



ANALYSIS OF PERSONAL PROTECTIVE EQUIPMENT IN MANUFACTURING INDUSTRY

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Abstract:

The purpose of personal protective equipment (PPE) is to shield or isolate individuals from the chemical, physical, and biological hazards presented on a working site. The study describes the various types of PPE used on uncontrolled hazardous work sites and provides guidance in their selection and use. It also discusses exposure limit and physiological factors that must be considered in connection with the PPE. The PPE ranges from respirators to full-body encapsulating ensembles. Proper selection of PPE requires careful assessment of the risk hazards. This assessment includes the chemicals involved, the skills of the workers, the tasks, and the duration of the potential exposures. The PPE must be selected on the basis of its demonstrated performance under such conditions.

Key Words: Personal Protective Equipment, Selection of PPE & Assessment of PPE

1. Introduction:

Personal protective equipment is commonly known as "PPE". In order to be able to choose the proper PPE, the individual must be aware of what hazards exist in the workplace. This involves obtaining information on the types of hazards present, the toxicity of the materials involved, and what other options are available to control exposure. PPE is of various types depends on the requirement usage, risk level and convenient ways. PPE that includes mainly of two types

- Respiratory protective equipment
- Non-Respiratory equipment

The Respiratory protective equipment categorized as

- Air purifying respirators
- Air supplying respirators

The Respiratory Protective Equipment: Respiratory Protective Equipment (RPE) is a particular type of Personal Protective Equipment (PPE), used to protect the individual wearer against the inhalation of hazardous substances in the workplace air.

The Non-Respiratory Equipment: The commonly used non-respiratory personal protective equipment's are Helmet, goggles, ear muffs, gloves, aprons, welding shields and so on. ANSI means the first standard for safety that have recommended for the head and eye protection for workers. Various standards are maintaining for various protections, mainly used standard is ANSI (American national standard institute). The personal protective equipment are said to be nothing but "The last time of defense. "It safeguards the workers from any hazard occurs. It gives the adequate protection against the hazard with maximum comfort and minimum weight as possible. This is good looking with the non-restriction of essential movements of disability and susceptibility, it can be easily maintained and user friendly when it is properly used. Even though the various types and availabilities and updates of protective equipment it only gets effectiveness while using it in proper selection, training of usage and maintenance. The use of PPE has many associated problems foremost of which the lack of comfort or fit (Lombardi et al., 2009). Akbar-Khanzadeh et al. (1995) documented that in an automobile encapsulating plant more than half of respirator users (62%) rated their respirators as uncomfortable. When the dangerous situation in the working environment cannot be figured out much easily or can suppress with guards, engineering or administrative control methods it only has the limit effectiveness, there is need of personal protective equipment. And also, it is important to know that personal protective equipment is not a alternative method for controlling the hazard but the last option in safety to employ after every other safety measures have been considered by the application. PPE gives effectiveness in various field operations like in the manufacturing of hazardous chemical industries. The necessity of considering chemical industry as a major part is that chemical exposure to workers can be in any form like inhalation, ingestion, injection.

Selection and Use of PPE: Personal protective equipment must be selected wisely in consideration with the material we choose, size and fitness for the wearer and also a reliable one. Personal protective equipment must be used by every worker for their own personal safety by instruction and training given by the trained people. There should be right decision taken for the selection of personal protective equipment.

2. Literature Survey:

Mansour A. Balkhyour et al (2018) Assessment of personal protective equipment use and occupational exposures in small industries in Jeddah: Health implications for workers. Small-scale industries account for a large proportion of jobs and play a vital role in most countries' economic growth and prosperity. Due to the very low use of personal protective equipment (PPEs), employees are exposed to numerous physical, chemical, and accidental hazards in small-scale industries

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Mashura Shamm et al (2018) Uncertainty, risk analysis and changes for ebola personal protective equipment's. In this project discuss the state of effective end efficiency of personnel protective equipment's. And shows the cost taken for that old and new personnel protective equipment's.

