APPLICATION OF HAZOP STUDY ON WATER TREATMENT PLANT

Pao-Chiang Yuan
School of Science and Technology
Department of Technology and Industrial Arts
Jackson State University

INTRODUCTION

A hazard is an inherent physical or chemical characteristic that has the potential for causing problems. A hazard evaluation is an organized effort to identify and analyze the significance of hazardous situations associated with a processor activity. Hazard are used to pinpoint weaknesses in the design and operation of facilities that could lead to accidental chemical release, fires, or explosions. Hazard evaluation studies usually focus on process safety issues, like the acute effects of unplanned chemical releases on plant personnel or the public. These studies complement more traditional industrial health and safety activities. Although hazard evaluation studies use qualitative methods to apply potential equipment failures and human errors that lead to accidents, the study also can highlight gaps in the management system of an organization's process safety program (McJilton 1996).

There are several synonyms for hazard evaluation such as process hazards analysis, process hazards review, process safety review, process risk review, and include hazard analysis. In my opinion, the process is similar to a risk assessment technique; both techniques are not to make final design and only make suggestion to the administrator. There is another process called risk management.

Comparison between risk assessment and hazard evaluation

The difference between the two processes is that one focuses on human and ecological exposure; the other concentrates on process safety and possible equipment failure. Table 1 shows the techniques used in both processes.

Table 1: Risk Assessment vs. Hazard Evaluation

Risk Assessment	Hazard Evaluation
Hazard Identification	Problems Identification
Dose-Response Evaluation	Frequency of Problems
Human/Ecological Exposure	Process Safety/Equipment Failure
Risk Characterization	Follow-up Study

HAZOP STUDY

It started in the early sixties in the Monde Division of Imperial Chemical Industries (ICI) in England. The method spread to ICI facilities in different countries. The technique was accepted by United Kingdom Chemical Association, Dutch Process Safety Committee, Institute for the Chemical Industries in Germany, Switzerland, and Austria. In 1975, Canada was the first North American country to use this process. The HAZOP (Hazardous and Operability Studies) is a set of techniques designed to identify hazardous problems, such as the hazards to humans, plants, and the living environment caused by the living process industry. They basically are safety oriented studies and used extensively in chemical and petroleum industries and are recognized as a powerful and flexible tool. The process could be used on batch mode and also applied on continuous ones. The study is seldom used on water industry. The techniques could be used on a new designed plant, an upgraded or modified plant, or on the operation and closure of plant.

We want to find possible hazards before accidents happen, someone gets hurt, or environmental damage occurs. Environmental safety is not a slogan, it is a job we need to implement as our major concern. We all know there are some unforeseen problems existing in different cases, whether you are building a new plant, remodeling, or closing a plant. HAZOP studies that try to prevent incidents rely on following the factors:

1. Code of Practice, design Codes
2. Experience of past
3. Knowledge of professional engineers and specialists
4. Plant manager, engineers, and operators
5. Similar plant operators
6. Creative thinking and imagination

HAZOP study is a teamwork effort.

Hazard Identification Methods - Examination and Guide Words

The examination is the fundamental part of a HAZOP study. After an accident and operational difficulties occur, there is some sort of investigation to find cause or causes. It may result due to fault design, wrong operation method, or human carelessness. Although we have a good design, it may happen. We learn partly from experience and while this is valuable, it can be expensive in terms of human suffering and financial loss. As I mentioned above, the study requires teamwork; everyone contributes his/her ideas and imagination and any conceivable malfunctions and maloperations. This work covers all parts of plant "Examination." This procedure exams a full description of the process and finds possible hazards, discovers these errors, and how many deviations there are from the intention of the design. These will arise by a number of questions, and a number of GUIDE WORDS could be used. Guide words are simple words that are used to qualify the intention in order to guide and stimulate the creative thinking process and so discover deviations. The questioning focuses in turn on every part of the design. The examination procedure generates a number of theoretical deviations and from those considered, decide how it happened and what will be the consequences. We may find out some of the causes are unrealistic and so the derived consequences are not meaningful. Some of the consequences may be trivial and would be considered no further. Certainly, we find some causes and consequences that are potentially hazardous. Then remediation is required.

Table 2. A LIST OF GUIDE WORDS

Guide Words	Definitions
NO or NOT	no part of intentions is achieved but nothing else happens (Ex. no flow)
MORE	quantitative increase (Ex. pressure, temperature, flow rate)
LESS	quantitative decrease (Ex. same as above)
AS WELL AS	all the design and operating intentions are achieved together with some additional activity (Ex. impurity, by-product)
PART OF	only some of the intentions are achieved; some are not (Ex. only one chemical from a mixture)
REVERSE	opposite of intentions (Ex. reverse flow, backflow)
OTHER THAN	no part of the intention is achieved. Something quite different happens (Ex. wrong raw materials)

