

PPE KITS: A Concise Review

Varun Gupta Omkar Gupta Shubhangi Gupta Rahul Kumar Gupta Dr. Amjad Ali

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ABSTRACT:

PPE (Personal Protection Equipment) is a protective barrier between the worker and operational hazards, adopted by operators to ensure safety and protect themselves from unavoidable noise, fire, radiation, height, healthcare-acquired infections, electricity, and so on.

PPE forms the last line of defence to be acquainted only when engineering designs and maintenance facilities do not ensure a sufficiently sound working environment.

PPE kits are designed to combat any unwanted hazard and assure the action after the failure of other supplementary protection facilities.

This article aims to create awareness about the types of PPE kits available for wide operational aspects and to maximize their use assuring operator safety with increasing working efficiency.

COVID, a disastrous disease widespread globally drove the pandemic and was halfway tackled by health professionals by using PPE kits, which in addition to ensuring optimum safety was the economic option available worldwide PPE kits provided the efficiency of about 99% in safeguarding one's health from a deadly pathogen.

Its use was not only limited to health professionals but also immigrants from Intra and inter nations.

Keywords: OSHA, Miasma, Zetex, Vermiculite, Silos, Midcalf, COVID-19, Pharmaceutical Industry, Hazards, Safety.

I. INTRODUCTION:

Personal Protective Equipment or PPE is protective equipment designed to protect the user's body from any kind of infection or injury. The hazards focused on by the PPE are Electrical, Fire, Gas, Machinery Plant & Equipment, Manual Handling, Noise, Pressure Equipment, Radiations, Working in Heights, Working in Confined Spaces, Vibrations, Healthcare, COVID-19, etc.

The PPE comes with a serious limitation as it doesn't eradicate the hazard and if the equipment fails the user will be exposed to the hazard.

All the components of the PPE create a barrier between the user & the working environment. PPE can create additional stress on

the user as it weakens their ability to carry out their work & it also creates major levels of discomfort. This can be minimized using good ergonomic designs.^[1]

II. MAIN COMPONENTS OF PPE

1. Safety for the head

Wearing a helmet offers protection & can prevent head injuries. Select a strong helmet that is modified to the working environment. These days you can find many elegant designs and you can choose extra options such as an adjustable interior harness & comfortable sweatband.



Figure 1.1: Helmet

2. Protect your eyes

The eyes are the most delicate part of our body. Every day, more than 600 people worldwide suffer eye injuries at work. Thanks to the excellent safety goggles, we were able to prevent these injuries. Do you touch bright light or infrared rays? Next, weld goggles or shields provide ideal protection!



Figure 1.2: Eye Goggle

3. Hearing Protection

Are you working in a noisy environment? In this case, it is very important to consider hearing protection. Earplugs are very comfortable, but earmuffs can be quickly attached and detached, which makes them useful for worktops.



Figure 1.3: Earmuffs

4. Maintain a good respiration

Wearing a mask at work is not a luxury, especially when in contact with dangerous goods. Fifteen per cent of EU workers inhale vapours, smoke, powder, or dim light while working. Dust masks protect against fine dust and other dangerous particles. If the material is toxic, use a full-face mask. It adheres firmly to the face and protects the nose and mouth from harmful stains.



Figure 1.4: Mask

5. Protect your hands with the right gloves

Hands and fingers can cause many injuries, so proper protection is important. You can choose from a variety of gloves for different purposes, depending on your industry.

- Protection against vibration
- Protection against cuts from sharp materials
- Protection from cold and heat
- Protection against bacteriological risks
- Protection against splashes of diluted chemicals.



Figure 1.5: Gloves

6. Protection for feet

Your feet also need to be well protected. Safety shoes (type Sb, S1, S2, or S3) and boots (type S4 or S5) are ideal solutions for protecting your feet from heavy weight. When working in a humid environment, a non-slip sole makes sense. It is

known that 16.2% of all accidents at work are caused by trips and slips. Claws are recommended on slippery roads such as snow and ice. Special socks can provide even more comfort.



Figure 1.6: Shoes

7. Wear the correct work clothing

In a crowded workplace, it is important to avoid accidents. This is why good visibility in the workplace is essential. A highly visible jacket and trousers made of durable fabric will help prevent accidents. As with handguards, there are versions for different purposes.

Worst-case scenario

Prevention is more important than treatment. Classic first aid kits are not a luxury, but eye first aid kits can also be an essential first aid. An emergency shower is essential so that if an employee comes into contact with a chemical, he or she can flush the substance from the body at any time.^[2]



Figure 1.7: Clothing

Figure 1.8: Emergency Case Equipments



1. History

16th-century European plague doctors also wore protective clothing consisting of long smocks, helmets, glass goggles, gloves, and boots to prevent transmission when dealing with plague victims. These are made of thick materials and are coated with wax to make them waterproof. The beak-like structure of the mask was filled with fragrant

flowers, herbs, and spices to prevent the spread of miasma.



