An Analysis of Industrial Hazards and Pertinent Risk Assessments

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Abstract- *This paper presents the Hazard identification and quantitative risk assessment. The study involves typical manufacturing industry (wire plant) storage of propane and qualitative risk assessment methodology. The present paper suggests that the propane storage facility was found to belong to the "highly hazardous category. The Fault Tree Analysis (FTA) was used to identify all the failure modes, which could result in the occurrence of the undesirable incident more commonly known as the "top event".*

Keywords- Hazard identification, Quantitative risk assessment Manufacturing industries, HAZOP, Fault Tree Analysis, propane.

I. INTRODUCTION

With With increase in the number of industries handling hazardous gases, there has been an equivalent increase in the number of accidents as well as their magnitude in terms of adverse consequences. This has led to a greater awareness of the imperative need for systematic identification and assessment of the potential hazards and associated risks in the industries handling hazardous gases [1]. Over the years, risk assessment has evolved as an important branch of science, which has been defined as a process, which includes both qualitative and quantitative determination of risks and their social evaluation [2]. This risk assessment tool can be used for estimating the risks associated with storage and use of hazardous gas. One such hazardous gas is propane , The storage area is on the outer periphery of operating plant so that the supply tankers do not have to enter the main plant area. This however implies that any ammonia release can easily travel across the boundary and affect the nearby habitation. This paper presents the results of risk analysis for the case of an instantaneous accidental release of ammonia under different prevalent weather conditions from a pressurized vessel.

II. OBJECTIVE

The objective of present study is as follows
(a) HAZOP Study in propane storage tank.
(b) Fault tree analysis of propane storage tank

III. HAZARD IDENTIFICATION & HAZARD ANALYSIS

A Hazard is generally realized as a loss of containment of a hazardous material. The routes for such loss of containment can include release from pipe fittings containing liquid or gas, releases from vents, relief & release from vessel rupture. Adhering to good engineering practices alone may not be adequate for controlling plant hazards thus, a variety of techniques of hazard identification & probability of their occurrence have been developed for analysis of process systems and operation`s. The main motto of hazard identification is to identify & evaluate the hazards & the unintended events, which could cause an accident. In hazard identification & quantification of probability of occurrence it is assume that they will perform as designed in the absence of unintended events (component & material failure, human errors, external event, process unknown) which may affect the plant & process behavior. The figure 1(a) and 1 (b) shows hazard and risk study progression and process of risk assessment respectively