Bozena poller et al (2018) a unified PPE ensemble for clinical response to possible high consequence infectious disease. The importance of appropriate PPE as a component of healthcare worker protection was highlighted during the ebolavirus diseases our break in West Africa. The large number of hcw deaths in africa was in part due to a lack of resources or prior training in ppe

Wang Lili et al (2012) The personal protection of emergency rescuers in dangerous chemical accidents, This paper discusses personal protective principles of emergency rescuers which is based on the requirements of fast, accurate and effective emergency rescue in dangerous chemical accidents. Firstly, this paper analyzes the emergency plan and the preparation that we need make for personal protection of rescuers. Then, this paper uses all kinds of exposure limiting concentration of dangerous chemical to classify the initial quarantine, protective area, hot area, warmer area and cold area based on the planning guide on emergency response of polluted air (American industrial hygiene association).

Marcin Jachowic et al (2012) electrostatic properties of selected personal protective equipment regarding explosion hazard In industries such as the mining, petrochemistry or power industries, personal protective equipment is often used in explosive atmospheres. What causes the occurrence of explosive hazards is ever-present in the work environment they include, electrostatic phenomena as well as the build-up of electrical charges on the surface of the protective equipment used. T

3. Analysis:

A wide range of hazard identification is carried out in the industry to know the major prevalence of workplace hazard. Four types of analysis done in the industry for the improvement of safety of the employees in the workplace.

- Hazard identification
- Analysis
 - Cost analysis
 - Quality analysis
 - Lifespan analysis,
 - Analyzing of controlling risk & hierarchy

Hazard Identification:

Any activity which could cause a potential harm to workers in a workplace is referred as hazard by OSHA. Even though PPE plays a vital role in giving much protection to workers sometimes accidents occurs due to workers bad behavior and discomforts of wearing PPE.

- I have observed few accident sequences in our company even though our company provided PPE for every worker.
- They find irritation to eyes during welding; they seem to be feeling discomfort of wearing PPE in few hot zones. As the basis of Hein rich theory 88% of all industrial accidents are caused by unsafe acts of the workers here are few problems I have identified.

Hazard Reduction:

line	Number of first aid accident (before reduction)	Number of first aid accident (before reduction)
Sub Assembly Line 1	10	3
Sub Assembly Line 2	8	3
Press Shop 1	8	2
Assembly Line 1	9	4
Assembly Line 2	8	2
Main Assembly Line	4	2
Paint Shop	3	3
Store 1	2	2
Store 2	2	2
New Product Development (NPD)	3	3

The main objective of this project is to reduce the hazards which are prevailing in the industry that cause occupational disease and other injuries to the employees. Major hazards prevailing inside the industry were observed and number of accidents per day was in each line was noted. Most of the accidents were observed and found to be happening with relevance to eye injury. In welding areas employees seem to be feeling discomfort in eye irritation, watering in eyes and so on. Continuous exposure to welding process is one of the reasons behind this hazard. Major reason is that employees does not seem to be wearing appropriate personnel protective equipment's. Hazard reduction has to be considered in such aspects. Hazard reduction was carried out by

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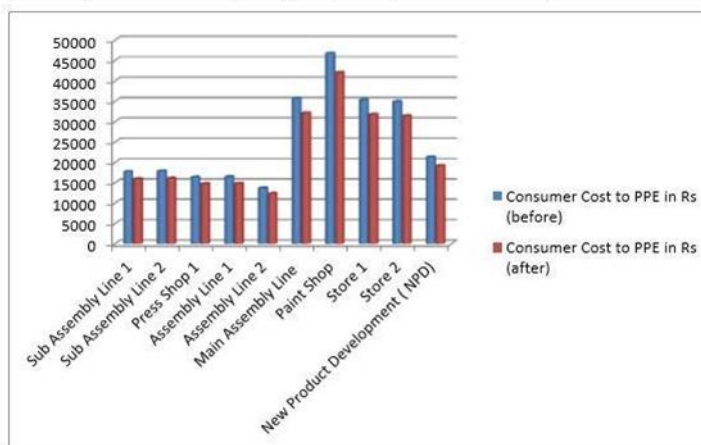
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suggesting a good recommendation after performing cost and quality analysis of the personnel protective equipment's being used and suggested goggles.

