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Hazard Identification and Risk Assessment in Petrochemical Industry

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Abstract: ***This study aims to investigate the potential hazards and accidents that might occur at Petrochemical industry. This research adopts HIRA to perform Hazard Identification and Risk Assessment in the workplace. This risk assessment tool will identify possible hazard involved in each task in every departments. HIRA is a proactive process to identify hazards and eliminate or reduce the risk of injury or illness to workers and damage to property.***
Once the hazard has been identified, risks involved will be estimated and categorized. If the estimated risk falls in a category, which is higher than the low risk category, then possible control measures will be recommended.
HIRA is a method by which we try to identify the main hazardous substance and then try to reduce the effect of the hazard.
Keywords: Hazard Identification, Petrochemical, health, safety

I. INTRODUCTION

Petrochemical industry plays a vital role in economic growth in nation. They supply basic and useful raw materials to other industries and final goods to the individual consumers. Nowadays, petrochemical products influence the entire life and cover almost every area such as housing, clothing, agriculture, construction, automobile, irrigation, medical equipment, electrical and electronics, etc. Petrochemical products are derived products of several chemical materials. More specifically, hydrocarbons are the main chemical components of petrochemicals, which in turn, are derived products of natural gas and crude oil.

Petroleum refers to all those compounds that can be derived from the petroleum refinery products. The petrochemicals sector is a major segment of manufacturing industry. Oil and Natural gas are supposed to be the man sources for most petrochemicals because they are economical and readily accessible. Processes and operations in petrochemicals industry are intrinsically hazardous due to potential energy that is stored in the chemicals. Chemical transformations during processing are either exothermic or endothermic reactions. Safe operations of process plants depend entirely on a complete understanding of the risk associated with the chemical. As large amount of flammable gases and liquids are handled and stored and because of chemical reactions involved in the manufacturing process, petrochemical plants are considered to be highly hazardous.

Industries like chemicals, petrochemicals, petroleum refineries, fertilizers, pesticides, distilleries etc, where a large quantity of flammable and explosive materials are manufactured, stored and handled and large number of highly toxic materials are used and handled give rise to a serious risk to the workers, public and environment around the plant. The possible hazards are like explosion, BLEVE, Confined and Unconfined Vapour Cloud explosion. In engineering industries, flammable materials like LPG, Pentene, Butane and acetylene are stored and handled in bulk quantities. In such industries, accidents can occur despite efforts to prevent them. They may give rise to suffering and damage. So, a great concern is needed to minimize the occurrence of these hazards and for this purpose it is very necessary to analyse the risk associated in usage and handling of hydrocarbon. In this project Hazard Identification and Risk Assessment has been performed in order to make the work place safe. HIRA is a process of defining and describing hazards by characterizing their probability, frequency of occurrence and severity and evaluating adverse effects, including potential losses and injury. It is a moral and legal responsibility of any employer to ensure identification of hazards and take required steps to minimize the risk to ensure Zero accidents at workplace. In many industries there is legislative requirement for risk assessment to be undertaken for all hazardous equipment, machinery and operations.

Liquified Petroleum Gas (LPG) is one of the widely used gases in industries for various applications. LPG is stored as liquid under pressure in storage tanks. LPG is used as a raw material in manufacturing of polymers. LPG is a highly flammable gas which results in fire and explosion in case if it leaks during the unloading and loading process and from storage container. The various fire and explosion scenarios associated with LPG are jet fire, pool fire, flash fire, Confined Vapour Cloud Explosion (CVCE), Unconfined Vapour Cloud Expansion (UVCE), BLEVE. In LPG storage system fire and explosion accidents happen due to leakage from tanks or pipelines.

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II. HAZARD IDENTIFICATION AND RISK ASSESSMENT

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 industries and workplace consist 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.

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.

HIRA is a combination of deterministic, probabilistic and quantitative method. The deterministic methods take into consideration of the products, the equipment and quantification of the various targets such as people, environment and equipment. The probabilistic methods are based on the probability or frequency of hazardous situation apparitions or on the occurrence of potential accidents. The quantitative methods analyse various data numerically.