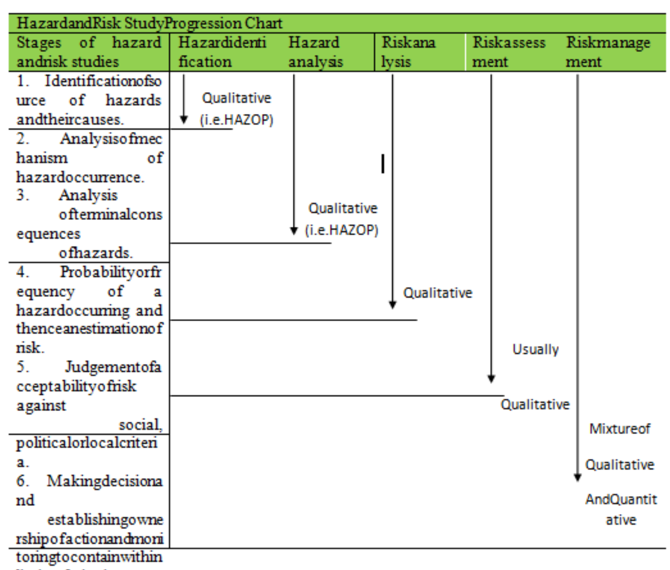


Figure 1 (a): Hazard and risk study progression chart

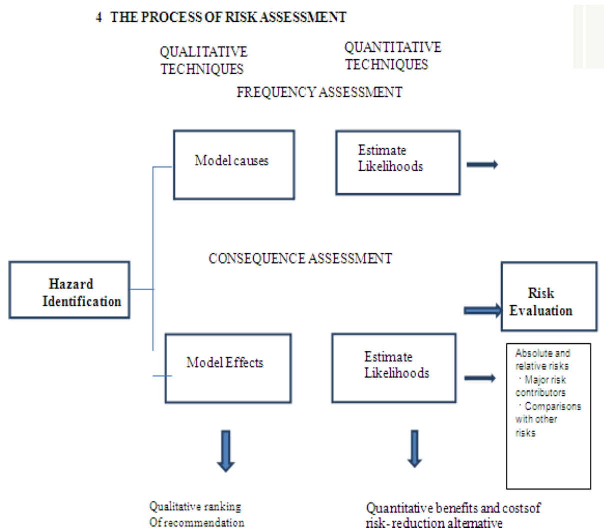
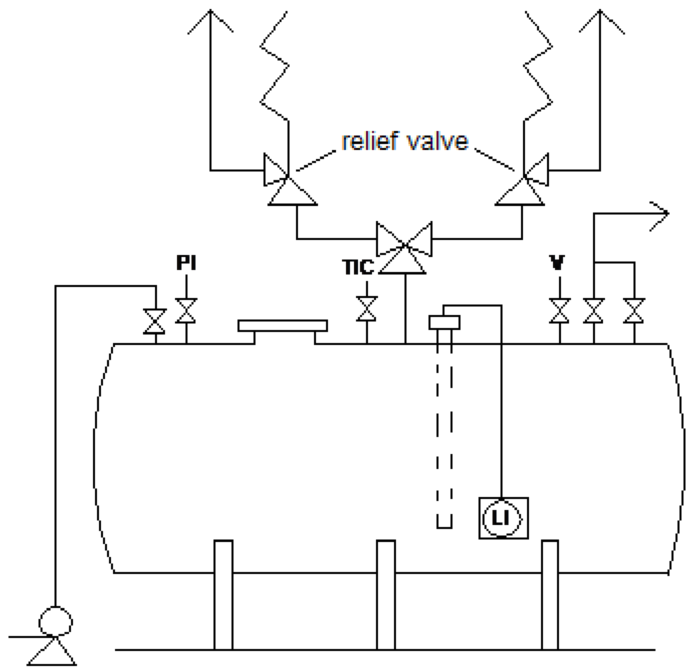


Figure 1 (b):Process of risk assessment

IV. METHODOLOGY

Analysis of the risk posed by the storage facility was carried out in several steps. The first step was the identification of factors, which can contribute to the occurrence of the potential accident scenarios. This was performed by HAZAN technique. The HAZAN techniques employed were Fire Explosion and Toxicity Index (FETI) for hazard ranking and Hazard and Operability Studies (HAZOP) for identifying the probable hazards, their associated causes and consequences at every stage of the process. This is followed by a detailed fault tree analysis, which depicts all possible routes for the occurrence of the probable scenario, commonly referred to as the top event. The top event probability was calculated using both probabilistic approach as well as the fuzzy logic approach. The most important aspect of the fuzzy logic approach is the way in which imprecision is handled. Fault Tree Analysis (FTA) leads to all possible minimum figure 2 is presented in the following combinations of basic human, instrument and equipment failures called minimal cut sets, which could lead to the occurrence of the “top event”. The end result of this analysis is a set of critical basic failure events and the failure rates of each of these events significantly affect the failure rate of the overall system. The analysis gives the system designers a set where the effort in improvement can be best focused. In this paper, fuzzy set theory has been used to define the probabilities of various basic events. The probability of the top event calculated, thus takes into account the uncertainties associated with the basic events. Importance of fuzzy set theory in fault tree analysis has been demonstrated with respect to failure analysis of structures [15]. This is followed by sensitivity analysis to check the effect of recommendations on the top event probability. The results obtained from the studies based on the above methodology for an propane storage facility as shown in



V:vent line;
PI: pressure indicator;
LI: level indicator;
TIC: temperature indicator
Figure 2. Schematic sketch of Propane storage facility.