Cost Analysis:

Cost analysis was carried out in the motive of knowing the expenditure being spent on Personal Protective Equipment in the safety budget. The cost analysis considered here because the most number of accidents happening in each day. Cost analysis performed for the existing Personnel Protective equipment's being used in the industry

S.NO	LINE	Consumer Cost to PPE in Rs (before)	Consumer Cost to PPE in Rs (after)
1	Sub Assembly Line 1	17676	15908
2	Sub Assembly Line 2	17854	16069
3	Press Shop 1	16354	14719
4	Assembly Line 1	16452	14807
5	Assembly Line 2	13679	12311
6	Main Assembly Line	35687	32118
7	Paint Shop	46718	42046
8	Store 1	35290	31761
9	Store 2	34892	31403
10	New Product Development (NPD)	21301	19171



Quality Analysis:

Part of Body	Hazard	Required PPE
Hands	☐ Penetration – sharp objects	☐ Leather/cut resistant gloves
	☐ Penetration – animal bites	☐ Leather/cut resistant gloves
	☐ Penetration – rough objects	☐ General purpose work gloves
	☐ Penetration – knives	☐ Metal/steel mesh, Kevlar, or heavy leather
	☐ Chemicals	☐ Chemical resistant gloves
	☐ Extreme cold	☐ Insulated gloves
	☐ Extreme heat	☐ Heat/flame resistant gloves
	☐ Blood	☐ Nitrile gloves
	☐ Electrical shock	☐ Insulated rubber gloves. Type:
	☐ Product contamination	☐ Plastic, cotton, or nylon
	☐ Other:	Other:
Respiratory System	☐ For comfort for nuisance dust/mist	☐ Disposable dust/mist mask
	☐ Welding fumes	☐ Respirator w/P100 filter
	☐ Asbestos	☐ Respirator w/P100 filter
	☐ Pesticides	☐ Respirator w/ cartridges as per pesticide label
	☐ Paint spray	☐ Respirator w/ Organic vapor/P100 filter
	☐ Organic Vapors	☐ Respirator w/ Organic vapor filters
	☐ Acid gases	☐ Respirator w/ Acid gas filters
	☐ Oxygen deficient, toxic, or IDLH atmosphere	☐ SCBA or Type C airline respirator

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Part of Body	Hazard	Required PPE
Head	☐ Object from overhead	☐ Type 1, ANSI Z89.1-1997
	☐ Impact to side of head	☐ Type 2, ANSI Z89.1-1997
	☐ Stuck by falling object	Hard Hat Class
	☐ Struck against fixed object	☐ Class A/G
	☐ Electrical contact with exposed wires/conductors	☐ Class B/E
	☐ Special circumstances – no electrical protection	☐ Class C
Body	☐ Hair entanglement or open flames	☐ Cap, hairnet, or bandana
	☐ Other:	☐ Other:
	☐ Impact – flying objects	☐ Long sleeves, apron, or coat
	☐ Moving vehicles	☐ Traffic vest
	☐ Penetration – sharp objects	☐ Cut-resistant sleeves or wristlets
	☐ Penetration – knives	☐ Metal mesh, Kevlar, steel mesh, heavy leather sleeves, wristlets, or aprons
	☐ Electrical – static discharge	☐ Static control coat or coveralls
	☐ Hot metal or sparks	☐ Flame-resistant jacket/pants or aluminized jacket/pants
	☐ Chemical:	☐ Lab coat or apron/sleeves
	☐ Unprotected elevated walking/working surface	☐ Body harness and lanyard
	☐ Other:	☐ Other:
Part of Body	Hazard	Required PPE
Eyes and Face	☐ Impact-flying objects, chips, sand, or dirt	☐ Safety glasses w/ side shields
	☐ Nuisance dust	☐ Goggles w/ face shield
	☐ UV light welding, cutting, torch brazing, or soldering	☐ Unvented chemical goggles
	☐ Chemical – splashing	☐ Welding goggles
	☐ Chemical – irritating mists	☐ Welding helmet/shield w/safety glasses and side shield
	☐ Hot sparks – grinding	☐ Chemical goggles/ face shield
	☐ Splashing molten metal	☐ Unvented chemical goggles
	☐ Glare or high intensity lights	☐ Safety glasses w/ side shields
	☐ Laser operations	☐ Safety goggles w/ face shield
	☐ Other:	☐ Safety goggle w/ face shield
Ears	☐ Exposure to noise levels less than 85 dBA 8-hour TWA	☐ Shaded safety glasses
	☐ Exposure to noise levels less than 105 dBA 8-hour TWA	☐ Laser goggles or glasses
	☐ Exposure to sparks	☐ Other:
	☐ Other:	

