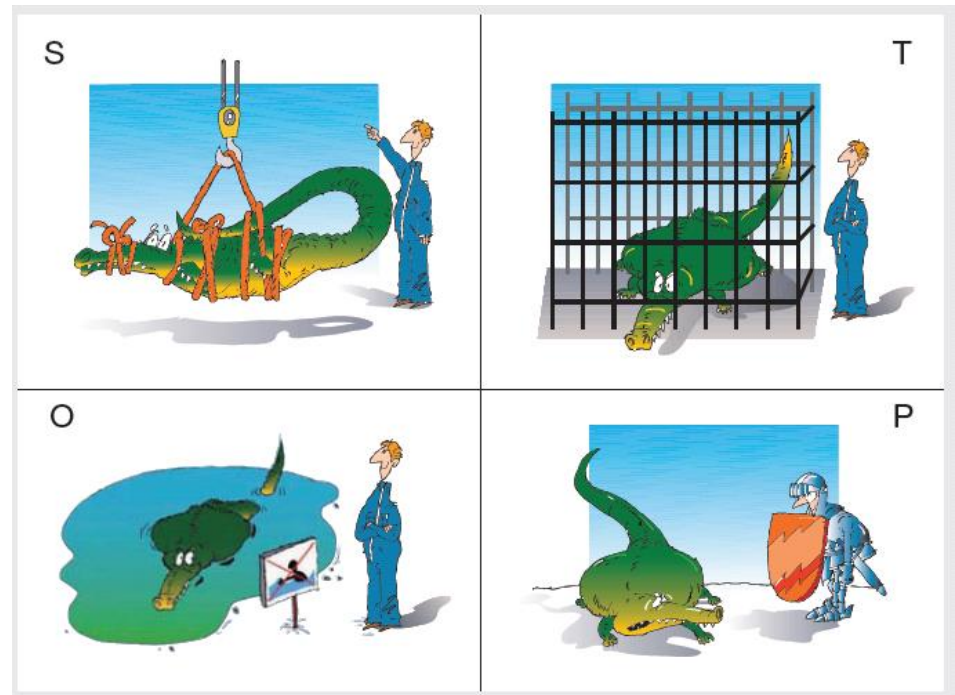


Source: Suva



Types of Prevention Measures

- Prevention measures follow the **STOP** logic:
 - S.** Substitution of the dangerous substances and processes
 - T.** Technical measures
 - O.** Organizational measures
 - P.** Personal protection measures



Source: Suva

What is Substitution?

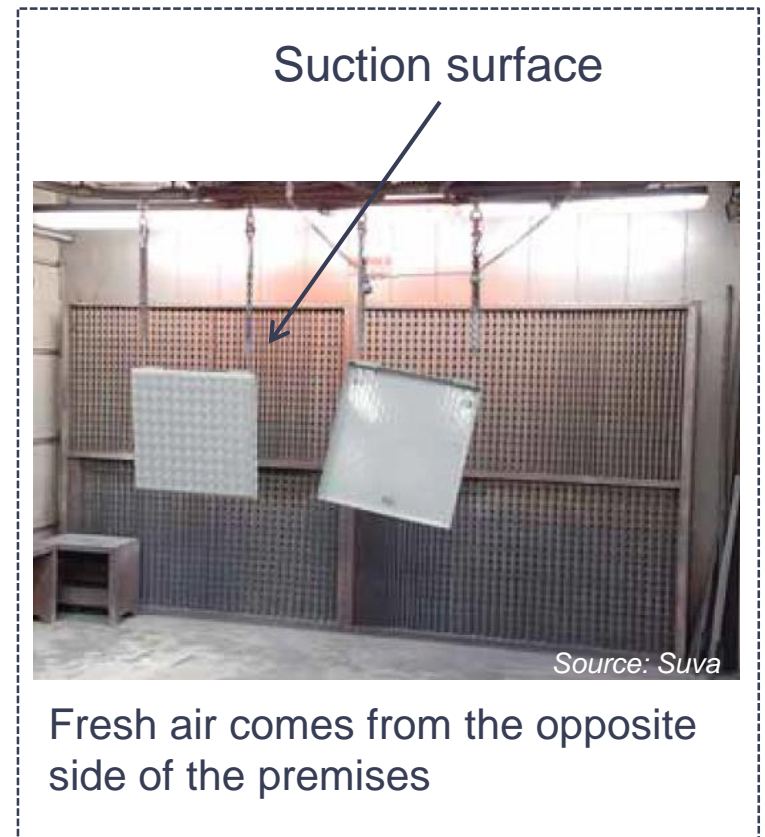
- Dangerous substances should be replaced by less dangerous alternatives, keeping in mind that the substitution should be:
 - Technically feasible
 - Economically viable
- Investigate the possibilities of:
 - Replacing products containing isocyanates
 - Using water-based varnishes and paints



