

## Hazard and operability (HAZOP) Study in Process industries

**Mr. Shahnawaz Rampuri**, CEng., M.Tech From BIT Durg, PDIS from RLI, AMIE, B.Tech, ADOHSEM, SMISE, NEBOSH-IGC with 14+ yr Experience as EHS professional

**Email id:** shahnawaz.rampuri2@gmail.com

### Abstract

*In every year several accident occur in process industries due to Failure of pipe lines, equipment, system or existing process facility and it results hazardous chemical leak, fire, explosion, rupture or damage to existing system. Such accident occurs in Process industries due to availability of process related potential source of harm and this is known as hazard. To identify process related hazard is challenging job for everyone and later such hazard may lead to cause of accident. Result of accident is injury, fatality, property damaged, damage to environment or combination of these together.*

*In industries, Hazard identification & Risk assessment, Checklist based inspection, Job safety analysis like different techniques is used to identify hazard in which one Technique is Hazard and operability (HAZOP) study. HAZOP is very effective safety tool used to identify process related hazard. This article is very helpful to learn the HAZOP study procedure, identify process related hazard and ensuring their risk management to prevent any possibility of failure of pipe lines, system or equipment or existing process facility. This articles help to know the procedure to conduct effective study and prepare HAZOP study report.*

### Key word

Process Hazard identification, Process safety, Operational hazard finding, Operational Risk control, Design intention, Guide word, Deviation, Consequence

### Objective of HAZOP study:

- To check a design & system
- Identify Process hazard.
- Identify Causes of Deviation & evaluate to consequence of Deviation
- To decide whether and where to build
- To identify gap in existing facility that may cause of operational failure.
- To improve the safety of existing facilities
- Prevent to failure of Process facility, existing system and equipment.

## 1. Introduction

In process Industries, Failure of system or existing facility cause huge losses to organisation and such failure occur due to deviation of pressure, Temperature, flow like parameter. Such deviation is known as hazard and different method used to identify process related hazard in which one method is Hazard and operability (HAZOP) study. A HAZOP study technique is used to identify process or operational hazards and operability problems. In industries, every day several injury occur, huge loss of organisation due to minor operational failure and such failure occurs due to not taking adequate control measure to eliminate hazard or minimise process related risk As Low as Reasonable Practicable .

Hazard and operability (HAZOP) study is detailed examination of existing process or operation in order to identify and evaluate the potential sources of harm that may lead to cause of equipment or system failure and it result injury, equipment damage, disaster or any harm. A HAZOP study is performed by multidisciplinary team members including operational managers, Engineers, Chemists, safety professional, Hygienist and other experts to identify process related hazards, Process related risk and design flows. Concept of HAZOP involve how plant might be deviate from the design intent and if process related problem identify during study then team try to find out effective solution to prevent deviation/ operational failure. Prime Objective of HAZOP study is to identify process related deviation/problem. HAZOP is based on several expert views with different background, work together or separate to identify problem and at ends of their work, they combined result together to interact each other. Guide word is main component of HAZOP study. For HAZOP study, firstly there is need to Team formation with expertise in their field. The success or failure of the HAZOP study depends on several parameters:

- Accuracy of P & I diagram and other available data such as operational manual, MSDS of chemical etc that will be used during study.
- Team member Competence, Experience & Skill
- Knowledge about Process or operation & process hazard
- Ability of team member thinking/brainstorming to evaluate deviations, causes and Consequences
- Effective Report and risk communication.
- Effective implementation to recommendation as per HAZOP study report.

## 2. Method of HAZOP study

Definition, Preparation, Examination, Report and follow are its main phase of HAZOP study.

### 2.1 Phase in HAZOP Study

#### Phase I: Definition

In This phase, clearly define and mention Aim & objective of HAZOP study. Team selection is carried out and one Team member will be act as leader. Role and responsibility should be clearly define and assign to each team member. HAZOP team including different person with a variety of expertise such as operations, Production, maintenance, instrumentation, engineering/process design, Chemical engineer / Chemist, Safety other specialists as needed. They should be good knowledge about process and variation. Following are few examples of guide word and deviation:

Parameter	Guide word	Deviation
Pressure	More, less	More Pressure, Less Pressure
Temperature	More, Less	More Temperature, Less Temperature
Flow	More, Less, None, Reverse, other, also	More Flow, Less Flow, No flow, Reverse flow, other flow, Contamination
Viscosity	More, Less	More Viscosity, Less Viscosity
Reaction	More, Less, None	Intense reaction, reaction incomplete, No reaction
Corrosion	Corrosion of tube	Damage to tube

#### Phase II: Preparation

In this Phase, HAZOP team prepare plan to conduct study. This typically includes piping and instrument diagrams (P&ID) or process model and examine every section and component of process to use guide word by HAZOP team. For each element, HAZOP team identify operating parameter of system that may lead to deviate to system or existing process facility such as Pressure, Temperature, Flow Rate etc. Target also define to



complete study within certain time frame and team mutually agree and decide the way to record collected data.