V. HAZARD AND OPERABILITY STUDY (HAZOP):-

HAZOP is a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation. The HAZOP technique was initially developed to analyze chemical process systems, but has later been extended to other types of systems and also to complex operations such as nuclear power plant operation and to use software to record the deviation and consequence. A HAZOP is a qualitative technique based on guide-words and is carried out by a multi- disciplinary team (HAZOP team) during a set of meetings which is shown in table 1.

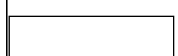
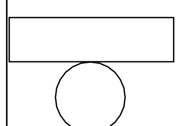
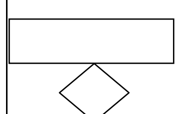
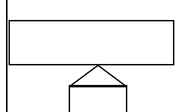
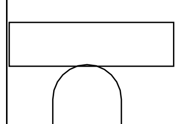
Table1Guide-words, Meaning and comments.

Guide Words	Meanings	Comments
NO or NOT	The complete negation of these intentions	No part of the intentions is achieved but nothing else happens.
MORE LESS	Quantitative increases or decreases	These refer to quantities + properties such as flow rates and temperatures as well as activities like „HEAT" and „REACT".
AS WELL AS	A qualitative increase	All the design and operating intentions are achieved together with some additional activity.
PART OF	A qualitative decrease	Only some of the intentions are achieved; some are not.
REVERSE	The logical opposite of the intention	This is mostly applicable to activities, for example reverse flow or chemical reaction. It can also be applied to substances, e.g. „POISON" instead of „ANTIDOTE" or „D" instead of „L" optical isomers.
OTHER THAN	Complete substitution	No part of the original intention is achieved. Something quite different happens.

VI. FAULT TREE ANALYSIS (FTA)

It is a method to represent the logical combinations of various systems which lead to a particular outcome (top event).It is a graphic model that determines various combinations of equipment faults and failures that can result in an accident. This is a sophisticated form of reliability assessment and it requires considerable time and skill. The procedure is to start from a selected undesirable top event such as 'gas coming out of a scrubber' and then trace it back to the combination of faults and conditions which could cause the events to occur. Apart from identification of hazards, it is widely used for quantitative risk analysis. It will be necessary to obtain meaningful failure data of each component to arrive at the frequency of occurrence of the 'top event'. In fault tree analysis, abnormal operations are assumed in normal operations of a plant. The ultimate abnormal event (such as gas leakage) is shown in a rectangle at the top. Then all combinations of individual failures that can lead to that abnormal event are shown in the logical format of the Fault Tree. By estimating the individual failure probabilities and then using the appropriate arithmetical expressions, the probability of the top abnormal event can be calculated or predicted. This Fault Tree Analysis makes it easy to investigate the impact of alternative preventive measures. Fault tree is developed from top to bottom through a series of symbols which define the flow of logic from the base causes of an event itself. Detailed' probability data are most desirable. This method of Fault Tree Analysis was developed by Bell Laboratories (USA) in 1961 to predict potential catastrophic events which could occur with the Air Force. It is more useful to assess chemical hazards. Without specific Fault Tree symbols (refer table 2), a schematic diagram of one top event (possibility of fire) is shown in table 2.

Table 2 Fault Tree symbols

Fault tree symbols	Type	Description
	Node Textbox	Contains the text for all FT node
	Basic event (primary failure)	A event Random Failure (internally)
	Basic event (Secondary failure)	An externally induced failure
	Normal event	Expected event in system operation normally
	AND Gate	The output occurs only if all of the Input occur together

VII. RESULTS & DISSCUSSION

This section describes results which are as follows

Guide Word	Deviation	Possible Cause	Consequences	Action Required
No	No Material	No Material in Tanker initially Material Completely Transfer due to operators error	Pump Cavitation Vacuum in Road Tanker	Weighting of tanker on entry Checking of rotogauge and document Connect vapor line to tanker for equalization Display decanting procedure with precautions
Less	Less material	Material received is less than normal consignment	Chances of early emptying of tanker.	Check level by rotogauge.
More	More material	Less size tanker. Over filling of tanker	Overfilling of tank. Thermal expansion of liquid locked in pipeline. Increase of tanker pressure.	Calibrate rotogauge periodically Check for adequate capacity of tanker warm supplier

The figure 3(a) and 3 (b) shows fault tree analysis for release of propane from storage tank.