Team member selection

Organizing the evaluation team, mainly depends on the type and size of the plant, but not more than seven nor less than two should be required. Too many persons may cause unnecessary problems. Following is the list of suggested persons; rank them by the importance of the plant.

a. plant manager
b. maintenance
c. on-site operator
d. engineer
e. R & D
f. instrument engineer
g. production manager
h. civil, mechanical, chemical engineer
i.project manager
j. others

Preparation for the study and examination

Preparing the document is an important task in this study. Information includes P & ID, plant layout, manufacturer's operating manual, computer programs, flow charts, etc. The data must cover the entire plant or selected study area. Once the data has been assembled, the team leader is in position to summon the meeting and estimate the man-hours required to complete the study. Each session should not examine more than four. The members of the team are generally familiar with the plant and processes for production. In case a member was not familiar with the plant, a tour should be provided. Examination sessions should be conducted in a room without outside interruption, plenty of table space for documents, flowsheets, charts, etc.

The team leader is the leading person. He organizes the examination sessions and he or she will initiate the first guide word and the team discussions. The team member should not only provide the technological opinions and answers but also be creative and think of all the deviations and hazards that could happen. If the questions are not needed for further evaluation, any member of the team can stop the discussion and go to next guide word or next evaluation. Time is an important factor; the leader should control it. Do not use more than four hours. Some of the problems are straightforward and do not need discussion. Although the team leader is prepared and good at the study area, he/she may postpone certain discussions in order to obtain more reference material or information. The problem will be discussed in the next session.

Follow-up report writing and record the results

According to the examination, hazards have been discovered. Several possible actions may be generated: a change in the process, a change in process condition, an alternative to the physical design and a change of operating methods, and others. All the findings must or may reduce the cause of hazards. If any changes are necessary, the team should be sure new designs or alternatives will not introduce new or unexpected hazards to the plant. The whole job should be completed in two weeks.

The final important activity is to record the results of the study. Record all data used during the evaluation and be sure the objectives of the studies are completely examined. All recommendations and process redesigns are put in writing. The report is submitted to the administrator to improve safety or can be used for future design.

Case Study

The City of Jackson was under a boil-water advisory from the State Department of Health on Feb. 6, 1996. The advisory was issued because of the increase in sediment levels in the water system. According to the newspaper, more than 40 other water systems in the state are also under the same advisory. The J. H. Fedwell Water Treatment Plant off I-55 was built 82 years ago. Four pumps used for adding aluminum sulfate (alum) into the water system are broken. The plant distributes water for most of Jackson's homes. The pump transported the coagulant into the water before the rapid mixer failed. This means sedimentation or filtration parts are not functioning. The incident has not happened just once; it also happened last August. The pumps were replaced or rebuilt. The water engineer explained that the problems are main breaks due to freezing weather and the pump locked after sucking in air. It has nothing to do with the age of the plant. I agree with this, but this kind of mistake is preventable. This is a case that needs HAZOP study. Figure 1 shows the basic flowchart of HAZOP study, and Figure 2 shows the basic flowchart of water treatment plant.

REFERENCES

Center for Chemical Process Safety of the American Institute of Chemical Engineering. 1992. Guidelines for Hazard Evaluation Procedures. 2nd edition. New York, N.Y.

Knowlton, E. Ellis. 1987. Hazard and operability studies. Chemetrics International Co.

McJilton, C. 1996. Emergency spill response. Pollution Engineering.

National Response Team. 1987. Hazardous materials emergency planning guide.

Ozog, H. and L. M. Bendixen. 1987. Hazard identification and quantification. Chemical Engineering.