### Phase III: Examination phase

In this Stage, HAZOP team Select the System and divide into different parts, define design intent in each part. Team will identify probability of deviation to use guide word, deviation Consequence and cause of deviation. All finding and data will be recorded and agreed action will be noted. Team will select effective recommendation/ possible control measure to avoid developing any deviation to protect to existing facility and system. A simple format of HAZOP study is given below

#### Format for HAZOP study

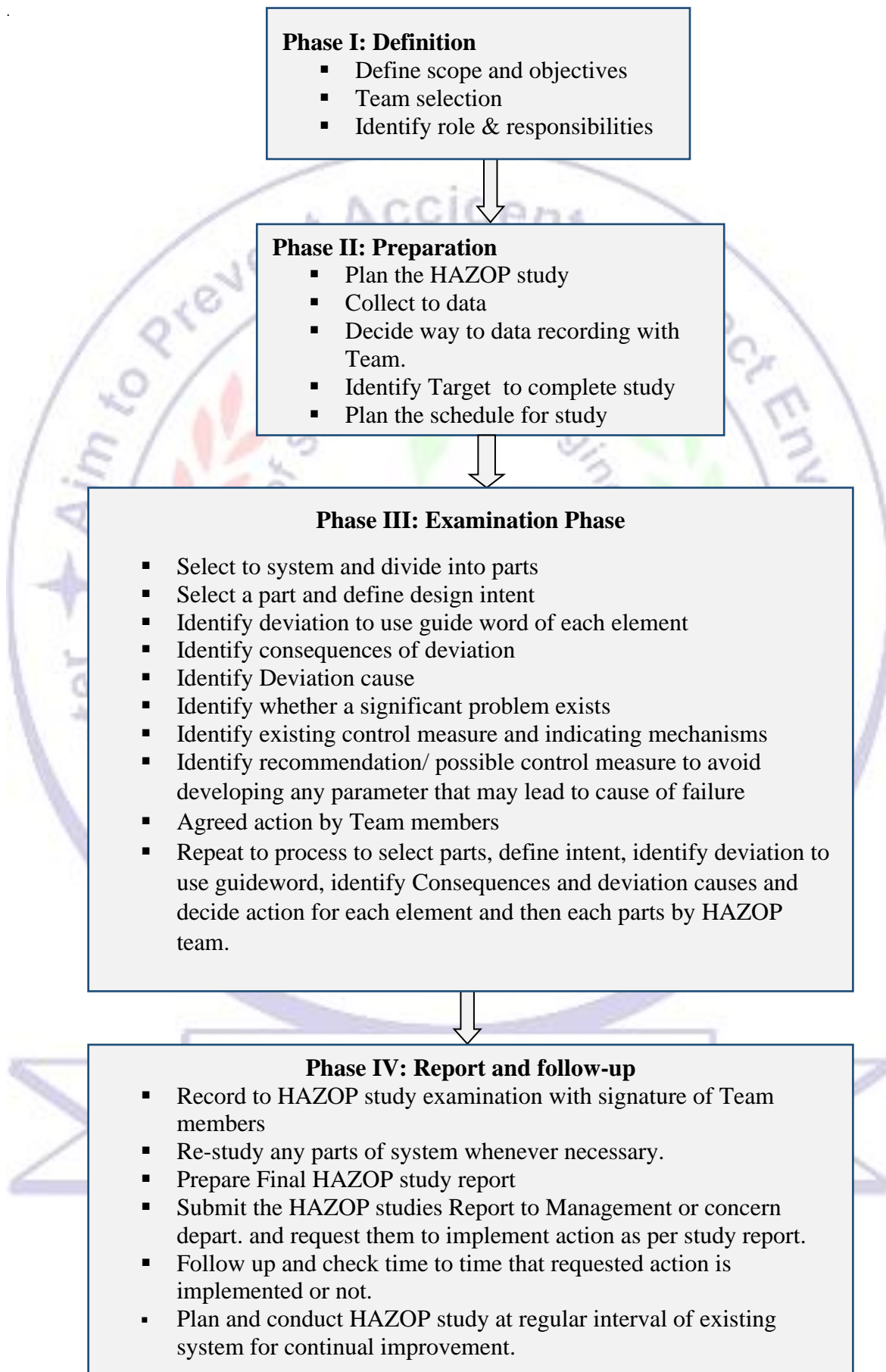
Name of equipment:

Guide word	Deviation	cause	consequence	Action

### Phase IV: Report & Follow up

In this stage, All HAZOP study examination related data should be recorded and Final report will be prepared and Submit to Management or concern department to implement action/recommendation as per study report. Team member should follow up regularly and check that requested action/ recommendation is implemented or not. Plan and conduct HAZOP study at regular interval to identify deviation and taking needful action for safety of Process plant and existing facility for continual improvement.

## 2.2 Phase of HAZOP Study



## 2.3 HAZOP Study Report of Heat exchanger:

A Heat exchanger is considered for HAZOP study. Flow, Pressure, Corrosion, contaminants are consider parameter. More Less, corrosion, Contaminant is considers guide word. On based on this is study carried and report prepared.