Figure 1.9: Plague Doctor PPE prevents contact with infectious agents or body fluids that may contain infectious agents by forming a barrier between potentially infectious substances and medical staff. [3]

2. Types of PPE Kits (Based on Usage)

I. For Electrical Safety:

This PPE kit is mainly used when entering or working in the electrical zone

Components:

- Hard hats (with full/partial brims as necessary)
- Safety glasses with side shields
- Face masks/shields
- Suitable footwear (safety/steel-toed boots, rated dielectric footwear)
- Insulating gloves (rated, used along with leather/cloth linings for shock protection)
- Insulated tools
- Electrical/insulation blankets
- Live-line tools/hot sticks



Figure 1.10: PPE for Electricity

Special safety devices for use in limited space, barriers, scaffolding, and gas/smoke detectors should also be available on request. [4]

- Insulated Gloves – Insulated gloves prevent electricity from being passed in the event of wire exposure, short circuits, or other problems.
- Insulated Matting – Insulation mats provide a protective layer between the employee and the floor. This is useful when working in switchboards, transformers, and other high voltage areas. It helps prevent electricity from entering the human body from the ground and eliminates the path of electricity through the body to the ground.
- Insulated Ladders – Insulated conductors do not conduct electricity to the user. If a regular metal ladder accidentally touches a live line, it can be devastating. For insulated conductors, this is not an electrical issue.
- Rescue Rods – If someone is electrocuted, people will want to rush in to save them. Unfortunately, this only electro cuts them. If rescue poles are installed, people in the area can keep the victims safe or push the power away.
- Voltage Detectors – Even after removing the power supply, the capacitors may still be powering the system. The voltage detector displays the current level of a particular system at the current time, so workers will not accidentally start working on the system until all power is turned off. [5]

II. For Fire Safety:

Fireproof clothing (silver bunker suits, asbestos suits) is a suit designed to protect firefighters and volcanologists from extremely high temperatures. Originally made from asbestos fabric, the current model uses vacuum-deposited aluminized material. There are 3 basic kinds of aluminized suits:

- Approach suit- It is used for general high-temperature work such as steel mills and smelters. They typically provide ambient heat protection up to approximately 200 ° F (93°C).
- Proximity suit- For more highly insulated versions for aircraft rescue and firefighting (ARFF), and for furnace operations that need to enter a heated furnace. The former provides ambient thermal protection up to about 500 ° F (260 ° C) and the latter provides a much higher level of protection up to about 2,000 ° F (1,093 ° C).

- Entry suit- It is used in situations where extreme heat intrusion or complete exposure to flames is required. Most commonly made from Zetex or Vermiculite and not aluminized. They provide environmental protection up to about 2,000 ° F (1,093 ° C) in a short period and lasting radiant heat protection up to about 1,500 ° F (816 ° C).^[6]



Figure 1.11: PPE for Fire

III. For Gas Safety:

It is important to choose the correct PPE for each particular task, including gas cylinders. The PPE you choose is always determined by a risk assessment, including referencing the Safety Data Sheet (SDS) for each gas you use.

The SDS (formerly known as the MSDS) contains information such as the properties of each chemical. Physical, health, and environmental health hazards; Protective measures; Safety precautions regarding the handling, storage, and transportation of chemicals.



Figure 1.12: PPE for Gas

Components:

- Eye Protection- Workers should always wear eye protection when handling compressed gas. Uncontrolled emissions of compressed gas can remove metal debris and create other dangerous projectiles.

When workers handle toxic or corrosive gases such as chlorine and ammonia, they need chemical goggles that are impervious to dangerous gases. You should always review the Safety Data Sheet recommendations to ensure that your eye protection, goggles, or face shield comply with the AS / NZS 1337 standard.

Make sure the glasses fit each employee properly. Loose glasses can slip and cause an accident, or employees can remove them prematurely.

- Protective Gloves- Protective gloves should be worn when handling the cylinder. Again, your decision depends on the type of gas in the field and how they are used. Work gloves should protect your hands from abrasions, cuts, crevices, and flat tires as you move or move the cylinder. However, if the transfer is

interrupted or gas such as LPG is transferred (there is a risk of heat), you will need warm gloves. Protective gloves must comply with AS / NZS2161.

- Safety Footwear- The cylinder is heavy and causes many fractures and other serious injuries to the feet and toes. Workers should always wear protective shoes that comply with AS / NZS 2210.2. See AS / NZS2210.1 for advice on shoe selection and care.
- Breathing Apparatus- If you store or handle toxic gas at work, you should consider an AS / NZS 1716 compliant respirator. Even if an oxygen-deficient atmosphere can occur. Some workplaces may require a self-sufficient chemical oxygen respirator or continuous airline system.
- Protective Clothing- The standard also recommends wearing overalls and other protective clothing when moving or handling gas cylinders.
- Hearing Protection- If hearing protection is required, hearing protection must be AS / NZS 1270 compliant.^{[7][8][9]}
- Particulate Filters:

Particulates filters are used to remove fine solid or liquid particles from inhaled air and have a prefix 'P' and a number indicating a class corresponding to its filtration efficiency e.g.

P1 - use against silica, asbestos

P2 - use against metal smokes, airborne disease spread

P3 - use against highly toxic materials (full face mask).^[44]



Figure 1.13: Particulate Filter

IV. Manual Handling:

Personal Protective Equipment (PPE) is a device or garment that protects you from the risk of injury, especially when working in a manufacturing / industrial environment. Be sure to check and use

the PPE before starting work as it is important for safety.

