Introduction

The HAZOP Concept

The HAZOP process is based on the principle that a team approach to hazard analysis will identify more problems than when individuals working separately combine results. The HAZOP team is made up of individuals with varying backgrounds and expertise. The expertise is brought together during HAZOP sessions and through a collective brainstorming effort that stimulates creativity and new ideas, a thorough review of the process under consideration is made.

The HAZOP Process

The HAZOP team focuses on specific portions of the process called "nodes". Generally these are identified from the P&ID of the process before the study begins. A process parameter is identified, say flow, and an intention is created for the node under consideration. Then a series of guidewords is combined with the parameter "flow" to create a deviations. For example, the guideword "no" is combined with the parameter flow to give the deviation "no flow". The team then focuses on listing all the credible causes of a "no flow" deviation beginning with the cause that can result in the worst possible consequence the team can think of at the time. Once the causes are recorded the team lists the consequences, safeguards and any recommendations deemed appropriate. The process is repeated for the next deviation and so on until completion of the node. The team moves on to the next node and repeats the process.

HAZOP Objectives

Philosophy- Hazard vs. Operability Study

HAZOPs concentrate on identifying both hazards as well as operability problems. While the HAZOP study is designed to identify hazards through a systematic approach, more than 80% of study recommendations are operability problems and are not, of themselves, hazards. Although hazard identification is the main focus, operability problems should be identified to the extent that they have the potential to lead to process hazards, result in an environmental violation or have a negative impact on profitability. A definition of hazard and operability is given below.

Definitions

Hazard - any operation that could possibly cause a catastrophic release of toxic, flammable or explosive chemicals or any action that could result in injury to personnel.

Operability - any operation inside the design envelope that would cause a shutdown that could possibly lead to a violation of environmental, health or safety regulations or negatively impact profitability.

HAZOP Responsibilities

Process Hazard Analysis (PHA) Team Leader

The PHA team leader works with the PHA coordinator in defining the scope of the analysis and selection of team members. Directs the team members in gathering of process safety information prior to the start of the study. Plans the study with the PHA coordinator and schedule team meetings. Leads the team in the analysis of the selected process keeping team members focused on discovering hazards associated with the process and directs the team scribe in recording the results of the teams findings. Ensures that the analysis thoroughly covers the process as it is defined at the start of the hazard analysis and ensures that the study is completed in the time allotted during the planing stage. Writes a report detailing the study findings and recommendations the group makes and report the findings and recommendations to management. Fields any follow-up inquiries by project implementation regarding the study recommendations.

Engineering Experts

The engineering experts assigned to the process hazard analysis may include some or all of the following: a project engineer, a machinery engineer, an instrument engineer, an electrical engineer, a mechanical engineer, a safety engineer, a quality assurance engineer, maintenance engineer or technician and a corrosion/materials engineer. These individuals will be responsible for providing expertise in their respective discipline as it applies to the hazard analysis of the process being studied. These individuals are responsible for attending the initial hazard analysis kick-off meeting. They are also required to be available to the team as required with the understanding that the team leader will give adequate advance notice when there expertise is required. They are required to provide documentation of any existing safeguards and procedures.

Guidewords, Selection of Parameters and Deviations

The HAZOP process creates deviations from the process design intent by combining guide words (No, more, less, etc.) with process parameters resulting in a possible deviation from design intent. For example, when the guide word "No" is combined with the parameter "flow" the deviation "no flow " results. The team should then list all credible causes that will result in a no flow condition for the node. A sample list of guide words is given below. It should be pointed out that not all guideword/parameter combinations will be meaningful. A of table of meaningful guideword/parameter combinations and their application is given in the Appendix.

Guidewords

- No
- More
- Less
- As Well As
- Reverse
- Other Than

The application of parameters will depend on the type of process being considered, the equipment in the process and the process intent. The HAZOP-PC software includes two pop-up menus that list both specific parameters and general parameters. The most common specific parameters that should be considered are flow, temperature, pressure, and where appropriate, level. In almost all instances, these parameters should be evaluated for every node. The scribe shall document, **without exception,** the team's comments concerning these parameters. Additionally, the node should be screened for application of the remaining specific parameters (see list below) and for the list of applicable general parameters (see PHA-Pro 3™ software). These should be recorded **only if** there is a hazard or operability problem associated with the parameter. A sample set of parameters includes the following:

Specific Parameters

Flow
Temperature
Pressure
Composition
Phase
Level
Relief
Instrumentation

Sampling
Corrosion/Erosion
Services/Utilities
Maintenance
Addition
Safety
Reaction
Inserting /Purging
Contamination

Requirement: Specific parameters should be considered by the team when evaluating each node.

If a particular parameter does not change from one node to the next then it is not necessary to repeat all of the deviations that were considered in the previous node. Merely refer to that case in the deviations column of the node presently being considered.