Source: Suva

Technical Prevention Measures (1)

- **Spray paint premises**
 - Spraying activities should be carried out in special premises where paint and varnish vapours can be effectively extracted.
- **Effective ventilation**
 - The ventilation of the spraying system should be designed in a way that the spray jet is always directed towards the suction surfaces (min. airflow: 10 cm/s).
 - A sufficient fresh airflow is also required.



Source: based on UN GHS, 2013



Technical Prevention Measures (2)

- **Prevention of explosions**

- The spraying of varnishes and paints containing solvents produces considerable quantities of potentially explosive mists.
- Installations and electrical devices should be designed to ensure protection against explosions.

- **Blending station**

- The blending of paints and varnishes is often associated with risks of fire and explosion (mainly due to solvents).
- In the vapour propagation zone, all electrical devices should be protected against the risk of explosion.
- Ventilation at source limits the propagation of vapours.



Organizational Measures to Prevent Diseases (1)

- During spraying activities, no other activity should take place at the premises.
- Spraying activities should only be performed by workers informed about the inherent hazards.



Airflow from the ceiling

Suction surface

Source: Suva

Organizational Measures to Prevent Diseases (2)

- **The quantity of aerosols can be reduced by:**
 - Using a device with reduced spray mist
 - Adjusting to the optimum pressure for spray guns
 - Directing the spray jet perpendicularly to the work surface
 - Avoiding spraying activities against the air stream
- **Maintenance**
 - Spraying installations should be regularly checked.
 - Dirty filters should be replaced in a timely manner.



When Should Personal Protective Equipment be Used? (1)

- *If technical and organizational measures are not sufficient to prevent the hazards, personal protective equipment should be used.*
- **Respiratory protection:**
 - Should be adapted to the activity (e.g. compressed air breathing apparatus, power-assisted filtering devices)



Source: based on UN GHS, 2013

When Should Personal Protective Equipment be Used? (2)

- Always wear respiratory protection during paint or varnish spraying processes, even for small tests.
- Workers should receive adequate training and wear protective equipment following the manufacturer's instructions.
- Take the protection off only once outside of the premises or after waiting for a few minutes.
- Protective equipment should be cleaned and filters should be regularly replaced. They should be stored in a dry and clean place.
- Respiratory equipment is to be used individually and should not be shared among workers.



Personal Protective Measures for Spray Painting and Varnishing

▪ **Eye protection**

- Eyes should be protected against aerosols containing isocyanates, irritating substances and vapours of concentrated solvents.
- Protective equipment:
 - Mask
 - Hood



Source: Suva

▪ **Skin protection**

- Hands should be cleaned with water and mild soap at the beginning and end of an activity.
- Protective equipment:
 - Gloves (Pay attention to the different kinds of gloves!)
 - Workwear