The checklist shows how PPE can make the work safer and protect people from other work nearby.

- Wearing safety shoes to protect the feet from falling objects.
- Using gloves to avoid cuts and hot or "cold" burns.
- Wearing eye protectors when handling molten materials, during welding, or near machinery that may emit flying particles. The person should also wear eye protection to avoid splashing chemicals when pouring liquid.
- Wear hearing protection if loud or sudden noises can distract or startle you and if certain noise levels can hurt your hearing.
- Wearing nose and mouth protectors where dust and smoke can be dangerous.
- Wearing a helmet when people are working overhead or in the restricted headroom area.
- Keep the PPE clean and functioning.

Various single PPE kit elements are used for this purpose.

For example,

Welding Shields

Protects the eyes from burns caused by infrared or intense radiant light and protects the face and eyes from flying sparks, metal spatter, and slag chips produced during welding, brazing, soldering, and cutting.



Figure 1.14: Welding Shield

Laser Safety Goggles

Protect eyes from intense concentrations of light produced by lasers.^[10]



Figure 1.15: Laser Safety Goggles

V. For Noise Safety:

Purpose: Hearing protection is necessary to prevent noise-induced hearing loss. Hearing protection devices reduce the sound energy that reaches the inner ear and causes damage there. Earmuffs and earplugs are the most common types of PPE.

Hearing Protection Use: Hearing protection PPE is required for employees exposed to an average noise level of at least 85 decibels for 8 hours.^[11]



Figure 1.16: Ear Protections

VI. For Radiation Safety:

Radiation safety involves grading control measures Employees can be protected from ionizing radiations by using any one or a combination of the following means:

- (A) Engineering controls
 - (B) Administrative methods
 - (C) Personal protective equipment (PPE)
- are the three essential principles of reducing exposure: time, distance, and shielding.^{[12][13]}

After optimizing engineering and administrative controls, PPE forms the last line of defence.

The designated expert person, administrator, or radiation protection officer should evaluate each worker's need for protection conferring on the work he or she is required to execute in the required environment. The PPE program should include the succeeding elements:

a) Lead Aprons

Flexible aprons with a thickness up to 0.33 mm Pb are accessible to shield the upper torso. Double-sided aprons shield the chest and the back against

radiations scattered behind the body. The aprons attenuate, by about 90%, low-energy radiations such as scattered X-rays (of 10 of keV). Wearing an apron for prolonged periods is strenuous. The aprons are cumbersome and may slow down working efficiency and thus result in higher radiation doses to the operator. Aprons must be kept flat or on round hangers. Folding or creasing causes cracks or wear in the shielding. Such damage, even though minor, may lead to repeated exposure to the same area of the body.

Application: In dose-intensive applications such as angiography, heart catheterization, and interventional imaging.^{[13][14][15][16]}



Figure 1.17: Lead Apron

b) Lead thyroid collar

A lead thyroid collar offers additional radiation protection for the thyroid, most sensitive to radiation.^{[17][18]}



Figure 1.18: Lead thyroid collar

c) Lead gloves

Lead-lined gloves offer safety for workers from radiation exposure to the hands and must be used for some X-ray equipment if hands must be sited in the direct X-ray field.^[17]



Figure 1.19: Lead Gloves

d) Safety goggles

Leaded eyewear (lead glasses or radiation glasses) or opaque safety goggles can protect a worker's eyes from radiation exposure.^[18]



Figure 1.20: Safety Goggles

VII. For Height Safety:

Height is a paramount safety factor conspicuously for Construction and Restoration Industry.

Fall from Height (FFH), is the term often used by healthcare professionals to relate injury or fatality accounted due to a fall or slip from any height.^[19]

Surprisingly working at a lower height often presents the greatest traumatic danger.

According to professor Ryan Groves, a Safety Advisor at construction safety organization Site Safe “DON'T OVERLOOK LOW HEIGHTS - THEY HAVE THEIR DANGERS”

Concluded that, people often become optimistic and confident about their safety from a small height (cleaning a rooftop with aid of la adder) and without assessing safety equipment fall prey to trauma and FFH as opposed to a worker operating at a gigantic height (whose personal safety becomes utmost priority).^[20]

Thus, employing Height safety equipment assuredly prevent a futile trauma.

Height safety equipment incorporated for personal protection:

1. Fall arrest system and Retractable:

These systems are employed with operations involving a sky-scraping degree of free fall to arrest

the fall and maintain the user in a very safe position.

A fall arrest system does not prevent falls, moreover, during a fall it holds an operator in an ergonomic position before the collision with the ground and holds the worker until rescued.

Fall arrest systems with characteristic components include:



Figure 1.21: Body Holding Device

A. Body harness or A Body Holding Device

It is the chief component of the Fall Arrest System intended to carry and sustain the body of the operator during and after a free fall.

It is formed with straps made of webbing, buckles, attachment, and other elements appropriately positioned and adjusted onto the operator's body.