The steps involved in HIRA are

1) Classify Work Activities
2) Hazard Identification
3) Risk Assessment
4) Risk Analysis
5) Monitor and Review

III. WORK ACTIVITIES CLASSIFICATION

The first step in the project is to gain knowledge about the process in which the project work is carried out. Every activity carried out in the plant is studied. This study includes the working principle of the equipment, the working condition and the standards to be followed, safety precautions taken, etc. The activities maybe routine or non-routine. Define the activity, their sub-activity and operations. Department heads in association with the core team member shall list out the routine and non- routine activities, activities of all having personnel access to the workplace in respective department and gather the following information wherever possible, for each work and activity.

1) Tasks being carried out: their duration and frequency.
2) Location where the work is carried out.
3) Who carries out the task.
4) Others who may be affected by the work.
5) Size, shape, surface characteristics, and weight of materials that might be handled.
6) Physical of substances used and recommendations as per MSDS.
7) Records of accidents and incidents and their analysis.
8) Workplace monitoring data.
9) Safety committee reports.
10) Communication from interested employees and other interested parties.

Work activities can be classified in accordance with their similarity, such as,

a) Geographical or physical areas within/ outside the premises.
b) Stages n production/ service process.
c) Not too big e.g., building a car.
d) Not too small e.g., fixing a nut or
e) Defined task e.g. loading, packing, mixing, fixing the door.

IV. IDENTIFICATION OF HAZARDS

Hazard identification is a proactive process to identify hazards and eliminate/ reduce the risk of injury/ illness to workers and damage to property, equipment and the environment. It also allows us to show our commitment and due to diligence to a healthy and safe workplace. We must identify hazards and potential hazards in the workplace in order to be able to take action to eliminate or control them. This is the process of examining each work area and work task for the purpose of identifying all the hazards which are inherent in the job. This is the first step in a process used to assess risk.

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It is the process of identifying hazards, which forms the essential first step of risk assessment. There are two possible purposes in identifying hazards:

1) To obtain a list of hazards for subsequent evaluation using other risk assessment techniques. This is sometimes known as "failure case selection".
2) To perform a qualitative significance of the hazards and the measures for reducing the risks from them. This is sometimes known as "hazard assessment".

During the hazard identification stage, the criteria used for the screening of the hazards will be established and possible hazards and accidents will be reviewed. For this purpose, this facility will be divided into several sections. Furthermost, the identified hazards will be classified into critical and non- critical hazards. It is of great importance that the hazards considered non- critical are clearly documented in order to demonstrate that the events in question could be safely disregarded.

The outcomes of the hazard identification process are to:

a) Identify all major incidents which could occur at the facility.
b) Provide the employer and workers with sufficient knowledge, awareness and understanding of the causes of major incidents to be able to prevent and deal with them.
c) Provide a basis for identifying, evaluating, defining and justifying the selection or rejection of control measures for eliminating or reducing risk.
d) Show clear links between hazards, causes and potential major accidents.
e) Provide a systematic record of all identified hazards and major accidents, together with any assumptions.

V. RISK ASSESSMENT

It is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of the harm and the likelihood of this occurring. Risk assessment is the determination of risk related to a well- defined situation and a recognized hazard.

Qualitative Assessment- Performed by checking the identified risks with Legislative Concern, Interested Party Concern, Business Concern and Potential Emergency Concern.

Quantitative Assessment- Performed using Risk Priority Number (RPN), which is obtained by the product of frequency and duration of exposure to hazard, severity of harm and number of people that could be affected.

There are certain logical steps to take when carrying out a risk assessment

1) Identify the hazard
2) Measure harm level
3) Evaluate the risks arising from the hazards and decide whether existing precautions are adequate or more should be done.
4) Record the findings.
5) Inform the departments about the findings.
6) Review the assessment from time to time and revise if necessary.

Risk Assessment is the systematic identification of hazards associated with work and the evaluation of the risks associated with those hazards. A hazard- risk assessment shall take into account of all work activities and consideration shall also be given to anyone else who could be affected by the work activities.

VI. RISK= PROABABILITY× EXPOSURE× CONSEQUENCE

A. *Procedure for Risk Assessment*

Follow these five steps:

1) Look for the hazards through job safety analysis for all critical operations.
2) Decide who might be harmed and how.
3) Evaluate the risks and decide whether the existing precautions are adequate or whether more should be done.
4) Record your findings.
5) Review your assessment and revise it if necessary. All risks to b brought to ALARP after providing significant control measures.

