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Personal Protective Equipments are Last Resort of Safety

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Abstract

This study and analysis will deal with this concept that before applying control over hazard to reduce risk, think on the hierarchy of control over hazards. The Personal Protective Equipments should be the last resort to reduce the risk level or to ill health. But it is common practices in Industries that they provide lots of Personal Protective Equipments from top to bottom body parts of their employees & to ensure the safety of employees. Before applying use of PPEs to control over Hazard, four stages of controls are available e.g. Elimination, Substitution, Engineering control, Administrative control. (Standard OHSAS-18001:2007)

Elimination of hazards stands at the top and most preferable means to control over hazard. Elimination means eliminate the Hazard, if elimination is not possible, try to reduce the risk level by substitution means using safer substances instead of exiting dangerous one, if substitution is also not possible, try to reduce the risk level by engineering controls mean taking advantage of technical progress such as automation / robotics instead of manual operations, improving machine guarding, erection of proper ladder / platforms, conveyor systems, acoustic enclosures, installing emergency alarms / indications etc., if Engineering controls is also not possible, try to reduce the risk level by Administrative controls means restricted entry, barricading, display of visual signage, training, work permit system, authorized pass system, introducing planned maintenance and inspection etc., if all above said is not possible; try to reduce the risk level by Personal Protective Equipments mean own body protection by wearing nose mask, helmet, ear plug/muff, safety shoes, safety goggles etc.

Meanwhile it is common culture in industries that safety means only wearing/visual of Personal Protective Equipments.

This paper analyzes five year data of accidents of a leading pump industry showing the dependence on the last resort of PPEs for control over hazard. All these accidents could have been prevented by thinking over the control of hierarchy.

Keywords: Safety, Accident, Unsafe Acts, Unsafe Condition, Hazard, Personal Protective Equipments.

Introduction

In total safety management system it is cumulative & joint effort of the top management, Safety team, head of the departments, supervisors, and workers etc. This gives the end result in incident prevention. Injury or ill health in Industry is common phenomena meanwhile in present scenario all multinational & national companies are become more aware & conscious about human safety.

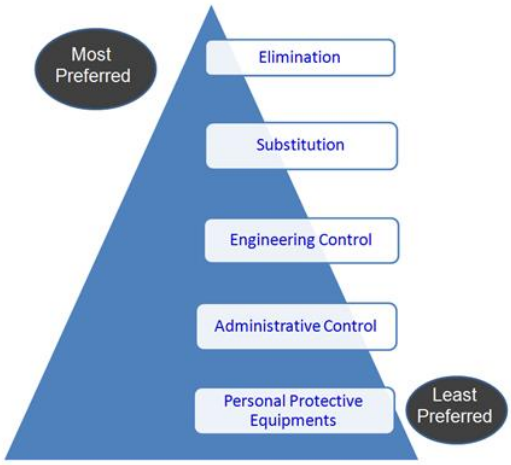

Fig. 1 Hierarchy of control over hazards

They All these have separately big size Safety cell in their organization & recruit higher educated, experienced & expert professionals to prevent human injury. But they are

giving more prominence to use of Personal Protective Equipments instead of other controls over hazards are possible to reduce base risk to avoid injury or ill health. Industrial accidents/hazards remain a major concern before the safety Personnel/ authorities consequent to the loss of lives as well as damage to the property and the environment that is inflicted on the society besides upsets in tranquil and a heavy economic strain. The problem of accidents caused in the industry poses a big question with its regional and global implications and efforts are also underway to minimize the damages and ensure all safer working environments around the industrial installations regarding the equipment-based safety. The safety regulations, measures or standards are not meant for to be only planned, incorporated or followed but they are for the overall safety in terms of human safety, environmental preservation and governing capital(financial) and operational losses from accidental incidents. So, safety should be considered as a necessity in terms of priority. The real challenges lie in managing these safety issues to avoid accidental incidents while keeping the wheels of growth moving by improving performance and profitability.

Literature Review

Industrial accidents are happens by only two reason one is unsafe acts and second is unsafe conditions according to research & survey it is analyzed that mostly(We can say above 88%) accident causes of unsafe acts & remaining are by unsafe condition while in unsafe condition natural clematis are also included e.g. Earth quack, Tsunami, storm etc.

Definition of Key words

Safety - The control of recognized hazards to attain an acceptable level of risk.

Accident - Undesired/unplanned event giving rise to death, ill health, injury, damage or other loss.

