IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A STUDY OF GAP ANALYSIS AND PROCESS SAFETY MANAGEMENT AUDIT IN A PROCESS INDUSTRY

Dr. P. SENTHILKUMAR[1], K.MANOGAR[2], K.SIVABALAN[3]
1 PRINCIPAL, 2 ASSISTANCE PROFESSOR, 3 PG SCHOLAR,
INDUSTRIAL SAFETY ENGINEERING
K.S.R COLLEGE OF ENGINEERING (AUTONOMOUS), TAMILNADU, INDIA

ABSTRACT

The purpose of this study is to find out the most possible factor which causes incident in the process industry and thus affecting the safety management in the process industry. The most common feature among the best known companies in the world is safety. In fact, process safety and manufacturing productivity go hand in hand. In the last century, a number of catastrophic accidents have drawn the attention of regulators towards process safety. In several developed, industrialized countries, strict regulations and standards are applied to emphasize process safety. In fact, in such countries, these are the required minimum for maintaining business license and permits. However, in developing and in under developed nations, the issue of process safety and their importance is still being debated. Process safety cannot just be driven by a set of rules, regulations, policies, etc. Multitudes of items are required in establishing and maintaining a safe and a reliable work environment. Such items, though can be expressed readily in paper, are quite arduous to establish in a highly competitive environment. The legislation, the government regulations, banking policies, management commitment, cumulatively share the responsibility in establishing organizations judiciously managing process safety. This paper reviews certain critical aspects in establishing a successful process safety management (PSM) program. Furthermore, the paper reviews the various elements that contribute towards the creation of a worthwhile PSM program.

Keywords: Process Safety, PSM program & Plants safe

1. INTRODUCTION

A recent article "Guidance to Improve the Effectiveness of Process Safety Management Systems in Operating Facilities," published in the Journal of Loss Prevention in Process Industries, summarizes the significant number of loss of process containment incidents that have occurred in the plant in 2020 and 2021. These incidents resulted in substantial damage to the plants in question, caused significant impact on the environment and damage to the reputations of the operating companies involved in the eyes of the public. The article identified a number of factors that led to these events and offered an overall approach for operating companies to improve the effectiveness of their process safety management systems to reduce the potential of future significant incidents occurring. A few fundamental questions that undoubtedly are on the minds of the public living in the affected regions are as follows:

Are these plants safe?

Am I safe to continue living near these plants?

What systems are in place to prevent a similar accident from happening? in the future?

This article examines the relevant issues and factors that need to be assessed to provide robust answers to the questions posed above and handled and the chemicals used in to process feedstock into marketed products. They also must deal with hazards associated with the equipment and the conditions in the plant. How

a facility manages these hazards and the associated risks will determine whether the operation is "safe." examine some of the issues and factors starting with defining several relevant terms.

2. OBJECTIVES

The primary objective of Process Safety Management is to prevent the unwanted release of highly hazardous chemicals/biological agents into locations which could expose employees, students or the public to serious hazards.

Process Safety is an integrated management system approach to evaluate processes that have the potential to cause catastrophic incidents such as fires, explosions or toxic releases.

The program is designed to reduce operational risks within three focus areas: technology, facilities/equipment, and personnel.

The program is based upon OSHA's Process Safety Management (29CFR 1910.119) standard and EPA's Chemical Accident Prevention (40CFR 68) program requirements.

3. LITERATURE REVIEW

3.1 QI *ET AL. (2012)* - CHALLENGES AND NEEDS FOR PROCESS SAFETY IN THE NEW MILLENNIUM

Process industries have made quite a bit of progress in process safety since the tragic night of December 2, 1984 in Bhopal. Nonetheless, incidents continue to occur on a regular basis due to insufficient understanding of the urgency to identify best practices and drive for process safety improvements in the organization. This paper addresses some of the critical challenges in implementing effective safety programs: (a) failure to learn from past incidents and to capture those lessons into process design, procedures, training, maintenance, and other programs, (b) insufficient attention to leading indicators, and (c) an increase in complexity of process operations and lack of communication. In the presence of these challenges, there is a great need to develop better solutions by utilizing good science based approaches and best practice studies. Potential research areas include, but are not limited to, incident database analysis, reactive chemicals, inherently safer design, combustible dust explosion, facility siting, and the flammability of fuel mixtures and aerosols. In addition, an example was presented on LNG industry safety to illustrate that science-based research is needed to ensure the safe operation and to avoid or mitigate unintended consequences.