A sub-pelvic strap, shoulder strap, thigh strap, chest strap, and positioning belt with back support are the principal points that hold the body in a safe position after a free fall.

Other attachment elements designed for a free fall arrest are placed above the centre of gravity of the body i.e., on the shoulders, back, or stern(chest).

Any signs of wear and tear that may affect mechanical strength (weigh holding capacity) shall be readily determined, to ease such an identification the threads shall have a colour different from other textile parts.^{[21] [22]}

B. Energy Absorbing Element i.e., energy absorber:

(i) Retractable type fall arrester

The retractable type fall arrester is a cable or webbing device, which self-retracts inside a housing unit to ensure that the cable or webbing remains taut in any respect of time. It is available in a variety of lengths up to 60m. With a built-in shock absorber, it arrests the falling worker within distances of less than 1m.

This type of fall arrest system should be used only in the vertical plane, with the anchor point being located above the head of the operator.^[23]



Figure 1.22: Retractable type fall arrester

(ii) Guided type fall arrester

Guided type fall arrester with flexible anchor line: Compatible in a horizontal use for a maximum load of up to 140kg.

Guided type fall arrester with rigid anchorage line: These devices are permanently mounted, usually on very high radio antennas, towers or chimneys, anchor line is an anchor rail fixed directly to the tower, the edge of a ladder, or a wire rope tensioned fixed on a structure to limit the lateral movements.^{[24][25][26][27][28]}



Figure 1.23: Fall arrester with the anchor line

C. Anchor line

Anchor line or a cable or a rail connection with a fall arrester or energy absorbing element to lock or stop the fall.^[29]



Figure 1.24: Anchor line

D. Anchor point

The Prime component attached to the roof aids in arresting falls with other components.^[30]



Figure 1.25: Anchor Point

E. Connectors, Karabiners/ Hooks

A carabiner is a metal loop with a sprung or screwed gate that is used to quickly and reversibly connect components in a fall protection system. Hook provides a site for the permanent attachment of the lanyard.^{[31][32]}



Figure 1.26: Connectors, Hook & Karabiner

F. Lanyard

Lanyard serves to connect an individual working at a height with an anchoring point, shock pack surrounding the lanyard absorbs the kinetic energy generated by the fall and helps in arresting falls.^{[33][34]}



Figure 1.27: Lanyard

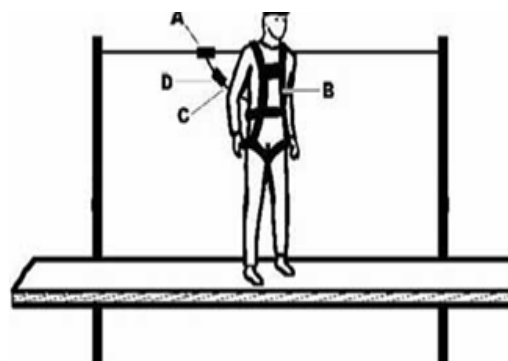


Figure 1.29: Fall Arrest System Uniting A Lanyard and Energy Absorber on A Horizontal

Fall Arrest System Uniting A Lanyard and Energy Absorber on A Horizontal

This system is used on platforms deprived of barriers, in absence of an anchoring point above the user

It integrates an added advantage of free movement allowing in a horizontal line but a limited free movement in front or behind this point, on a distance equal to the total length of the absorber and lanyard.^{[21] [22] [33] [34]}

Type of fall arrest system and components: Fall Arrest System Incorporating A Lanyard and Energy Absorber

- Full body harness (B)
- Lanyard (C)
- Energy absorber (D)
- Anchor point – (A)
- Connectors - optionally, to join the other components.

This type of fall arrest system is hired with the presence of an anchoring point above the user and a satisfactory high clearance, the system arrests fall within a distance of 3 meters.

Fall Arrest System Incorporating A Retractable Type Fall Arrester

- A Full Body Harness (B)
- A Retractable Lanyard – Element of Retractable Type Fall Arrester (C)
- A Retractable Type Fall Arrester (D)
- An Anchor Point (A)
- Connectors

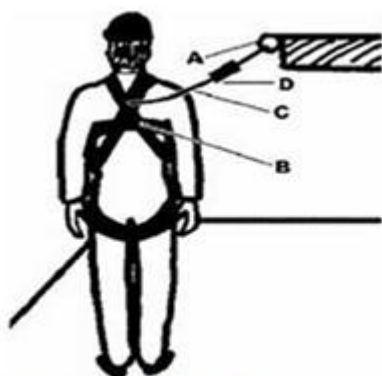


Figure 1.28: Fall Arrest System

Incorporating A Lanyard and Energy

Fall Arrest System Uniting A Lanyard and Energy Absorber on A Horizontal Line

- Full Body Harness (B)
- Lanyard (C)
- Energy Absorber (D)
- Mobile Anchor Point Located on the Flexible Horizontal Anchor Lines (A)

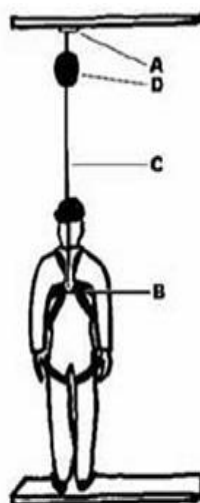


Figure 1.30: Fall Arrest System Incorporating
A Retractable Type Fall Arrester

The retractable type fall arrester is a cable or webbing device, which self-retracts within a housing unit to ensure that the cable or webbing remains taut at all times. It is available in a variety of lengths up to 60m. With a built-in shock absorber, it arrests the falling worker within distances of less than 1m

This type of fall arrest system should be used only in the vertical plane, with the anchor point being located above the head.