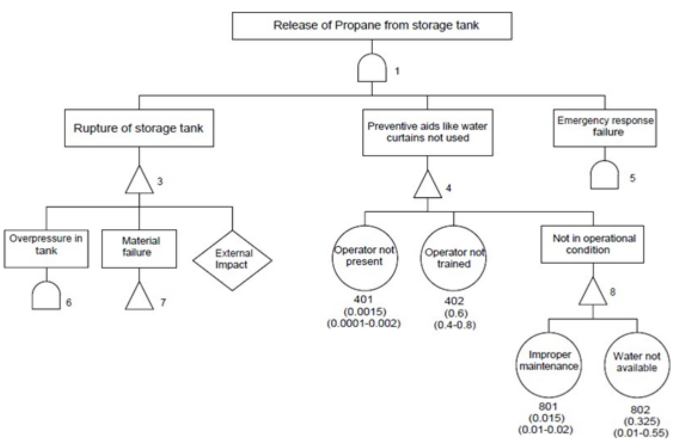


Figure 3 (a) fault tree for release of propane from storage tank.

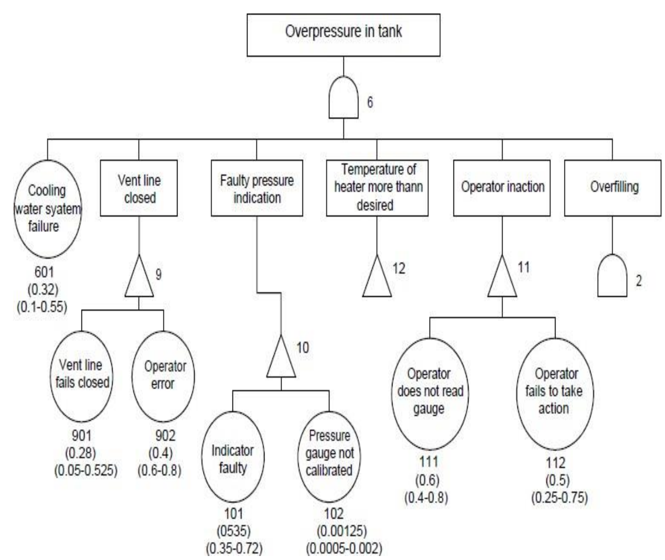


Figure 3 (b) Fault tree for release of propane from storage tank.

VIII. CONCLUSIONS

This report has provided a useful overview of the majority of the hazard identification Techniques and quantitative risk assessment was performed for propane storage facility using quantitative risk assessment and fault tree analysis approach. Based on the hazard identification analysis, the storage section was found to belong to “high” hazard category with respect to both F&EI and TI. Since propane is stored under pressurized conditions, accidental rupture would lead to instantaneous dispersion of propane into the surrounding atmosphere. The release of propane into the atmosphere resulting from rupture of the storage vessel was identified as the top or unwanted event. Fault tree analysis technique was used to identify the combination of basic events responsible for the top event occurrence. The top event probability was calculated using both the conventional probabilistic approach. The hazop study was developed to identify hazards in a process plant and to identify operability problems which though not hazardous, could compromise the plants ability to achieve design productivity. The data require in hazop study is detailed plant description such as drawing, procedures and flow charts & the results are the team findings which include identification of hazard and operating problems recommended change in design, procedures etc. Fault Tree Analysis is a deductive technique that focuses on one particular event and provides a method for determining causes of that accident event. The fault tree itself is a graphic model that displays the various combinations of event. The Nature of result is Qualitative with quantitative potential it can be evaluated quantitatively when probabilistic data are available.

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