3.2 SASANGOHAR *ET AL (2018)* – INVESTIGATING WRITTEN PROCEDURES IN PROCESS SAFETY: QUALITATIVE DATA ANALYSIS OF INTERVIEWS FROM HIGH RISK FACILITIES

Written procedures can play an integral role in mitigating risks and hazards in industries such as petrochemical, nuclear, and aviation. However, failure to adhere to procedures has resulted in major incidents. While there have been multiple studies investigating procedures in the aviation and nuclear industries, a comprehensive study of the high-risk industries' use of written procedures is largely absent. This paper documents one part of a large-scale project that addresses this gap by investigating the issues with procedure forms, usage, adoption, and challenges in a wide range of high-risk industries. A grounded theory approach in qualitative data analysis was used to examine 72 interviews with operators of varying roles and experiences across 6 countries and an offshore drilling vessel. Findings reaffirm previous research, suggesting an explanation for the lack of use of procedures due to the abundance of outdated procedures and procedures plagued by information overload. New findings suggest that frequency of the task and the experience level of the worker would impact workers' procedure use. Other unintended consequences associated with written procedural systems included reactive organizational behavior surrounding procedures and a general disconnect between the users and the writers of these documents.

3.3 D. Parker *et al (2016)* – A framework for understanding the development of organizational safety culture

A framework for the development and maturation of organizational safety culture was formulated. The content of the framework was informed by 26 semi-structured interviews with oil and gas company executives, each very experienced in the industry. The form of the framework was based on West rum's [West rum, R., 1996. Human factors experts beginning to focus on organizational factors in safety. ICAO Journal] typology of organisational cultures, which was adapted and extended as proposed by Reason [Reason, J., 1997. Managing the Risks of Organizational Accidents. Ashgate, Aldershot]. The product was a set of short descriptions of each of a number of aspects of organizational safety at each of five levels of safety culture advancement. The framework was assessed for face validity. Theoretical implications and possible applications of the framework are discussed.

3.4 KUMARAN SHANMUGAM & MUSAB ABDUL RAZAK (2022) ASSESSMENT ON PROCESS SAFETY MANAGEMENT IMPLEMENTATION MATURITY AMONG MAJOR HAZARD INSTALLATIONS IN MALAYSIA

The process industry operates in high risks and hazardous environments that impose significant risks on workers' lives, assets-loss, and operational environments. Using the digitalized method for analyzing risk in the process operations to identify and evaluate risk emanated in the working environment is considered as a possible way of providing a warning of deviating conditions in the process environment. From this research, we realized that digitalizing process operations are highly relevant to the process industry, due to challenges such as fire, explosion, and toxic release to the environment. However, the focus on risk analysis using a digitalized method is to support decision-making by assessing and analyzing the risks associated with the operation, designing a technical system, and estimating the industry's accident and possible controlling measures. This research provides a viable solution to the process industry with risk and hazard in their process environment by installing an alarm system on the processing plant, which will give early warning information of unforeseen risk. Some of the benefits of digitalized process operations are the virtually eliminating transcription risk and hazard from the operational environment, the increased copy factor of understanding between process operation and workers, as well as to provide an early warning deviation that will interrupt the operating system. This research's findings have identified a valuable process of the digitizing process industry for useful risk analysis and protection of the operational environment.

3.5 SHUAIQI YUANMING YANGJIANSONG WU (2022) – SAFETY BARRIERS IN THE CHEMICAL PROCESS INDUSTRIES: A STATE-OF- THE-ART REVIEW ON THEIR CLASSIFICATION, ASSESSMENT, AND MANAGEMENT.