Fall Arrest System Incorporating A Guided Type Fall Arrester Including A Flexible Anchor Line

- An Anchor Point (A)
- A Full Body Harness (B)
- A Lanyard (C)
- A Guided Type Fall Arrester (D)
- A Flexible Anchor Line (E)
- Connectors

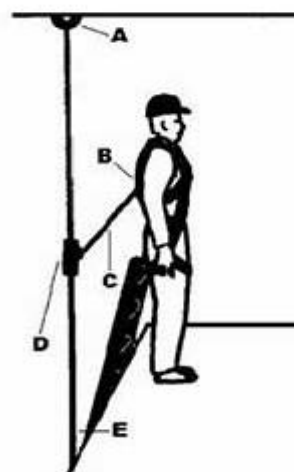


Figure 1.31: Fall Arrest System Incorporating A Guided Type Fall Arrester Including A Flexible Anchor Line

The flexible anchor line could be a lanyard or a wire cable fixed at an anchor point above the pinnacle of the operator and is an easily tensioned downside. These devices are installed temporarily and must be used in conjunction with a harness with frontal or dorsal attachment elements. Reckoning on the length of the lanyard allows a specific free lateral movement, but the arrest distance, i.e., the clearance increases with the length of the lanyard.

Fall Arrest System Incorporating A Guided Type Fall Arrester Including A Rigid Anchor Line

- A Full Body Harness (B)
- A Lanyard (C)
- A Guided Type Fall Arrester (D)
- A Rigid Anchor Line (A)
- Connectors

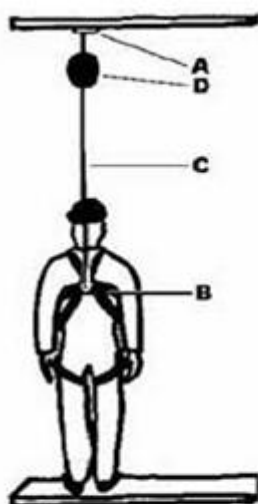


Figure 1.32: Fall Arrest System Incorporating A Guided Type Fall Arrester Including A Rigid Anchor

These devices are permanently installed, usually on very high radio antennas, towers, or chimneys. The anchor line is an anchor rail fixed directly onto the tower, the sting of a ladder, or a wire rope tensioned fixed on a structure, in such a technique to limit the lateral movements. The system should be utilized in conjunction with a front attachment harness onto a connector with/without a lanyard. It allows little free lateral movements of the wearer and is usually characterized by small values of the arrest distance.^{[22] [24] [25] [27] [33] [35]}

G. Multi Impact Helmet.

Included diligently controlling traumatic head injury from falling.^[36]



Figure 1.33: Multi Impact Helmet

VIII. Working in Confined Spaces:

Confined spaces are found in almost every industry and pose a safety challenge.

Confined spaces pose a danger to workers who have to enter them. Of course, it is possible (and necessary) to mitigate these risks. With a complete understanding of the limited space, the dangers of

working there, and how to manage them, workers can complete their work safely and efficiently.



Figure 1.34: PPE for Confined Space

What Makes a Space a Confined Space?

There are some criteria that a workspace must meet to be considered a confined space:

- The room isn't strictly dedicated to workers, but it's big enough for someone to enter and complete a particular task.
- Space has limited or restricted entry and exit options.
- This area is not designed for permanent use.

The following are examples of confined spaces that are commonly encountered:

- Tanks
- Vessels
- Silos
- Storage bins
- Vaults
- Manholes
- Tunnels
- Ductwork
- Pipelines

OSHA believes some confined spaces "permit required." As the name indicates, only staff who are qualified and hold the essential permit may enter these particularly hazardous confined spaces. Permit required spaces:

- May contain a hazardous or potentially hazardous atmosphere.
- May contain material that can engulf an entrant.
- May contain walls that converge inward or floors that slope downward, which could trap an entrant.

- May contain other physical hazards, such as unguarded machines or exposed live wires.
- Must be identified by the employer, who must then inform exposed employees of the location of such spaces and their hazards.

Manage danger with proper PPE

The good news is, despite the great danger posed by limited space. Proper confined space PPE can protect workers and even save lives during shifts. Although engineering and management controls need to be applied first, personal protective equipment provides the final (and important) line of worker defence.

This is what you need to know.

Fall Protection

All workers, not just those entering the space, must be equipped with fall protection. Employees working near openings (such as manholes) should wear straps or fall arrest devices.

Workers entering limited space must wear a chest or body harness with sufficient lifelines to successfully remove the worker in an emergency. The harness can be attached to an auto-retractable lifeline that acts as a personal fall arrest system in the event of a fall. Workers unfamiliar with fall protection devices should be properly trained before using them. Special care must be taken to prevent the fall arrester from interfering with the free movement of the space.