Lifespan Analysis:

S.NO	PPE'S	REPLACEMENT PERIODS
1	HELMETS	3 YEARS FROM THE DATE OF MANUFACTURING
2	EAR PLUGS	3 - 4 MONTHS FROM THE DATE OF MANUFACTURING
3	GOOGLES	3 MONTHS FROM THE DATE OF MANUFACTURING
4	GLOVES	1 WEEK / BASED ON THE CONDITIONS / LEVELS TO BE REPLACED
5	MASK	8 HOURS OF USAGE TO BE REPLACED
6	SAFETY SHOES	1500 KM / 1 YEAR OF USAGE TO BE REPLACED
7	HARNESS	5 YEARS FROM THE DATE OF MANUFACTURING

It would be difficult to cover every single type of PPE equipment from head protection to hearing protection to eye protection to respiratory protection (and more), but here are some quick rules as to when your equipment should be replaced.

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(Most of these tips will be somewhat common sense.) The important factor is safety, and if any part of your equipment is defective or damaged, it's no longer safe and will need replacing.

- Replace any equipment that is damaged, defective, or worn.
- Replace if equipment is cracked, gouged, excessively scratched, ill-fitting, or broken.
- Replace equipment if exposed to excess dust, sunlight, humidity, extreme cold/heat, and chemicals.
- Replace equipment that is heavily soiled, or anything damaged from UV rays, chemicals, sunlight, or tearing (for clothing).
- Replace anything that no longer works to provide safety to the wearer.
- Replace equipment by its - shelf life at the maximum.
- Always throw away disposable PPE (ear plugs, dust masks, gloves, respiratory filters, etc.) after use.

To lengthen the shelf life of your PPE, maintain and clean equipment regularly, and store your equipment properly. Inspect PPE equipment on a schedule, and make regular checklists to ensure you are meeting the highest safety standards

Analyzing of Controlling Risk & Hierarchy:

Controlling risk is a system used in industry to minimize or eliminate exposure to hazards. It is a widely accepted system promoted by numerous safety organizations. This concept is taught to managers in industry, to be promoted as standard practice in the workplace. Various illustrations are used to depict this system, most commonly a triangle. The hazard controls in the hierarchy are, in order of decreasing effectiveness:

- Elimination
- Substitution
- Engineering controls
- Administrative controls
- Personal protective equipment

Elimination:

Physically removed the hazard—is the most effective hazard control. For example, if employees must work high above the ground, the hazard can be eliminated by moving the piece they are working on to ground level to eliminate the need to work at heights.

Substitution:

Substitution, the second most effective hazard control, involves replacing something that produces a hazard (similar to elimination) with something that does not produce a hazard—for example, replacing lead-based paint with titanium white. To be an effective control, the new product must not produce another hazard. Because airborne dust can be hazardous, if a product can be purchased with a larger particle size, the smaller product may effectively be substituted with the larger product.