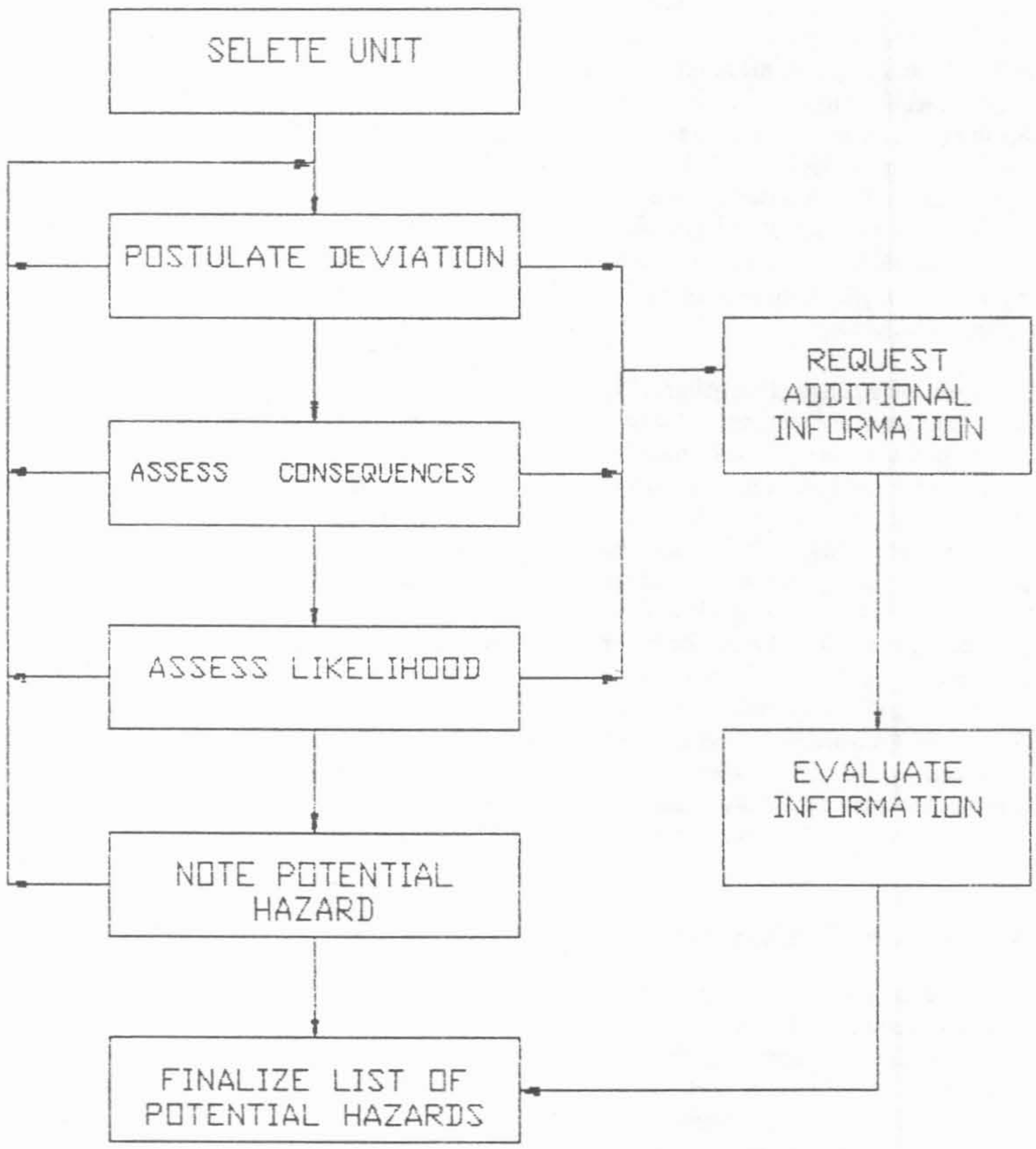

Fig 1. HAZOP STUDY FLOWCHART

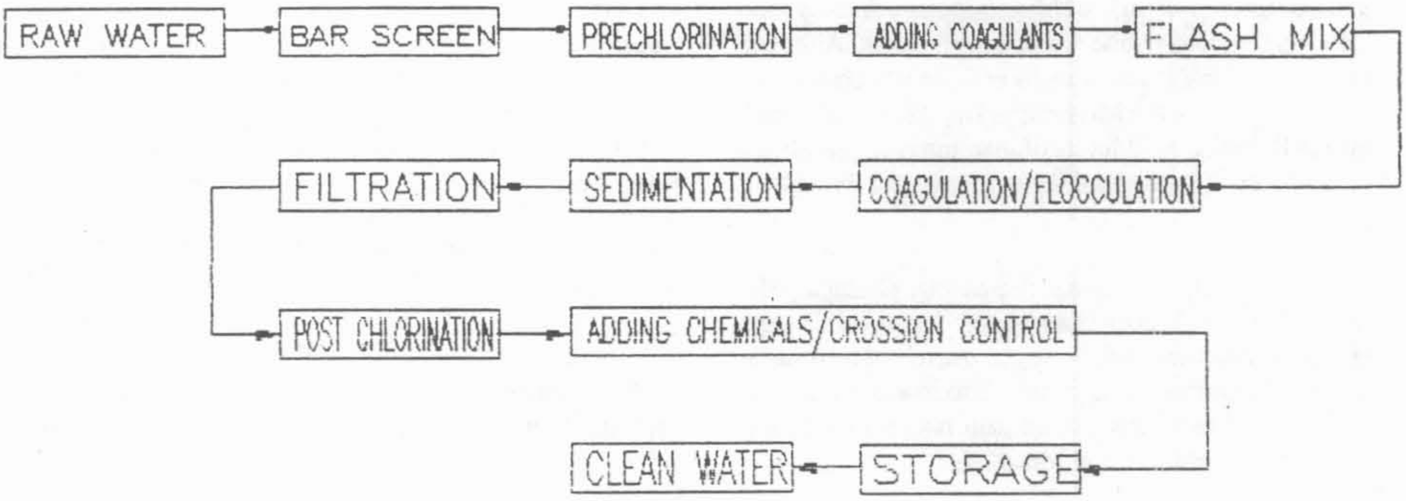

Fig. 2 Bacis Water Treatment Plant Flowchart