However, keep in mind that rescue using the back-mounted droop carries the additional risk of endangering the neck and head of an unconscious worker. Therefore, full-body harnesses used in confined spaces should have an accessory ring on the shoulder to allow for a safer rescue.

An estimated 60% of deaths in confined spaces occur during unsuccessful rescue operations. Therefore, rescuers must be trained and wear fall protection devices. It doesn't take long for an incident to be a complex rescue for multiple people.

Gas Detection

When working in a confined space, the gas detector is treated as a PPE. Employers must provide workers with equipment free of charge, maintain the equipment, and provide training on how to use it. Before entering the space, the atmosphere should be checked in the order of oxygen content, flammable gases and vapours, and toxic air pollution. Atmospheric tests help assess danger and ensure that space can enter safely. For

this reason, a reliable multi-gas detector is essential for working in confined spaces.

Respiratory Protection

Respiratory protection is required by OSHA regulations whenever the space does not meet the following conditions:

- Oxygen: 19.5 to 23.5 per cent
- Flammable: Less than 10% of the lower flammable limit of gas, vapour, mist, or flammable dust.
- Toxic gas: below the permissible exposure limit of the substance or the time-weighted average

If a breathing device is required, the athlete must use a self-contained breathing system (SCBA) or a compressed air supply respiratory system. When choosing, be sure to consider the type of work you are doing. The length of the airline hose limits the movement of the user. The rescuer must also be equipped with a well-maintained, ready-to-use breathing system during the rescue.

Communication Device

Communication gear is an important part of keeping workers safe in a safe room, so it should be falling under the PPE's umbrella. Many things need to be searched on communication devices:

- Hands-free
- Wireless
- Full duplex
- It is driven independently.
- It is integrated into auditory protection

Mobile phones should be avoided. You need workers to choose on a keyboard to achieve someone, and mobile services may not be able to be seriously reliable. Today Radios are also wireless and thus are susceptible to the interruption of services.

Portable devices are excellent options to protect workers during work. Wearable technologies suitable for working in tight spaces range from headsets and helmets to smartwatches and phones. Devices tend to be hands-free, making them ideal for use in tight spaces that are difficult to operate. Options include devices that measure brain activity, alert supervisors if a worker falls or becomes tired, detect gas, and pinpoint the wearer's location. Includes device. Rapidly changing technology means that this area of PPE needs to be reliably monitored.^[37]

IX. For COVID-19

Coronaviruses are a large family of viruses, some of which cause disease in humans and some of which circulate among animals such as camels, cats, and bats. Rarely, as observed in MERS and SARS, animal coronaviruses can evolve to infect humans and then spread among humans. The outbreak of the new coronavirus disease (now called COVID-19) was first noticed at the fish market in Wuhan, Hubei Province, China in mid-December 2019, covering more than 185 countries/regions around the world including India. The causative agent of COVID-19 was formerly tentatively named severe acute respiratory syndrome but was officially named SARS-CoV2. Personal Protective Equipment (PPE) is a protective device designed to protect the health of workers by minimizing exposure to biological agents.



Figure 1.35: PPE for COVID

Components of PPE:

The PPE consists of goggles, face shields, masks, gloves, overalls/gowns (with or without an apron), hats, and shoe covers. Each component and the reasons for its use are described in the paragraph below.

Face shield and goggles

Contamination of the mucous membranes of the eyes, nose, and mouth can occur during the scenario of droplets produced by coughing or sneezing by an infected person, or during an aerosol production procedure performed in the clinical setting. Accidental eye/nose/mouth touch

with contaminated hands is another possible scenario. Therefore, eye/nose/ mouth mucosal protection with face shields/goggles is an integral part of standard and contact protection measures. The flexible frame of the eyewear should provide a good seal with the skin of the face, cover the eyes and the surrounding area, and even accommodate prescription eyeglasses.

Mask

Respiratory viruses, including coronavirus, primarily target the upper and lower respiratory tracts. Therefore, it protects the respiratory tract from the fine dust produced by droplets/aerosols, thus preventing human infection. Contamination of the mucous membranes of the mouth and nose by infectious droplets or contaminated hands also allows the virus to invade the host. Therefore, using aerial precautions/masks is important when dealing with suspected or confirmed cases of performing COVID-19 / aerosol generation procedures. There are different types of masks. The type of mask used depends on the specific risk profile of the person in the category and its work. Depending on the working environment, there are two types of masks recommended for staff of different categories working in hospitals and outpatients which are:

- 1) 3-layer medical mask
- 2) N95 respirator

Gloves

When an individual touches a surface contaminated by COVID-19 diseased person and then touches his eyes, nose, or mouth, he might get exposed to the virus. Though this is not thought to be a major means of spread, care must be exercised while handling objects/surfaces possibly contaminated by suspect/confirmed cases of COVID-19. Nitrile gloves are chosen over latex gloves since they resist chemicals, including certain disinfectants such as chlorine. There is a high number of allergies to latex and contact allergic dermatitis amongst health workers. Though, if nitrile gloves are not available, latex gloves can be used. Powderless gloves are chosen over powdered gloves.