Process of evaluating the risks that arising from a hazard, then taking into account the adequacy of any existing controls and deciding whether or not the risks are acceptable.

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Table Style

Prioritising Risks					
Severity	Probability				
	5	4	3	2	1
5	25	20	15	10	5
4	20	16	12	8	4
3	15	12	9	6	3
2	10	8	6	4	2
1	5	4	3	2	1

B. Risk Analysis

The information collected in the risk assessment step will be analysed in this step. The desired outcome of risk analysis is the ranking of hazards. This highlights the hazards that should be considered a current priority of your emergency management program.

A technique for analysing the risk associated with potential failures is by calculating RPN (Risk Priority Number).

C. Risk Priority Number

Risk Priority Number is the mathematical product of the numerical Severity(S), Occurrence(O) and detection(D) ratings.

1) *Severity (S):* Severity is an assessment of how serious the effect of potential failure modes. Severity rating with the higher number represents the higher seriousness of risk which could cause death.
2) *Occurrence (O):* Occurrence rating for FMEA are based upon the likelihood that a cause may occur based upon past failures and performance of similar system in similar activity. Occurrence values should have data to provide justification.

VII. MONITOR AND REVIEW

Risk control is the elimination or inactivation of hazard in a manner such that the hazard does not pose a risk to workers. Hazard should be controlled at their source where the problem is created. According to the measures taken to protect the plant from risk exposure are:

1) *Excellent:* The facility has taken measures exceeding industry standards and the best practices. Loss potential is considered significantly reduced.
2) *Good:* The facility has taken measures that are consistent with industry standards and best practices. Loss potential is considered to be average.
3) *Fair:* The facility has taken some measures that approach industry standards and best practices; however, deficiencies exist. Loss potential is considered somewhat increased.
4) *Poor:* The facility has major deficiencies and does not approach industry standards and best practices. Loss potential is considered to be significantly increased.

Having identified the hazards in your workplace, assessed their risks and reviewed the existing controls, all hazards must be managed before people are hurt, become ill or there is a damage to plant, property or the environment. The management of risks in the workplace requires eliminating risks so far as possible, then risks should be minimised, so far as reasonably practicable.

All hazards that have been assessed should be dealt in order of priority. The most effective control option/s should be selected to eliminate or minimise risks. The Hierarchy of Controls ranks control options from the highest level of protection and reliability to lowest. This should be used to determine the most effective control/s.

VIII. RESULTS AND DISCUSSION

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.

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C4 Area- LPG Storage

S. No	Activity	R/NR Activity	Hazard	Risk	Evaluation			Is there any legal requirement	Control measures
					S	O	R=S *O		
1	Bullet boot water draining	R	1. Chocking 2. Valve cannot be closed 3. Draining of LPG with water	LPG accumulation LPG leak Fire if ignition source found	3 5 5	3 1 1	9 5 5	No No No	Plug valve and Gate valve to be provided
2	LPG loading and unloading	R	1. Hose puncture 2. Coupling failure 3. Spark arrestor failure 4. Shut off valve failure 5. Tanker hit the wall	LPG leak LPG leak Ignition of LPG vapour in air Jet fire Damage to the wall	5 5 5 5 1	3 1 4 2 5	15 5 20 10 5	No No No No No	Hydrostatic test to be done. Stopper to be provided.
3	Effluent pumping to CPCL	R	1. Pressure Safety Valve failure 2. Damage in pipeline 3. Corrosion in pipeline	Increase in the pressure- the line may blast LPG leak- Jet fire/ Pool fire LPG leak	5 5 5	2 3 2	10 15 10	No No No	Calibration to be done regularly. Hydrostatic test to be done Copper strip test can be done
4	Blender feed lining up	R	1. CPCL feed line corrosion or damage. 2. RIL feed line corrosion or damage	LPG leak LPG leak	5 5	4 4	20 20	Yes Yes	Maintenance to be done regularly
5	Flare knock pot draining	R	1. Chocking 2. Liquid escape	LPG leak Flames may fall outside and maybe a source of ignition	3 5	5 2	15 10	No No	Plug valve and gate valve to be provided.
6	Recovery of LPG from plant to bullet	R	1.Compressor stress	LPG leak	3	2	6	No	Alignment and noise to be checked regularly. Suction and discharge pressure to be checked regularly.

