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Hazard Identification and Risk Assessment by Qualitative and Quantitative methods

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Abstract-**The Hazard Identification and Risk Assessment is a tool used by industries to identify the hazards and providing control measures as per the risk priorities of each hazard. After the hazards are identified the risks can be assessed by quantitative and qualitative method to determine whether the identified risks are significant or non significant. The Qualitative risk assessments can be performed by checking the identified risks with Legislative Concern, Interested Party Concern, Business concern and Potential Emergency Concerns. The Quantitative risk assessment can be performed using Risk Priority Number (RPN) which is obtained by the product of Frequency and duration of exposure to the hazard, Severity of harm and Number of people that could be affected. After the Identification of Hazards and assessment of Risks the Risk based control plan have to be made as per the Values of Risk Priority Number. The Risk Control measures have to be in following hierarchy Elimination/Substitution, Engineering Controls, Administrative Controls, and Personal Protective Equipments. This method is applicable to all Industries to in order to reduce the hazard and Risks which makes the workplace as a safe working environment.**

Index terms: **Hazards, Risks, Risk Priority Number.**

I. INTRODUCTION

Hazards are the sources or situations which have the potential to cause undesired events. Risks are the combination of likelihood which creates a chance for the undesired events. All the Industries and workplace consists of Hazards and Risks which creates and cause the chances of accidents. In order to reduce those hazards and risks, the hazard identification and risk assessment have to be performed periodically. The Qualitative and Quantitative assessments are the effective methods to prioritize the hazards which have to be mitigated in a sequential order. In order to provide the control measures in proactive manner than a reactive manner the Hazard Identification and Risk Assessment by Quantitative and Qualitative methods plays a vital role.

II. PROCEDURE FOR HAZARD IDENTIFICATION AND RISK ASSESSMENT (HIRA)

The sequence / Flow chart of hazard Identification and Risk assessment is as follows.

1) Classify the Work activities, Identify the Hazard, Determine Risks, Determine existing control measure, Assess the risk considering probable failures in the existing risk control measures, Decide whether the risk is tolerable, Decide the Risk control Plan.
2) Classification of work activities: Department heads in association with the core team member shall list out routine and non-routine activities, activities of all having personnel access to the workplace in the respective department and gather the following information wherever possible, for each work and activity.

    - Tasks being carried out: their duration and frequency.
    - Location where the work is carried out.
    - Who normally carries out the tasks?
    - Others who may be affected by the work
    - Training, those personnel have received, about the tasks.
    - Work permit system for the job.
    - Size, shape, surface characteristics of, and weight of materials, that might be handled.
    - Utility services such as compressed air, steam, water, electricity, PNG etc.
    - Substances used or encountered during the work
    - Physical form of substances used and recommendations as per MSDS.
    - Legal and other requirements.
    - Records of accident(s) & incident(s) and their analyses.
    - Communications from employees and other interested parties.
    - Work place monitoring data
    - Control measures to be in place
    - Safety committee reports.

3) Identify hazards and determine risks. Hazard Identification and risk assessment to pro-active rather than reactive. The broad categories of hazards are Mechanical, Electrical, Substances, Fire/Explosion, Radiation, Toxic Release, Natural Calamities, and Biological Hazards.

4) The following three questions enable hazard identification:
    a. Is there a Source of harm?
    b. Who (or what) could be harmed?
    c. How could harm occur?

5) while identifying the hazards and determining the risks, the following factors shall be considered:
   - Human behavior, capabilities and other human factors.
   - Hazards originating outside the workplace capable of adversely affecting the health and safety of personnel under the control of the organization within the workplace.
   - Hazards created in the vicinity of the workplace by work related activities under the control of the organization.
   - Infrastructure, equipment and material at the workplace, whether provided by the organization or others.
   - Changes or proposed changes in the organization: its activities and materials.
   - Modification to the OH&S Management system including temporary changes
   - Applicable legal obligations relating to risk assessment and implementation of necessary controls.
   - Design of workplace, processes, installations, machinery/equipment, operating procedures and work organization, including their adaptation too human capabilities.

6) However, Hazard identification and risk assessment shall be reviewed before implementing changes to the activity/process/equipment/existing risk control measures. Review of risk assessment shall be carried out during the following situations.

   - During changes from normal operation, new or modified process/installation, changes in raw materials, chemicals etc.
   - During expansion, reduction or restructuring.
   - New or modified legislation.
   - New information/inputs from interested parties.