Cover all / Gown

Coverall / Gowns need to be protected from being exposed to the virus of the healthcare provider's torso. The cover of medical/insulating lumps provides non-continuous protection, as the cover is typically providing protection of 360 ° C., but covers the whole body including the back foot

and the lower extremity (e.g., B). The possible openings are the back of the cover of MIDCALFS. The use of appropriate protective clothing makes it possible to create a barrier to eliminate or reduce the contact and droplet filling or secretions. The whole and clothes are less effective if the lack of comparison detection is less effective, and it is more effective whether it is more effective, the other is effective to reduce the movement of health. It is whether there is. The gown is quite easy to make it easy to use. An apron can also be worn over the gown while the medical professional is in the treatment area. Strict standards apply to coveralls/gowns, from exposure to biologically contaminated particulate matter to protection from chemical hazards.

Shoe Covers

The shoe cover is made of impermeable cloth and should be worn over the shoes to facilitate personal protection and decontamination.

Head Covers

Overalls usually cover the head. People wearing gowns should wear headcover that covers the head and neck while providing clinical care to the patient. Hair and hair extensions should fit in the headcover.^[38]

X. For Pharmaceutical Industry:

When worn in clean rooms, manufacturing facilities, and laboratories, protective clothing controls contamination, protects against particulate, biological and chemical hazards, and ensures the safety of pharmaceutical personnel and sensitive medicines and processes.

The pharmaceutical industry is one of the most dynamically developing areas of the modern European economy.

Rapid research development and technological and scientific advances are driving advances in this segment, constantly improving the quality and length of human life. Market trends show that this sector is highly competitive with the pressure to increase efficiency, optimize and improve manufacturing processes and consistently demonstrate high-quality products.

Meanwhile, manufacturing, handling, and packaging guidelines and guidelines that regulate this industry, such as those issued by the FDA, WHO, or the European Union, are becoming stricter each year, especially regarding the manufacture of sterile agents. product. To help you achieve your goals and quality, it's important to use

proven products and services that help companies develop and improve their day-to-day activities.



Figure 1.36: PPE in Pharmaceutical Industry Flowchart

Employees working in the pharmaceutical segment encounter many on-the-job hazards as they come into contact with chemicals, biological substances, and drugs. Workers in the pharmaceutical industry require different types of protection different by protection such as non-ordinary particles and dangerous particles, liquid dielectric chemicals, liquid aerosols, etc. The chemicals that they have to respond are, inter alia, phenols, ammonium, cell growth suppressants, antibiotics, or toxicants. It is important to ensure the safety of pharmaceuticals, but it is also important to protect sensitive pharmaceuticals and processes that are only dangerous pollutants such as chemicals but also particles and microorganisms that can be damaged their quality.

Important PPE considerations in the pharmaceutical industry

The important role of protective clothing in pharmacies is to protect personnel from dangerous chemical and biological pathogens such as infectious agents and other substances that can be harmful to health. Equally important is the protection of products and processes from human and mutual pollution. The choice of appropriate protective clothing depends on the type of application, type of contamination, and other criteria (see here for more information on chemical risk assessment), but should be considered when choosing the appropriate PPE. There are some important aspects.

Key Aspects of Choice Appropriate PPE in the pharmaceutical industry.

- Quality
- Comfort
- Microbiological protection
- Compliance with standards and regulations
- Particulate matter discharge
- Tightening procedure
- Cost^[39]

3. The Hazard Assessment

The first important step in developing a comprehensive safety and health program is to identify physical and health hazards in the workplace. This process is called "hazard assessment". Potential risks can be physical or healthy, and a comprehensive risk assessment should identify risks in both categories. Examples of physical hazards include moving objects, fluctuating temperatures, strong lighting, rolling or pinched objects, electrical connections, and sharp edges.



Figure 1.37: Hazards

Examples of health hazards include excessive exposure to harmful dust, chemicals, or radiation. The hazard assessment should start with the site walkthrough and generate a list of potential hazards for the following basic hazard categories:

- Impact
- Penetration
- Compression
- Heat/Cold
- Harmful dust
- Radiations^[40]

4. Selecting PPE

All PPE apparel and device ought to be of secure layout and production, and ought to be maintained easily and dependably. Employers ought to take the suit and luxury of PPE into attention whilst deciding on suitable gadgets for

