APPLICATION OF RISK MANAGEMENT POLICY FOR CHEMICAL PLANT

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Reprinted from Proceedings of The First National Conference on Chemical Hazard Prevention Technology, May 1994, pp. 5-1 ~ 5-8

APPLICATION OF RISK MANAGEMENT POLICY FOR CHEMICAL PLANT

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ABSTRACT

Society is becoming increasingly aware of many chemical plant related hazards heretofore unknown or ignored. The abundance and severity of these hazards dictates the need for a structured plan to mitigate risks. An organized body of information concerning risk, if available to plant officials from top to bottom level, would support this plan. This paper will address on the essential features for the development of a risk prevention and management plan to ensure the safety of a chemical plant.

A good risk prevention and management plan should be able to answer the following questions:

(1) which kind of hazard or risk we try to prevent and/or mitigate;
(2) how can the hazard or risk happen;
(3) what is the people attitude to the hazard or risk;
(4) what is the current safety policy implemented in the plant; and
(5) how can the risk reduction benefit to the plant.

The approach consists principally of defining the specific features under each of the above five questions, increasingly detailed deductions which qualitatively and/or quantitatively solve the questions. For example, the specific features of the hazard or risk being concerned are hazard or risk itself and magnitude of the hazard or risk. To find the solution of how can the hazard or risk happen, we must be able to identify the cause of the hazard or risk and the situation in which hazard or risk is encountered. To know the people attitude to the hazard or risk, we must investigate the manner in which hazard or risk is perceived and the responsibility of risk or safety management in which the top management is involved. For the current safety policy, the items should be discussed are what is the way the hazard or risk is already managed, how many dollars expended to manage the hazard or risk, and what safety training program exists. Finally, analyzing the benefit to the risk reduction can be based on the ratio of dollar damage to dollar benefit such as increasing the productivity with better quality by reduction human errors, increasing availability of the system, and reducing the loss caused by the accident.

This paper provides a systematic approach for developing the safety management policy of a chemical plant, which can be valuable in at least three ways. First, this paper introduces a systematic way to quantitatively represent risk. Second, the top management might learn to

think in a broader domain-situation of risk, ratio of dollar damage to dollar expanded to reduce risk, source of risk, better quality and more productivity etc. And third, with the basis or framework for rational decision making by identifying a more complete array of risks, the top management will be able to address risk/safety management in a broader domain and to recognize the actual involvement (i.e., he or she really want to make it safer) which is the essential feature of the success of any safety management policy.

Key words: hazard, risk, safety, management

I. INTRODUCTION

People in Republic of China live longer and healthier lives today than at any time in Chinese history. Yet they seem preoccupied with risks to health, safety and the environment. With increasing aware of many chemical plant related hazards heretofore unknown or ignored, the public agenda is now crowded with unresolved issues of these chemical related hazards. For a long time, our decision makers have also been dealing with the problems on a reactive basis; namely, reacting only to the aftermath and cleanup, or at best preparing for emergencies and not planning ahead to try to avoid the risk. The abundance and severity of these hazards dictated the decision makers need to take preventative measures prior to the occurrence of an incident.

A traditional safety management system has been utilized throughout the major chemical plants. The traditional safety typically deals with personnel safety and activities related to protective gear, fire and emergency training, and such. These activities, although extremely important, do not include all the elements necessary for preventing major accidents. For meeting the challenge to mitigate risks by preventative measures, the decision makers will have to change their agenda from traditional safety management policy to total safety management policy.

The total safety management system consists of traditional safety management system and risk analysis technique. The total safety management system applies a risk analysis technique to identify, understand and control the process hazards for the prevention of major incidents having the potential for personnel injuries and damage to equipment, facilities and the environment. Hence, a total safety management system is a product of a relatively new philosophy which prefers a long-lasting and well-planned effort to minimize or avoid future risks, as opposed to the reactive approach associated with traditional safety management system.

With the application of the risk analysis technique, the total safety management system is able to identify hazard and provide mitigation measures (if necessary) to minimize or avoid future risks. Hence, the total safety management system is also named as a risk management system.

To meet the challenges of larger plants, more complex processes and increased throughput in today's chemical industry, risk management system is definitely needed to ensure the operational and environmental safety.

II ANALYSIS MATERIAL AND METHODOLOGY

For the past twenty years, a lot of chemical related disasters have been occurred around the world. In American, from 1974 through 1977 an insurance company paid claims on 83 chemical plant explosions, each of which exceeded US. $100,000. Fifty percent of these involved combustion reactions, forty percent resulted from runaway chemical reactions, and ten percent were brought about by metal failure such as corrosions or overheating, poor equipment layout and design, and inadequate knowledge of the chemicals being handled [1].