Unsafe Acts - Means "an element of unsatisfactory behavior immediately prior to an accident event which is significant in initiating the event" e.g. risk taking, short cuts, carelessness, lack of attention, horseplay etc. It means either a positive act i.e. commission of an act or a negative act i.e. omission or failure to perform an act which a prudent man should not have done and which results in hazard, accident or injury. The unsafe act might be deliberate (mischief, sabotage etc.) or committed due to absence knowledge, ignorance or through forgetfulness (human error, mistake etc.). The unsafe act may be the sole accident cause or one of several causes. e.g. are standing under suspended load, design mistake, starting machine without authority or warning, removal of safeguard, chance taking, wrong interpretation of safety rule, not following the safety precaution, poor vision or judgment etc.

Unsafe act is concerned with the human being and can be corrected by the action of the human being only. Training plays an important role. Even if the condition is fully safe, an accident may happen because of the unsafe act. At the root of creation of unsafe condition, many times the underlying cause is unsafe act i.e. human failure somewhere, which can be detected and corrected. According to H.W. Heinrich, 88% accidents are due to unsafe acts.

He considered unsafe acts responsible for most of the unsafe conditions.

- Operating without qualification or authorization.
- Lack of or improper use of PPE.
- Failure to lockout /tagout.
- Operating equipment at unsafe speed.
- Failure to warning signals.
- Bypass or removal of safety devices.
- Using defective equipment.
- Use of tools for other than their intended purpose.
- Working in hazardous locations without adequate protection or warning.
- Improper repair of equipment.
- Horseplay during working.
- Wearing unsafe clothing.
- Taking an unsafe position.

Unsafe Condition - An unsatisfactory physical condition existing in the workplace environment immediately prior to an accident event which is significant in initiating the event. e.g. slippery floor, broken glass, unguarded machine, open/loose electric cable, low lighting levels etc.

Examples are –

- Defective tools, equipment, or supplies.
- Inadequate supports or guards.
- Congestion in the workplace.
- Inadequate warning systems
- Fire and explosion hazards.
- Poor housekeeping.
- Hazardous atmospheric condition.
- Excessive noise.
- Poor ventilation.

Hazard –Source or situation with a potential for harm in terms of injury or ill health, damage to property, damage to the work place environment or a combination of these e.g. Open electrical wire.

Types of hazards

A common way to classify hazards is by category:

Biological - bacteria, viruses, insects, plants, birds, animals and humans etc.

Chemical - depends on the physical, chemical and toxic properties of the chemical.
Ergonomic - repetitive movements, improper set up of workstation etc.,
Physical - radiation, magnetic fields, pressure extremes (high pressure or vacuum), noise etc.
Psychosocial - stress, violence etc.

Table 1 - Examples of Hazards and Their Effects

Workplace Hazard	Example of Hazard	Example of Harm Caused
Thing	Sharp edge	Cut
Substance	Acid	Burn
Material	Asbestos	Mesothelioma
Source of Energy	Electricity	Shock, electrocution
Condition	Wet floor	Slips, falls
Process	Welding	Metal fume fever
Practice	Sand Blasting	Silicosis

Risk - Is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss. A term applied to the individual or combined assessments of "probability of loss" and potential amount of loss.

We can say mathematically

Risk = Probability X Severity

Factors that influence the degree of risk include:
• How much a person is exposed to a hazardous thing or condition?
• How the person is exposed
• How severe are the effects under the conditions of exposure.

History of Industrial

Accidents During the past 50 years safety has played an increasingly important role in defining operational standards in industries all over the world. The fact that safety now plays such an important role in legislative and operational standards is a reflection of the demand from society that all activities should be free from risk to the worker or at least kept at tolerable levels of risk.

A certain level of risk is inherent in every activity in the workplace. Tolerating some level of risk is necessary, but to protect against unwanted loss such as injury, property damage or production downtime, risks must be eliminated, transferred, controlled or tolerated.

This worldwide trend is emphasized by the fact that the International Labour Organisation first accepted a convention on protection against accidents on 21 June 1929. This convention, Convention C28, was aimed at reducing accidents during work performed on shore or on board ships whilst loading or unloading any ship. This convention was revised twice since then, first in 1932 with the introduction of convention C32 and again in 1997 when convention C152 was passed. The International Labour Organisation also accepted the following conventions relating to health and safety:

- A convention for safety provisions for buildings, convention C62 in 1937,
- A convention on the prevention of accidents associated with seafarers, convention C134 in 1970,
- A convention on occupational health and safety, convention C155 that applied to all branches of economic activity in 1981,
- A safety and health in construction convention C167 in 1988,
- A convention on the prevention of major industrial accidents, convention C174 in 1993,
- A safety and health in mines convention C176 in 1995.