their place of work. PPE that suits nicely and is cushy to put on will inspire workers' use of PPE. Most shielding gadgets are to be had in a couple of sizes and care ought to be taken to choose the right length for every worker. If numerous one-of-a-kind varieties of PPE are worn together, ensure they may be compatible. If PPE does now no longer suit properly, it may make the distinction between being properly protected or dangerously exposed. It won't offer the extent of safety preferred and might discourage worker use. OSHA calls for that many classes of PPE to meet or be equal to requirements advanced through the American National Standards Institute (ANSI). ANSI has been getting ready protection requirements for the reason that 1920s, whilst the primary protection preferred become authorized to shield the heads and eyes of business workers. Employers who want to offer PPE inside the classes indexed beneath have to ensure that any new device procured meets the noted ANSI preferred. Existing PPE shares have to meet the ANSI preferred in impact on the time of its manufacture or offer safety equal to PPE synthetic to the ANSI criteria. Employers ought to tell personnel who offer their very own PPE of the employer's choice choices and make sure that any worker-owned PPE used inside the place of work conforms to the employer's criteria, primarily based totally on the risk assessment, OSHA necessities, and ANSI requirements. OSHA calls for PPE to satisfy the subsequent ANSI requirements: Eye and Face Protection: ANSI Z87.1-1989 (USA Standard for Occupational and Educational Eye and Face Protection). Head Protection: ANSI Z89.1-1986. Foot Protection: ANSI Z41.1-1991. For hand safety, there's no ANSI preferred for gloves however OSHA recommends that choice be primarily based totally upon the responsibilities to be done and the overall performance and production traits of the glove material. For safety towards chemical compounds, glove choice nine has to be primarily based totally on the chemical compounds encountered, the chemical resistance, and the bodily homes of the glove material.^[40]



Figure 3.1: PPE Selection

5. Education & Training:

Education and Training for PPE use:

Employees are instructed and informed about the kind of risk against which the PPE is capable of

- Protecting the employee
- PPE limitation
- For which purpose and manner PPE is used

Training for workers the following should be provided

- What PPE is and when it is necessary
- How to don, adjust and wear PPE
- The proper care and maintenance of PPE
- Limitation of PPE^[41] ^[42]

6. PPE Assessment

PPE assessment is a step following a risk assessment of the chemical or chemical operation.

PPE assessment should be made by a person who has an appropriate understanding of the chemicals and the operation involved as well as good knowledge of the safe practices and the PPE, including their uses and limitations. He should also know when he needs to call on a specialist for expert advice. The assessment should include:

- (a) an assessment of any risk to safety and health that has not been eliminated or reduced by other means such as engineering control measures;
- (b) the definition or determination of the characteristics that a PPE must have to be effective for reducing the risks referred to in paragraph (a) above, considering any risk that the equipment itself may create; and
- (c) a comparison of the specifications of the PPE that the employer intends to provide with the characteristics referred to in paragraph (b) above.

In assessing the risks to safety and health as outlined in paragraph 3.1.2(a) above, factors taken into consideration should include:

- (a) hazards of the chemicals or chemical operation
- (b) physical nature of the chemicals and the ways of passing into the human body
- (c) the environmental conditions; and
- (d) the effectiveness of the control actions in minimizing the risk.^[43]

7. Maintenance of PPE

Using a defective PPE gives the wearer a false sense of safety, and may do more harm and reduce working efficiency.

All PPE must be routinely checked before utilizing for performance and maintained in good working conditions so that the equipment can continuously offer the necessary degree of protection for which it is desired.

Maintenance, generally includes cleaning, disinfection, replacement, repair, examination, and testing.

The schedule should include:

- (a) designation of personnel for maintenance of PPE and their responsibilities;
- (b) performance checking, cleaning/disinfection, and storage procedures;
- (c) information on the expiry date or service lifetime of certain PPE such as safety helmets, gloves, canisters of respirators;
- (d) training on correct maintenance of PPE at the workplace;
- (e) time-table for performance checks, cleaning/disinfection, and other maintenance work;
- (f) standards for replacement.

PPE should be inspected to guarantee that it is in good working order before being allotted to the wearer. PPE should also be observed by the user before it is put on and should not be worn if it is found to be defective, dirty, or in unhygienic condition.

Significantly, all PPE should be kept clean, cleaning is particularly important for eye and face protective equipment where dirty or fogged lenses may hinder vision.

All faulty equipment should be taken out of service instantly and should be repaired or disposed of as applicable.

A procedure should be established to alert all staff that a certain piece of equipment is under maintenance or is defective and should not be used, equipment after reparation or maintenance should be examined for performance before it is placed into service again.

All PPE should be replaced:

- (a) when it no longer provides desired level of protection required to protect the user against the particular hazard;
- (b) when the service lifetime, as specified by the manufacturer of the equipment has expired; or
- (c) when it is damaged and cannot be repaired.^[43]

8. Storage of PPE

- All PPE should be provided with appropriate accommodation for the storage when it is not in use. The storage should be adequate to protect the PPE from contamination or damage by harmful substances, dampness, or sunlight. PPE should be returned after use to the storage place provided.
- Where PPE becomes contaminated during use, it should be cleaned or disinfected, as far as practicable, before returning to its storage place. If this is not possible, the contaminated PPE should be separately housed to prevent cross-contamination and should be suitably labelled.
- Where quantities of PPE are stored, PPE should be adequately segregated, among the ones to conditioned ones ready for use, and appropriate labelling should be carried out with utmost attention.^[43]

III. CONCLUSION:

As discussed, PPE forms the last line of protection which should not be avoided as it imbues a positive working attitude towards the operation, being economic it is widely being adopted among reputed industries and start-ups too. Eventually, its use during the pandemic has also enlightened its importance, the main aim of this article in creating awareness among people and working professionals about the different types of PPE kits available for every tiny operation is fulfilled.

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