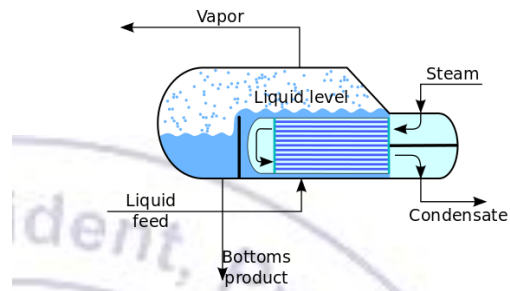


Fig. 2.3, Heat exchanger

Guide word	Deviation	Causes	Consequences	Action
More	Flow (More cooling water Flow)	Cooling water valve failure	Process fluid Temperature decrease	Provide Temperature Gauge & Low temp. Alarm
Less	Flow (Less cooling water Flow)	Blockage of pipe	Temperature remains constant of Process Fluid	Provide High Temperature alarm
More	Pressure (More pressure on Tube Side)	Failure of Process Fluid Valve	Brusting of Tube	Installing High Pressure alarm
corrosion	Corrosion of Tube	Hardness of Cooling water	Crack of Tube and less Cooling	Inspection & Proper maintenance
Contamination	Contamination of Process Fluid Line	Leakage of Tube and cooling water goes in	Contamination of Process Fluid	Proper maintenance & Operator Alert

### 3. Result & Discussion

In this Heat exchanger Fig. 2.3, more, less, Corrosion, contamination like guide word is used to identify deviation, Deviation causes and consequences of deviation. In Heat exchanger, more flow of fluid may be cause of Valve failure and it results decreases of Fluid temperature, less flow of fluid may be blockage to pipe and it results Failure to pipe. Similarly Corrosion may be cause of hardness to cooling water and damage to tube of heat exchanger, Contaminates may be contaminate to fluid and it result leakage of tube. On based on these, team ensure effective recommendation to prevent deviation and save to equipment and system from any failure. Team imagine the probability of deviation and imagine consequence of deviation. On based on this, they ensure remedial measure. Pressure gauge, High temperature alarm, regular inspection and maintenance are few actions are recommended to prevent catastrophic event. HAZOP team member recorded their observation and team members take jointly decision of examination to finalise the report.

### 4. Conclusion

HAZOP is very effective way to identify process related hazard and ensuring effective control measure to protect to System or existing facility. Some time existing facility parameter such as pressure, Temperature increase or decrease or deviate due to operability problem and it results equipment damage, failure to system or any major accident. To prevent similar accident, HAZOP study is carry out to examine the system, identify deviation to use guideword, identify Cause of deviation, imagine to consequence of deviation and based on observation, Team ensure recommendation to avoid any future accident.

### References

- Center for Chemical Process Safety, Guidelines for risk based process safety, New York: American Institute of Chemical Engineers, 2007.
- Study & analysis of occupational health safety management system (OHSMS) in organisation: a review nair. J sindhu, 2shahnawaz rampuri, International Journal of Exploring Emerging Trends in Engineering (IJEETE) vol. 04, issue 01, jan- feb, 2017 pg. 34 – 39 [www.ijeete.com](http://www.ijeete.com) , ISSN – 2394-0573
- Kitajima T, Fuchino T, Shimada Y, Naka Y, Yuanjin L, Iuchi K, Kawamura K. A New Scheme for Management-of-Change Support Based on HAZOP Log. COMP AID CH 2010; 28: 163- 168.
- B. K. Vaughen and T. A. Kletz, "Continuing our process safety management journey," Process Saf. Prog., 2012, vol. 31, pp. 337-342.



- Mata JL, Rodriguez M. HAZOP studies using a functional modeling framework COMP AID CH 2012; 30:1038-1042.
- Jeerawongsuntorn C, Sainyamsatit N, Srinophakun T. Integration of safety instrumented system with automated HAZOP analysis: An application for continuous biodiesel production. J Loss Prev Process Ind 2011; 24 (4): 412-419.
- Dunjo J, Fthenakis V, Vilchez JA, Arnaldos J. Hazard and operability (HAZOP) analysis. A literature review. J Hazard Mater 2010; 173 (1-3): 19-32.
- Bartolozzi, V., L. Castiglione, et al. (2000). "Qualitative models of equipment units and their use in automatic HAZOP analysis." Reliability Engineering & System Safety70(1): 49-57.
- S. Q. Shan, Q. H. Zhao, and F. Hua, "Impact of quality management practices on the knowledge creation process: The Chinese aviation firm perspective," Comput. Ind. Eng., 2013, vol. 64, pp. 211-223.
- Vaidhyanathan, R., V. Venkatasubramanian, et al. (1996). "HAZOPEXpert: An expert system for automating HAZOP analysis." Process Safety Progress15(2): 80-88.
- Bartolozzi, V., L. Castiglione, et al. (2000). "Qualitative models of equipment units and their use in automatic HAZOP analysis." Reliability Engineering & System Safety70(1): 49-57.