In this Act the emphasis was altered to make it clear that reducing or eliminating risks would improve safety. Design, control or management could be used to reach the desired level of risk reduction for identified hazards. In practice a combination of these approaches is called for.

The decriminalization of accident investigations was given direction with the inclusion of Section 63 in the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) that attempted to increase the effectiveness of investigations by making it possible for the Chief Inspector of Mines, in consultation with the Attorney General, to issue a certificate of non-prosecution under certain circumstances. Despite the inclusion of this section the inspectors did not make use of it, as there was no formal accident investigation methodology in use in the mining industry that effectively identified the fundamental contributing factors of accidents.

Most industrial accidents result from factors that are constantly present for weeks, months, or even years. It is only a matter of time before the event will occur. This state of affairs was addressed by the developing of the fundamental contributing accident investigation model. It was determined that knowledge of fundamental contributing factors influenced decision-makers to seek to

avoid taking the risk that such events will occur. Companies where the culture is such that employees are allowed to take risks, it is likely that the attitude towards accidents is that "accidents just happen and there is nothing we can do about it." This type of attitude is not conducive to an effective safety culture. Employers with a healthy attitude towards risk will require the pro active correction of fundamental contributing factors.

Control over Hazards

What are Control Measures?

Control measures include actions that can be taken to reduce the potential of exposure to the hazard, or the control measure could be to remove the hazard or to reduce the likelihood of the risk of the exposure to that hazard being realised. A simple control measure would be the secure guarding of moving parts of machinery eliminating the potential for contact. When we look at control measures we often refer to the hierarchy of control measures.

Table 2 - Hierarchy of control measures

Eliminate the hazard	Elimination of the hazard is not always achievable though it does totally remove the hazard and thereby eliminates the risk of exposure. An example of this would be that petrol station attendants in Ireland are no longer exposed to the risk of chronic lead poisoning following the removal of lead from petrol products sold at forecourts.
Substitute the hazard with a lesser risk	Substituting the hazard may not remove all of the hazards associated with the process or activity and may introduce different hazards but the overall harm or health effects will be lessened. In laboratory research, toluene is now often used as a substitute for benzene. The solvent-properties of the two are similar but toluene is less toxic and is not categorised as a carcinogen although toluene can cause severe neurological harm.
Isolate the hazard	Isolating the hazard is achieved by restricting access to plant and equipment or in the case of substances locking them away under strict controls. When using certain chemicals then a fume cupboard can isolate the hazard from the person, similarly placing noisy equipment in a non-accessible enclosure or room isolates the hazard from the person(s).
Use engineering controls	Engineering Controls involve redesigning a process to place a barrier between the person and the hazard or remove the hazard from the person, such as machinery guarding, proximity guarding, extraction systems or removing the operator to a remote location away from the hazard.
Use administrative controls	Administrative controls include adopting standard operating procedures or safe work practices or providing appropriate training, instruction or information to reduce the potential for harm and/or adverse health effects to person(s). Isolation and permit to work procedures are examples of administrative controls.
Use personal protective equipment	Personal protective equipment (PPE) include gloves, glasses, earmuffs, aprons, safety footwear, dust masks which are designed to reduce exposure to the hazard. PPE is usually seen as the last line of defense and is usually used in conjunction with one or more of the other control measures. An example of the weakness of this control measure is that it is widely recognized that single-use dust masks cannot consistently achieve and maintain an effective face piece-to-face seal, and cannot be adequately fit-tested and do not offer much, if any real protection against small particulates and may lead to a false sense of security and increase risk. In such instances an extraction system with fitted respirators may be preferable where the hazard may have significant health effects from low levels of exposure such as using isocyante containing chemicals.

Data collection

Five year accidents data is showing that management focus on only control over hazards by Personal Protective Equipment.