Records show that at least eight incidents of fire, explosion, and drum over pressurization occurred at American Department of Energy (DOE) facilities from 1970 through 1985 [2]. An ignition source or a reaction between incompatible materials triggered each incident; the hazardous waste constituents of the mixed radioactive waste served as fuel. Of particular interest is the explosion of a 54 gallon drum in a truck at Argonne National Laboratory (ANL)-East on December 2, 1976. Apparently two solvents, xylene and pentane, diffused through a polyvinylchloride pouch and collected in the drum's void space. The ignition source was an electrical discharge, possibly either static electricity from the plastic bags containing the solid radioactive waste or electricity generated by piezoelectric crystals from a discard ultrasonic cleaner. Fortunately, no one was near the truck at the time of explosion, and there was no spread of contamination [3].

Consistent with the other industries, an increase in the number of catastrophic oil and petrochemical industry incidents occurred during the 1980's. Because of the abundance and severity of these hazards, it was recognized that more comprehensive and cost effective safety system were needed to identify and understand hazards that might lead to major incidents. This led to involvement in the improvement of internal standards and support of the American Petroleum Institute's RP 750 "Guidelines for Management of Process Hazards" [4].

A good risk prevention and management plan should be able to answer all the five questions listed below:

(1) which kind of hazard or risk we try to prevent and/or mitigate;
(2) how can the hazard or risk happen;
(3) what is the people attitude to the hazard or risk;
(4) what is current safety policy implemented in the plant; and
(5) how can the risk reduction benefit to the plant.

In other words, a risk prevention and management plan should be able to manage risks based on the nine characteristics of risk [5], namely

(1) the situation in which hazard or risk is encountered;
(2) the cause of the hazard or risk;
(3) the hazard or risk itself;
(4) the manner in which the hazard or risk is perceived;
(5) the magnitude of the hazard or risk;
(6) the risk management responsibility;
(7) the dollars expend to manage the hazard or risk;
(8) the ratio of dollars damage to dollar benefit;
(9) the way the hazard or risk is already managed.

For example, a person has to be in a hazardous situation before he or she can be affected by the hazard. Clearly, a person involved in an occupationally related accident has to be working there (or at least visiting the place). This risk can be avoided if avoiding the situation is possible and if it is cost-effective. For instance, a chemical plant can be complete automation to eliminate the direct human contact to the machinery for preventing personnel injuries. Hence, a risk management system is a system to manage risks through the use of hazard/risk analysis technique to identify the risk, to quantify it perhaps, to take action to reduce its probability of occurrence, and to mitigate the consequences.

In 1990, Occupational safety and Health Administration (OSHA) published a document entitled, "Process Safety Management of Highly Hazardous Chemicals" [6]. In this document, OSHA shows the essential twelve elements for a risk management system. The twelve essential elements are mechanical integrity, safe work practices, pre-startup reviews, management of change, incident investigations, auditing, training, contractors, emergency response, process safety information, process hazard analysis, and operating procedure. Most of the elements shown in above are not new, they can be found in the traditional safety management system too. The most important new ingredient in the 1990 OSHA program is the element of process hazard analysis. In 1989, the Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIchE) published a document entitled "Guidelines for Chemical Process Quantitative Risk Analysis" [7]. This document discusses the current practices for the process risk analysis.

Currently, lots of hazard analysis techniques, from qualitative to very complicated calculation, are available for risk evaluation; however, the two having usually been used for conducting process risk analysis are Failure Mode and Effects Analysis (FMEA) and Hazard and Operability Study (HAZOP). The FMEA technique is a bottom to top analysis procedure, which identified the potential failure modes of critical components and analyzes the effects on the system (or plant) caused by the failures. For the HAZOP technique, it uses a group of guide words to hypothesize the abnormal conditions and conducting a consequence analysis based on the hypothesis conditions. If the hypothesis case were identified as a major incident, the mechanism to cause this case was deduced through the use of process information and system engineering technique.

Decision regarding resolution of identified hazards will be based on assessment of the risk involved through the use of the risk analysis techniques stated above. To aid in the achievement of the objectives of system safety, hazards will be characterized as to hazard severity categories and hazard probability levels, when possible. Hazard severity categories are defined to provide a qualitative measure of the worst credible mishap resulting from personnel error, mechanical failure, or other malfunction as shown in Table 1 [8]. Hazard probability categories, as shown in Table 2 [8], are defined to provide a qualitative measure of the likelihood of hazard when quantitative probabilities are not available. Identified hazards will be categorized by hazard severity and hazard probability and given a corresponding Risk Assessment Code (RAC) from Table 3 (as an example) [8], for the purpose of prioritizing the hazards for corrective action. Collectively, these will form the basis for establishing priorities and resource expenditures for controlling identified hazards.