Barriers are used in various forms to assure the safety of chemical plants. A deep understanding of the literature related to safety barriers is essential to tackle the challenges in improving their design and management. This paper first provides an overview of the history of the development of the safety barrier concept. Subsequently, this paper elaborates a systematic review of the definition, classification, evaluation, performance assessment, and management of safety barriers in the chemical process industries. Based on the literature review, this study proposes a practical classification of safety barriers benefiting the identification of performance indicators and the collection of indicator- related data for safety barriers. The safety barrier functions are extended and illustrated by involving the resilience concept. Performance assessment criteria are proposed corresponding to the adaptability and recoverability of the safety barriers. Finally, the management of safety barriers is discussed. The roadmap for future studies to develop integrated management of safety and security barriers to ensure the resilience of chemical plants is suggested.

4. METHODOLOGY

Some knowledge can be explicit while some is tacit. It is important that we establish a methodology that allows one to convert information into knowledge in an objective manner:

Causal inference is a process of drawing a conclusion about a causal connection between events based on the condition of effects can be useful in establishing relationship among information at hand.

Ladder of causality provides different levels of insights by converting data and information into knowledge in a more objective fashion.

The model has three levels of causation: association, intervention and counterfactual.

5. CONCEPTUAL FRAME WORK

PSM framework provides a common understanding of requirements for all levels in the organization from senior management through to operational staff and provides a consistent basis for discussion with regulators, insurers and other stakeholders. There are four 'focus areas' defining the key high level components of the PSM framework. Within each of the focus areas are a number of 'elements', 20 in total, which set out the key aspects of the operation that organizations need to get right. Each of these elements contains a number of 'expectations' which set out a more detailed definition of what they need to do in order to assure the integrity of the operation. Focus areas there are four 'focus areas' defining the key high level components of the PSM framework.

6. REVIEW & IMPROVEMENT

Within the review & improvement focus area there are two elements.

6.1. Incident reporting & investigation

An essential aspect of HS&E and process safety performance improvement is learning from incidents and 'near hits' and taking appropriate action to prevent their recurrence.

6.2. Audit, assurance, management review & intervention

Regular review and audit of compliance with the PSM framework is vital to ensure that HS&E and process safety performance continue to meet
the defined targets.

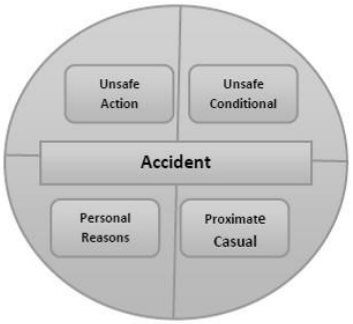
Figure.1. components of the PSM framework

6.3. Safety Policy

Company has a social and legal obligation to provide a safe and health working environment to all his improvement to all his employees.

6.4. Accident

Accident is an undesirable or unfortunate happening that occurs unintentionally and usually results in harm, injury, damage, or loss. The below Figure.2. Shows the four factors of basic accident occurrences



6.5. Incident

An unplanned event that may or may not result in injuries and/or loss.

6.6. Safety

It is a condition which gives you freedom from hazard, risk, accident which may cause injury, damage and loss to material or property damage and even death. Safety is defined as freedom from that condition that can cause injury to persons including death or damage to property or environment. Safety is the state of being "safe" the condition of being protected against physical, social, spiritual, financial, political, emotional, occupational, psychological, educational or other types or consequences of failure, damage, error, accidents, harm or any other event which could be considered non-desirable. Safety can also be defined to be the control of recognized hazards to achieve an acceptable level of risk. This can take the form of being protected from the event or from exposure to something that 19 causes health or economical losses. It can include protection of people or of possessions.

6.7. Injury

It is defined as a harmful condition sustained by the body as a result of an accident.

6.8. Hazard

Inherent property of a substance or an occurrence which has potential to cause loss or damage property, person or environment.

6.9 Near Miss

An event that did not result in an accidental release of a highly hazardous chemical, but which could have, given another "failure." Near misses, sometimes called "precursors," include:

The occurrence of an accident initiator where the protection functioned properly to preclude a release of a highly hazardous chemical; or, the determination that a protection system was out of service such that if an initiating event had occurred, a release of a highly hazardous chemical would have taken place.

7. PROCESS HAZARD

An inherent chemical or physical characteristic with the energy potential for damaging people, property, and/or the environment.

7.1. Risk

In probability of the realization of potential for loss or damage or injury.

