Personal Protective Equipments are Last Resort of Safety

Bachchan Kanungo¹, Girish Thakar² and Prashant Sharma³

¹Associate Manager,
Kirloskar Brothers Limited (KBL), Dewas – 455001, M.P., India

²Associate Professor,
Department of Industrial and Production Engineering (IPE),
SGSITS, Indore - 452003, M.P., India

³Professor, Pacific College of Engineering,
Pacific Academy of Higher Education and Research University,
Udaipur (Rajasthan), India

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.

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

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

\[
\text{Risk} = \text{Probability} \times \text{Severity}
\]

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,

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 proactive correction of fundamental contributing factors.

**Control over Hazards**

What are Control Measures?

<table>
<thead>
<tr>
<th>Table 2 - Hierarchy of control measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eliminate the hazard</strong></td>
</tr>
<tr>
<td><strong>Substitute the hazard with a lesser risk</strong></td>
</tr>
<tr>
<td><strong>Isolate the hazard</strong></td>
</tr>
<tr>
<td><strong>Use engineering controls</strong></td>
</tr>
<tr>
<td><strong>Use administrative controls</strong></td>
</tr>
<tr>
<td><strong>Use personal protective equipment</strong></td>
</tr>
</tbody>
</table>
Data collection

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

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Brief Description of Incident</th>
<th>Body Parts Injured</th>
<th>Existing Control Over Hazard</th>
<th>Appropriate Control for this procedure/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Workmen was handling 50 Kg pump manually &amp; pump fell down on his foot</td>
<td>Foot injury</td>
<td>Safety Shoes</td>
<td><strong>Engineering Control</strong> - Pump to be handled by electric crane or hydraulic lifter</td>
</tr>
<tr>
<td>2</td>
<td>Turning operation on Lathe was going on, Chips flew &amp; entered in the operator eye</td>
<td>Eye injury</td>
<td>Safety Goggle</td>
<td><strong>Engineering Control</strong> - Guard/Protector should be there</td>
</tr>
<tr>
<td>3</td>
<td>New Trainee was deployed on Grinding machine</td>
<td>Finger injury</td>
<td>Hand gloves</td>
<td><strong>Engineering Control</strong> - Interlocking of Guard/protector should be operative</td>
</tr>
<tr>
<td>4</td>
<td>Horseplay during pouring operation of molten metal in CI Foundry. Metal splashed on hand</td>
<td>Hand injury</td>
<td>Hand gloves</td>
<td><strong>Administrative Control</strong> - Safe operating procedure to be displayed</td>
</tr>
<tr>
<td>5</td>
<td>Spare material rack fell down on the floor during taking out of material</td>
<td>Foot injury</td>
<td>Safety Shoes</td>
<td><strong>Engineering Control</strong> - Proper grouting of rack should be done</td>
</tr>
<tr>
<td>6</td>
<td>Brake assembly of electric Crane fell down during lifting of load</td>
<td>Hand &amp; Foot injury</td>
<td>Safety Helmet &amp; Safety Shoes</td>
<td><strong>Engineering Control</strong> - Additional protector/ mesh should be provided</td>
</tr>
<tr>
<td>7</td>
<td>On the walk way over head electrical line (220 V) broken due to overloading &amp; fell down on the employee who was passing below the wires</td>
<td>Electric Shock</td>
<td>NIL</td>
<td><strong>Engineering Control</strong> - Cable tray should be provided</td>
</tr>
<tr>
<td>8</td>
<td>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 &amp; he got internal shoulder injury</td>
<td>Shoulder injury</td>
<td>NIL</td>
<td><strong>Substitution Control</strong> - Twin fixture tube light should be replaced by LED / CFL and fixed on the side wall of office</td>
</tr>
<tr>
<td>9</td>
<td>Fire observed due to electrical short circuit in Inflammable store room</td>
<td>Property Loss</td>
<td>Small Fire Extinguishers</td>
<td><strong>Elimination Control</strong> - Transaction in inflammable store should be restricted only allow between Sun rise &amp; Sun set(Day time).In this situation no need of lighting arrangement. <strong>Substitution Control</strong> - Lighting should be provided flam proof lighting</td>
</tr>
<tr>
<td>10</td>
<td>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</td>
<td>Foot injury</td>
<td>Safety Shoes</td>
<td><strong>Engineering Control</strong> - Locking arrangement(Safety Latch) should be provided in Crane hook</td>
</tr>
<tr>
<td>11</td>
<td>After main switch made &quot;OFF&quot; by Housekeeping workman of machine &amp; doing cleaning on machine, operator of machine came &amp; main switch made on for regular production without seeing surrounding, so Housekeeping workman got electric shock.</td>
<td>Electric Shock</td>
<td>Hand gloves</td>
<td><strong>Engineering Control</strong> - LOTO (Lock Out &amp; Tag Out) system should be provided</td>
</tr>
<tr>
<td>12</td>
<td>Sand blasting operation</td>
<td>Possibility of Silicosis</td>
<td>Nose mask</td>
<td><strong>Substitution Control</strong> - Sand blasting should be replace by Sand blasting operation.</td>
</tr>
<tr>
<td>13</td>
<td>Fire observed due welding work was going on the Paint booth without Safe operating procedure</td>
<td>Property Loss</td>
<td>Small Fire Extinguishers</td>
<td><strong>Administrative control</strong> - Safe operating procedure/Work permit system should be implemented whenever hazardous work is going on</td>
</tr>
</tbody>
</table>
Analysis of data

![Graphical presentation of analyzed data](image)

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.

**References**

[1] OHSAS 18001:2007, Occupational Health and Safety Assessment Series, Occupational health and safety management systems, ICS 03.100.01; 13.100


First Author – Bachchan kanungo is doctoral candidate in Pacific University, Udaipur (Rajasthan), India, perusing Ph.D., Master of Engineering in “Industrial Engineering & Management” (2006), Post Diploma in Industrial Safety from Regional Labour Institute, Kanpur (2008-09), Certified Energy Manager & Energy Auditor by Bureau of energy Efficiency approved Ministry of Power, Govt. Of India, (May 2010), Certified Lead Auditor (OHSAS 18001:2007) by Confederation of Indian Industry (CII), Eighteen years’ experience in Maintenance Department at Gajara Gears Pvt. Ltd. Dewas (M.P.) and seven year’s experience at Kirloskar Brothers Limited, Dewas (M.P.) as Associate (Deputy) Manager in HSE (Health, Safety and Environment) and presently working in Lean Manufacturing and Plant Engineering & Maintenance department. Senior Member of “Indian Institute of Industrial Engineering, Navi Mumbai”, Membership Number is SM 10357 (35).

Second Author – Dr. Girish Thakar, Associate Professor, Department of Industrial Engineering & Production, Shri Govindram Seksaria Institute of Technology and Science, Indore(M.P.)

Third Author - Dr. Prashant Sharma, Director of Pacific College of Engineering, Pacific Academy of Higher Education and Research University, Udaipur (Rajasthan)