No.	Job Position	Activities	Hazards	Types of Incidents	Types of Hazards			Scores of Risk Assessment					Risk Control Planning	Scores of Risk Assessment				
					Equ.	Peop.	Env.	S	P	E	R=SPE	Risk Grade		S	P	E	R=SP	Risk Grade
27	Operator	Deburring / Final Inspection	Parts / Silings	Head Injury	x			3	3	6	54	D	Provided Hard hats	7	1	3	21	E
28			Noise	Hearing Impair	x			3	3	6	54	D	Ear Plugs	3	1	1	3	F
29			Flying chips	Chips falling on eyes				3	10	3	90	D	Safety goggles	3	1	3	9	F
30			Manual Handling	Sprain	x			3	3	3	27	E	Working table	3	1	1	3	F
31	Staff & Operator	Office for supervisors & Tool Crib	Running wires	Slip Hazard	x			1	1	6	6	F	Safety Shoes	1	1	2	2	F
32			Flying chips	Chips falling on eyes	x			3	1	6	18	F	Safety goggles	3	1	3	9	F
33	Staff & Operator	CMM	Parts hit on head	Head Injury	x			7	3	6	126	C	Provided Hard hats	7	1	3	21	E
34			Silings / Pendet	Head Injury	x			3	3	6	54	D	Provided Hard hats	3	1	3	9	F
35	Staff & Operator	Standards Room	Splash during Drop of Gages	Eye Injury	x			3	3	3	27	E	Safety goggles	3	1	3	9	F
36			Loose Wire	Feet Injury	x			3	3	3	27	E	Safety Shoes	1	1	2	2	F
37	Staff & Operator	Projects Office	Loose Wire	Slip Hazard	x			1	1	6	6	F		1	1	6	6	F
38			Revolvin g Chairs	Fall	x			3	3	6	54	E		3	3	6	54	D
39	Staff & Operator	LT Room	Open Trench	Fall	x			3	3	6	54	E	Partially covered	3	3	6	54	D
40			Loose Wire	Slip Hazard	x			1	1	6	6	F		1	1	6	6	F
41	Staff & Operator	Casting Store	Noise (Shot)	Hearing Impair	x			3	1	6	18	F	Ear Plugs	3	1	1	3	F
42			Loading & Noise	Head / Leg / Eye Injury	x			3	6	6	108	C	Hard Hats / Safety Shoes / Safety	3	3	2	18	F
43			Noise (Shot)	Hearing Impair	x			3	1	6	18	F	Ear Plugs	3	1	1	3	F

Engineering Controls:

Third most effective means of controlling hazards is engineered controls. These do not eliminate hazards, but rather isolate people from hazards. Capital costs of engineered controls tend to be higher than less effective controls in the hierarchy; however, they may reduce future costs. [6] For example, a crew might build a work platform rather than purchase, replace, and

maintain fall arrest equipment. "Enclosure and isolation" create a physical barrier between personnel and hazards, such as using remotely controlled equipment. Fume can remove airborne contaminants as a means of engineered control.

Administrative Controls:

Administrative controls are changes to the way people work. Examples of administrative controls include procedure changes, employee training, and installation of signs and warning labels (such as those in the Workplace Hazardous Materials Information System). Administrative controls do not remove hazards, but limit or prevent people's exposure to the hazards, such as completing road construction at night when fewer people are driving.

Personal Protective Equipment:

Personal protective equipment (PPE) includes gloves, Nomex/Uniform, respirators, hard, safety glasses, high-visibility clothing, and safety footwear. PPE is the least effective means of controlling hazards because of the high potential for damage to render PPE ineffective. Additionally, some PPE, such as respirators, increase physiological effort to complete a task and, therefore, may require medical examinations to ensure workers can use the PPE without risking their health

4. Conclusion:

I conclude that Effectiveness and Efficiency of Personal Protective Equipment were observed by using the correct Personnel Protective equipment's which were being used in the industry effectively and efficiently. The advantage of the recommended Personnel Protective equipment's reduces irritation and injuries of the employees. As a result, it is found that change of Personnel Protective equipment's gave an effective outcome in improving safety of the employees. It is clear that injuries were happened due to the unused Personnel Protective equipment's. The durability of the existing Personnel Protective equipment's was seemed to be low than the recommended Personnel Protective equipment's. Number of accidents while using existing and recommended Personnel Protective equipment's were shown comparatively. It clears that number accidents happened per day was reduced ultimately.

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