7.2. Chemical Hazard

A chemical hazard is a type of occupational hazard caused by exposure to chemicals in the workplace. There are many types of hazardous chemicals, including neurotoxins, immune agents, dermatologic agents, carcinogens, reproductive toxins, systemic toxins, asthmagens, pneumoconiotic agents, and sensitizers. These hazards can cause physical and/or health risks.

7.3. Explosion

An explosion is a rapid expansion of gases resulting in a rapid moving pressure or shock wave. The expansion can be mechanical or it can be the result of a rapid chemical reaction. Explosion damage is caused by the pressure or shock wave. It is sudden buildup of gas pressure that constitutes the nature of an explosion. A mechanical explosion is due to the sudden failure of a vessel containing high-pressure non-reactive gas.

7.4. Fire

Fire is one of the simplest forms of energy, known to mankind. It is the release of heat and light from rapid combination of oxygen and other materials. The reaction between Fuel, Oxygen & Energy is called Combustion. The process of chemical combination of oxygen is called oxidation.

7.5. Flammable Gas

A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 13 percent by volume, regardless of the lower limit.

7.6. Toxicology

Toxicology is the study of the adverse effects of chemical, physical or biological agents on living organisms and the ecosystem, including the prevention and amelioration of such adverse effects. It includes environmental agents and chemical compounds found in nature, as well as pharmaceutical compounds that are synthesized for medical use by humans.

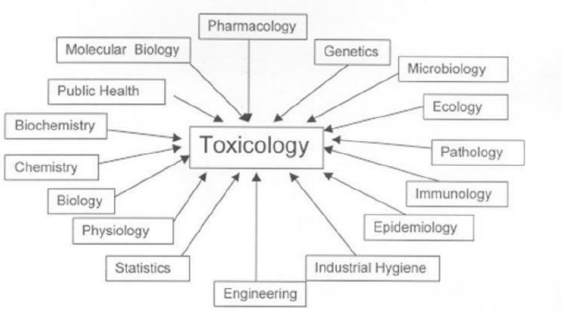


Figure.3. Toxicology

7.7. Working at Height

Falls from height are one of the biggest causes of workplace fatalities and major injuries. Common causes are falls from ladders and through fragile roofs. Work at height means work in any place where, if there were no precautions in place, a Person could fall a distance liable to cause personal injury.

8. CONCLUSION

During this Project work, I have gone through many literatures, Process Safety Management System documents, Various meeting minutes, Statutory and critical equipment list, Work permits, Training documents, Audit Nonconformance and observations, and walk through survey. From this study, I conclude that all the systems are in ―Hyundai Motor India Limited found to be very effective while comparing with Process Safety Management System requirements and they have very good Engineering control, Administrative control and Personal Protective Equipment. Even though, there is some gap in the elements. Hence, I have given some recommendations for the system effectiveness. If the recommendations given through this study will be implemented, they can eliminate the chances of accidents getting happen.

Major Risk prone areas control measure Recommendations:

270 Scanner installation in drop lifter zone
AI Camera installation in Robot zone
Third eye monitoring in confined space works
Biometric access system installation in critical areas
IR camera installation in Paint Booth & Fuel storage tank farms

9. REFERENCE

1. The factories act 1948 (63 of 1948) with the Tamil Nadu factories rules 1950: The Tamil Nadu factories (welfare officers) rules 1953 The Tamil Nadu safety officers (duties, qualifications and services and conditions of service), 2005 published by madras book agency. Page No 115 TO 120 and 350 to 364.
2. Journal Article: Qi et al. (2012) - Challenges and needs for process safety in the new millennium
3. Journal Article: Sasangohar et al (2018) – Investigating written procedures in process safety: Qualitative data analysis of interviews from high risk facilities
4. Journal Article: D. Parker et al (2016) – A framework for understanding the development of organizational safety culture.
5. Journal Article: Kumaran Shanmugam & Musab Abdul Razak (2022) Assessment on process safety management implementation maturity among major hazard installations in Malaysia.
6. Journal Article: Shuaiqi YuanMing YangJiansong Wu (2022) – Safety barriers in the chemical process industries: A state-of-the-art review on their classification, assessment, and management.
7.Journal Article: Agnieszka GajekBruno FabianoNiels Jensen (2021) - Process safety education of future employee 4.0 in Industry 4.0