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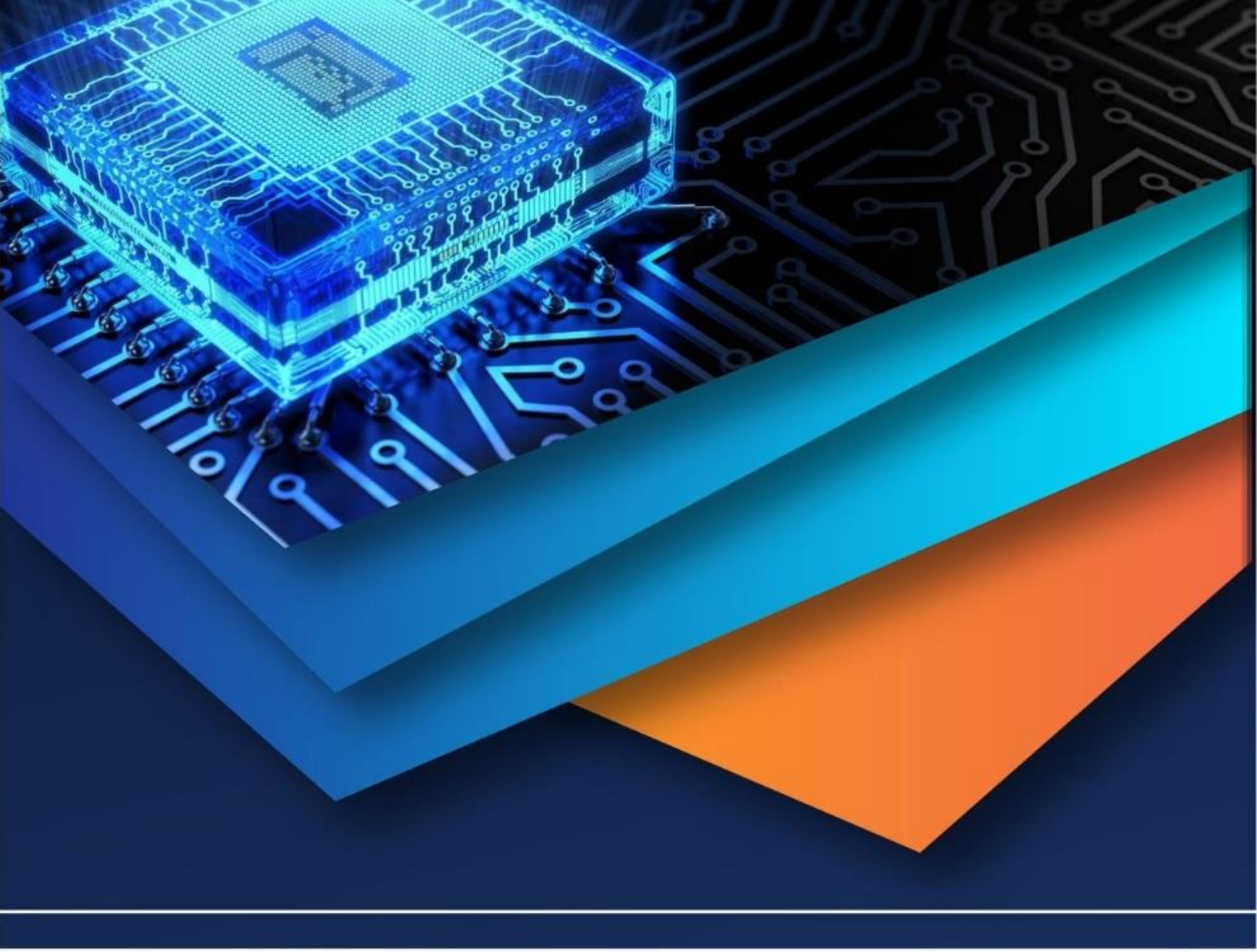
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