7) The significant OH&S Risks identified by all departments are to be taken as OH&S objectives of the organization. In addition to this, the individual departments may identify OH&S objectives in a proactive manner. These are reviewed in the management review meeting.
8) Hierarchy of Risk Control Measures: While determining risk controls or considering changes to existing controls, consideration shall be given to reducing the risks according to the following Hierarchy:
   a. Elimination/Substitution
   b. Engineering control
   c. Signage/Warnings and/ or Administrative Controls
   d. Personal Protective Equipments

III. QUALITATIVE ASSESSMENT OF RISKS

a) Legal Concern (LC): The hazard or risk is addressed by applicable legal requirements such as Indian Factories act, State Rules & regulations, Government notifications, etc.
b) Interested Party Concern (IPC): The hazard/risk having a concern expressed by employees, Neighbors, local residents.
c) Business Concern (BC): Any hazard and Risk which will result in
   - Fatal accidents/severe damage to human health and safety.
   - Damage to property resulting in loss of production.
   - Huge financial implications.
d) Emergency potential Concern (E): Potential emergency situations which result in loss or damage to humans/property/environment.

Any Hazard /Risk which is associated with a Legal Concern (LC), Interested Party Concern (IPC), Business Concern (BC), and Emergency potential Concern (E) are considered as "Significant Risks" by default.

IV. QUANTITATIVE ASSESSMENT OF RISKS

a) RISK PRIORITY NUMBER (RPN) is obtained by multiplying the following factors: RPN=A*B*C. Where;

   A: Frequency & Duration of exposure
   B: Severity & Likelihood
   C: Number of people that could be affected.

b) While assigning A, B, C ratings, Consider the adequacy and effectiveness of existing risk control measures.
c) Refer to following tables for allocating values for A, B, C

TABLE I (A) FREQUENCY OF ACTIVITY VS. DURATION OF EXPOSURE

A (Frequency & Duration of Exposure)					
Duration of exposure	Frequency of Activity				
	Every shift	Daily	Weekly	Monthly	>1month
<30 min	4	3	2	1.5	1
30min-2hr	6	5	4	3	2
2-4hr	8	6	5	4	3
>4hr	10	8	7	6	4

d) Severity of harm: The risk from the hazard is determined by estimating the potential severity of the harm and likelihood of the occurrence of that harm.

TABLE II (B) SEVERITY & LIKELIHOOD

B (Severity & Likelihood)					
Likelihood	Fatal/Total Permanent disability	Permanent disability	Temporary disability	Noticeable and requiring First Aid	Physical discomfort
Certain	200	150	100	40	10
Quite Possible	150	100	70	20	5
Unusual but Possible	100	50	30	10	2
Remote	50	20	5	2	1
Improbable	5	2.5	1.5	1	0.5

e) Number of People affected:

TABLE III (C) NUMBER OF PEOPLE THAT COULD BE AFFECTED

C(Number of people that could be affected)	
Number of people affected	Rating
1-10 people	3
10-50 people	4
>50 people	5

f) Risk Based Control Plan:

TABLE IV RISK BASED CONTROL PLAN

RPN	Risk Category	(Risk based Control Plan): Decision/ What needs to be done?
<99	Very Low Risk	• These risks are considered acceptable. No further actions are necessary other than to ensure that controls are maintained.
100-199	Low Risk	• Acceptable provided the existing risk control. • No additional controls are required unless they can be implemented at very low cost
200-1000	Medium Risk	• Look into the possibility of reducing the risk level within the acceptable level. • The risk reduction measures should be implemented within a defined period. • Arrangements should be made to ensure that the controls are maintained.
		• Substantial efforts should be made to reduce the risk levels. • The risk reduction measures should be implemented urgently within the defined time

1001-3000	High Risk	period. • It might be necessary to consider suspending or restricting the activity. • Considerable resources might have to be allocated towards additional control measures. • Arrangements should be made to ensure that the controls are maintained.
>3000	Very High Risk	• These Risks are Unacceptable. • Substantial improvements in risk controls are necessary. • The work activity should be halted until risk controls are implemented. • If it is not possible to reduce the risk, the work should remain prohibited.

V. CONCLUSION

The Hazard Identification and Risk Assessment by Qualitative and Quantitative method is the effective tool to reduce the hazards and risks in any industry. It is applicable to all the hazardous areas. It also helps to develop a safety policy, planning and modifying the safety objectives of the industry. During the safety audit, Hazard Identification and Risk Assessment play a major role. It helps the industry to provide the control measures for the hazards and risks with respect to time as it prioritize the risks as Very low risk, Low risk, Medium risk, High risk, and Very High risk. The accidents in the workplace will be reduced and the production will be improved as the skilled employees will be free from injuries.

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