Table - 3 -Five Year Safety Statistics of A Leading Pump Industry

S. No.	Brief Description of Incident	Body Parts Injured	Existing Control Over Hazard	Appropriate Control for this procedure/Activity
1	Workmen was handling 50 Kg pump manually & pump fell down on his foot	Foot injury	Safety Shoes	**Engineering Control** - Pump to be handled by electric crane or hydraulic lifter
2	Turning operation on Lathe was going on, Chips flew & entered in the operator eye	Eye injury	Safety Goggle	**Engineering Control** - Guard/Protector should be there
3	New Trainee was deployed on Grinding machine	Finger injury	Hand gloves	**Engineering Control** - Interlocking of Guard/protector should be operative
4	Horseplay during pouring operation of molten metal in CI Foundry. Metal splashed on hand	Hand injury	Hand gloves	**Administrative Control** - Safe operating procedure to be displayed
5	Spare material rack fell down on the floor during taking out of material	Foot injury	Safety Shoes	**Engineering Control** - Proper grouting of rack should be done
6	Brake assembly of electric Crane fell down during lifting of load	Hand & Foot injury	Safety Helmet & Safety Shoes	**Engineering Control** - Additional protector/ mesh should be provided
7	On the walk way over head electrical line (220 V) broken due to overloading & fell down on the employee who was passing below the wires	Electric Shock	NIL	**Engineering Control** - Cable tray should be provided
8	In office area seating arrangement of a Clark was such that a Twin Tube light fixture installed just above his head. When Clark was doing his routine work, Tube light fixture suddenly fell down & he got internal shoulder injury	Shoulder injury	NIL	**Substitution Control** - Twin fixture tube light should be replaced by LED / CFL and fixed on the side wall of office
9	Fire observed due to electrical short circuit in Inflammable store room	Property Loss	Small Fire Extinguishers	**Elimination Control** - Transaction in inflammable store should be restricted only allow between Sun rise & Sun set(Day time).In this situation no need of lighting arrangement. Substitution Control - Lighting should be provided flam proof lighting
10	During lifting of pump by electric crane with the help of wire rope, wire rope came out from the hook and pump fell down, because Locking arrangement (Safety Latch) was not there	Foot injury	Safety Shoes	**Engineering Control** - Locking arrangement(Safety Latch)should be provided in Crane hook
11	After main switch made "OFF" by Housekeeping workman of machine & doing cleaning on machine, operator of machine came & main switch made on for regular production without seeing surrounding, so Housekeeping workman got electric shock.	Electric Shock	Hand gloves	**Engineering Control** - LOTO (Lock Out & Tag Out) system should be provided
12	Sand blasting operation	Possibility of Silicosis	Nose mask	**Substitution Control** - Sand blasting should be replace by Sand blasting operation.
13	Fire observed due welding work was going on the Paint booth without Safe operating procedure	Property Loss	Small Fire Extinguishers	**Administrative control** - Safe operating procedure/Work permit system should be implemented whenever hazardous work is going on

Analysis of data

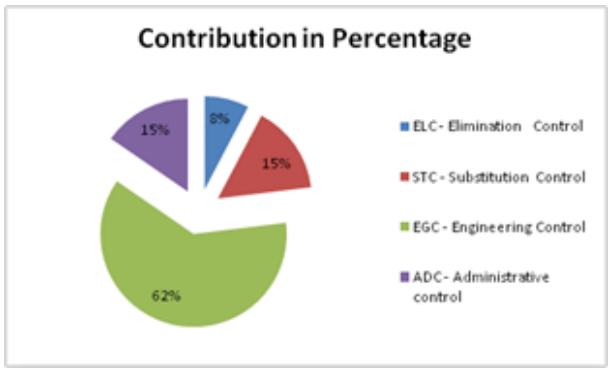

Fig. 2 Graphical presentation of analyzed data

According to the close analysis of the data it is obvious that maximum hazard control probably in five years safety statistics lays with engineering control 61.54% instead of PPEs control. Maximum hazards could have been possible by more emphasis on engineering control. It is cost efficient also.

Conclusions

The most important finding of this study is that when organizations take proactive measures to protect their employees, the company derives a financial benefit in reduced lost time and workers compensation expenses. According to above mentioned study Elimination of hazard is most preferable method and use of PPEs is least preferable method to reduce risk of hazard.

When reviewing the results of this study of a leading pump industry we can say accidents are preventable if we think on the hierarchy of control over hazards. In this pump industry risk of approximately 90% accident can be reduced by adopting elimination, Substitution or by engineering control over hazard.

A close analysis of the data shows that 7.69% probable contribution is of elimination of hazards, 15.38% probable contribution is of substitution of hazards, 61.54% probable contribution is of engineering control of hazards and 15.38% probable contribution is of administrative control over hazards. Through this study we can conclude that PPEs should be the least preferable method to reduce risk of hazards and Elimination of hazard is most preferable method.

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