It should also be realized that the implementation of a risk management system is a major task which requires systematic application of good management practices. To support this system, the organized body of information concerning risk should to available to plant officials from top to bottom level through the use of Total Quality Management (TQM). The TQM consists of commitment, policy, self-assessment, objectives/targets, improvement plan, analysis of result (audit) and management review [4]. The commitment and policy elements are implemented from the top down to provide a management signal supportive of program missions/goals and required resources. The actual involvement of the top management(i.e., he or she really want to make it safer) is the essential feature of the success of any safety management policy.

III RESULTS AND DISCUSSIONS

A number of model total safety management systems are in existence in the United States and the other parts of the world. Depending on the safety goal and characteristics of the chemical plant, the existing total safety management systems are not identical although they are similar. Two existing total safety management systems will be described below.

Mobil has implemented a process safety management (PSM) system to ensure the integrity and continuity of its worldwide operations [4]. The introduction of PSM adds two major benefits to the original Mobil safety system. First, PSM provides a large amount of hazard study data that can be collected, prioritized and shared across division activities. Second, all of the elements of PSM can be applied to specific units on a risk prioritization basis as determined by the overall corporate wide program.

Using this approach, PSM principles can be applied in depth to refinery units that pose higher potential risks, e.g., LPG, hydrogen sulfide and HF alkylation operations. In Mobil, this complementary approach facilitates prioritization of risks, allocation of limited capital and people resources and adjustment of insurance coverage to achieve desired residual risks on a worldwide basis. With the achievement of PSM, the Mobil top management recognized Process Safety Management is a good business.

The second example is a system safety management plan has been developed to enable the office of the program manager for chemical demilitarization to implement and manage a system safety program (SSP) in accordance with the appropriate military standard, system safety program requirements, for the chemical stockpile disposal program (CSDP) [8]. This plan describes the organizational responsibilities of the CSDP SSP, method of system safety analysis, procedures to verify the attainment of safety objectives, program milestones, integration with other CSDP activities, and procedures for evaluation of safety program performance. With the implementation of this safety plan to a complex systems such as the CSDP, all the undesirable events will be identified at the design phase and can be eliminated or controlled to ensure the safety of operational personnel and the public.

To resolve the issues for the public agenda associated with chemical related hazards or environmental problems, our decision makers should change from a reactive mode to a preventative mode. A long-lasting and well-planned effort to minimize or avoid potential (or future) risks is the only solution for promising to give the public a clean and safe place to live.

IV CONCLUSIONS

This paper provides a systematic approach for developing the safety management policy of a chemical plant, which can be valuable in at least three ways. First, this paper introduces a systematic way to quantitatively represent risk. Second, the top management might learn to think in a broader domain-situation of risk, ratio of dollar damage to dollar expanded to reduce risk, source of risk, better quality and more productivity etc. And third, with the basis or framework for rational decision making by identifying a more complete array of risks, the top management will be able to address risk/safety management in a broader domain and to recognize the actual involvement (i.e., he or she really want to make it safer) which is the essential feature of the success of any safety management policy.

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VI TABLES AND FIGURES

Table 1 - Hazard Severity Categories

Description	Category	Mishap Definition
Catastrophic	I	Chemical accident, death, off-post hazard, system loss
Critical	II	Chemical incident, serious injury, serious occupational illness, major facility damage
Marginal	III	Minor injury, minor occupational illness, minor facility damage
Negligible	IV	No injury or significant damage

Table 2 - Hazard Probability Categories

Description	Level	Occurrence Rate
Frequent	A	Frequently experienced
Probable	B	Will occur several times
Occasional	C	Likely to occur
Remote	D	Unlikely to occur, and almost certainly, not more than once
Improbable	E	Extremely unlikely to occur, but possible
Impossible	F	So unlikely as to be indistinguishable for incredible

Table 3 - Hazard Risk Assessment Code (RAC)

	Hazard Category			
Frequency	Catastrophic	Critical	Marginal	Negligible
A - Frequent	1	1	1	3
B - Probable	1	1	2	3
C - Occasional	1	2	2	4
D - Remote	2	2	3	4
E - Improbable	3	3	3	4
F - Impossible	4	4	4	4

RAC	Description
1	Unacceptable
2	Undesirable
3	Acceptable with controls
4	Acceptable