Source: Suva

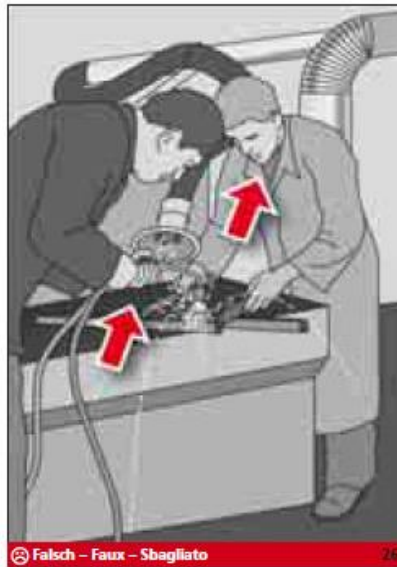
Source: based on UN GHS, 2013

Personal Protective Equipment Exercise



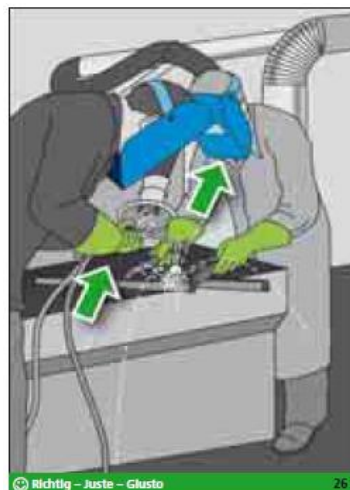
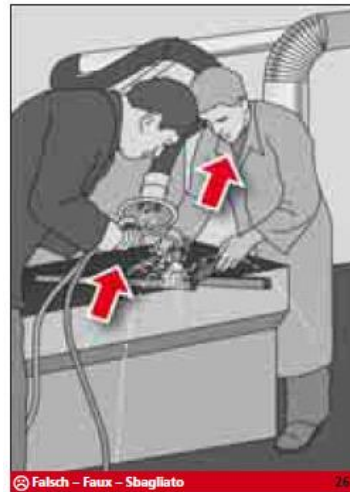
Personal Protective Equipment – Exercise

- What should you do in these situations?



Source: CFST

Personal Protective Equipment – Exercise



Source: CFST



Responsibilities



Safety Rules

- The company should provide PPE and ensure that the workers and third parties (as well as visitors) wear them when required.
- The safety rules, instructions and regulations related to the use of PPE should be:
 - Clearly formulated
 - Available for consultation in the following technical documentation:
 - Instruction manual of the equipment
 - Process/Installation instructions
- A list of the PPE required for different tasks should be available.

Example of safety rules

	Risk area	Activity
	Workplace	All activities
	Logistic sector	Loading Unloading
	Workplace	Drilling, grinding, polishing
	Wash station	Cleaning of trucks
	Pipe	Access to pipes

Source: Suva

Source: based on UN GHS, 2013

Safety Rules

- If a workplace requires a specific equipment, it should be clearly indicated.
- The PPE should be regularly checked and kept in proper conditions.
- Employees should be able to easily ask for the replacement of a damaged PPE and should know whom to approach.
- Management and superiors should set a good example by also wearing PPE when required and implement a safety culture.
- Workers should be involved in the use, monitoring and inspection of the PPE. Safety committees can be created within the company.

Source: based on UN GHS, 2013



Training and Information

- Training and awareness sessions are necessary to ensure the proper use of PPE. They should cover the following topics:
 - Risks associated with the workplace and their potential consequences
 - Compulsory wearing of PPE when required and the consequences in case of non-compliance
 - Checking of PPE before usage
 - Instructions for use
 - Replacement of components
 - Maintenance
 - Procedure in case of malfunction
- A training and information session should be organized when handing out PPE to the staff.

Monitoring

- To ensure that employees comply with the mandatory use of PPE, management should establish the following procedures:
 - Quality checks of the PPE
 - Monitoring of the staff's working behaviour
- If the safety rules are not complied with, the employee should first be warned and then sanctioned.
- The results of the monitoring activities should be documented and compared to the objectives set.



Key messages

- If a workplace requires a specific equipment, it should be clearly indicated.
- The company should provide PPE and ensure that the workers and third parties (as well as visitors) wear them when required.
- Training and awareness sessions are necessary to ensure the proper use of PPE.
- The results of the monitoring activities should be documented and compared to the objectives set.

Sources



Sources

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Images

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