The Concept of Point of Reference

When defining nodes and performing a HAZOP on a particular node it is useful to use the concept of point of reference (POR) when evaluating deviations. As an illustration of this idea, suppose in the example of the flash drum in section 5.3 the node consists of the flash drum and liquid product piping up to the flange on a product storage tank. If the deviation "no flow" is proposed then a dilemma becomes apparent when you start talking about the causes of no flow. If a cause of no flow is pipe rupture and the pipe ruptures at the flange connection on the flash drum. The term "no flow " is ambiguous since there is flow out of the flash drum but not through the piping to the storage tank. Therefore a POR should be clearly established at the time the node is defined. It is recommended to always establish the POR at the downstream terminus of the node.

Screening for Causes of Deviations

It is necessary to be thorough in listing causes of deviations. A deviation is considered realistic if there are sufficient causes to believe the deviation can occur. However, only credible causes should be listed. Team judgment is used to decide whether to include events with a very low probability of occurring. However, good judgment must be made by the team in determining what events have a low probability of occurring so that credible causes are not overlooked.

There are three basic types of causes. They are:

1. Human error which are acts of omission or commission by an operator, designer, constructor or other person creating a hazard that could possibly result in a release of hazardous or flammable material.

2. Equipment failure in which a mechanical, structural or operating failure results in the release of hazardous or flammable material.

3. External Events in which items outside the unit being reviewed affect the operation of the unit to the extent that the release of hazardous or flammable material is possible. External events include upsets on adjacent units affecting the safe operation of the unit (or node) being studied, loss of utilities, and exposure from weather and seismic activity.

The level of detail required in describing causes of a deviation depends on whether or not the cause of the upset occurs in inside or outside the node. For example, suppose that a drum includes a level controller as part of the node. Suppose the level control valve closes resulting in a high level condition. Since the valve and controller are part of the node the causes should be stated in more detail. The valve may close because the wrong set point was input by an operator (human error); the valve may fail closed due to mechanical failure of the valve; or the valve may close due to loss of instrument air to the unit (external event). If the level controller were outside the node being studied it is sufficient to merely state "Level control valve LV-XXXX closes". When the team reaches the node in which the level controller is located then more detail can be listed for the various causes.

Requirement: Screen for causes of deviations based on human error, equipment failure and applicable external events.

Consequences and Safeguards

The primary purpose of the HAZOP is identification of scenarios that would lead to the release of hazardous or flammable material into the atmosphere, thus exposing workers to injury. In order to make this determination it is always necessary to determine, as exactly as possible, all consequences of any credible causes of a release that are identified by the group. This will serve a two fold purpose. One, it will help to determine a risk ranking in HAZOPs where multiple hazards are uncovered by the group so that priority can be established in addressing the hazard. And two, it will help make the determination as to whether a particular deviation results in an operability problem or hazard.

If the team concludes from the consequences that a particular cause of a deviation results in an operability problem only, then the discussion should end and the team should move on to the next cause, deviation or node. If the team determines that the cause will result in the release of hazardous or flammable material, then safeguards should be identified.

Safeguards should be included whenever the team determines that a combination of cause and consequence presents a credible process hazard. What constitutes a safeguard can be summarized based on the following general criteria:

1. Those systems, engineered designs and written procedures that are designed to prevent a catastrophic release of hazardous or flammable material.

2. Those systems that are designed to detect and give early warning following the initiating cause of a release of hazardous or flammable material.

3. Those systems or written procedures that mitigate the consequences of a release of hazardous or flammable material.

The team should use care when listing safeguards. Hazards analysis requires an evaluation of the consequences of failure of engineering and administrative controls, so a careful determination of whether or not these items can actually be considered safeguards must be made. In addition, the team should consider realistic multiple failures and simultaneous events when considering whether or not any of the above safeguards will actually function as such in the event of an occurrence.

Deriving Recommendations (Closure)

Recommendations are made when the safeguards for a given hazard scenario, as judged by an assessment of the risk of the scenario, are inadequate to protect against the hazard. Action Items are those recommendations for whom an individual or department has been assigned. 'Information Needs' are identified as recommendations in the software for follow-up by one of the team members.

The following guidelines are suggested for the implementation of hazard analysis recommendations:

I. High priority action items should be resolved within 4 months
II. Medium priority action items should be resolved within 4-6 months, and
III. Lower priority action items should be resolved following medium priority items.

AcuTech recommends that the Facility's Safety Coordinator review all recommendations made in the studies to determine relative priorities and determine a schedule of implementation. After each recommendation has been reviewed, the resolution of each recommendation should be recorded in a tracking document such as a spreadsheet, and kept on file.

Recommendations include design, operating, or maintenance changes that reduce or eliminate Deviations, Causes and/or Consequences. Recommendations identified in a hazard analysis are considered to be preliminary in nature. Requests for additional information or study can also be recommended.