# HAZOP STUDY

# REPORT

***PREPARED FOR***

ASSAM GAS COMPANY LTD
( A GOVT OF ASSAM UNDERTAKING )

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***CONDUCTED & PREPARED BY***

GREEN MEMBER GROUP
THE GREEN PEOPLE


## GREEN CIRCLE CONSULTANTS (I) PVT LTD.

***Environmental, Health, Hygiene, Safety, Risk, & Quality***

***Consulting Engineers & Trainers***

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## QUALITY CONTROL SHEET

| Rev. | Date | Reason History | Prepared By | Reviewed By | Approved By |
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| 00 | 01/10/10 | Draft Report of HAZOP Study | KP | DD | YD |
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# ACKNOWLEDGEMENT

*WE EXPRESS OUR SINCERE THANKS TO MANAGEMENT & EMPLOYEES OF **ASSAM GAG COMPANY LTD, ASSAM (INDIA)** FOR THEIR CO-OPERATION & UNSTINTED HELP WITHOUT WHICH THE **'HAZOP STUDY'** COULD NOT HAVE BEEN POSSIBLE. THE COURTESY EXTENDED TO OUR TEAM IS HIGHLY APPRECIATED.*

**For: GREEN CIRCLE CONSULTANTS (I) PVT.LTD.**

**AUTHORISED SIGNATORY**

# ABBREVIATIONS

| | |
|---|---|
| **IS** | Indian Standard |
| **EPA** | Environment Protection Act |
| **MoEF** | Ministry of Environment & Forest |
| **OS&H** | Occupational Safety & Health |
| **PPE** | Personal Protective Equipment |
| **MSIHC** | Manufacturing, Storage & Import of Hazardous Chemicals |
| **FA** | Factories Act |
| **SMPV** | Static Mobile & Pressure Vessel |
| **LFB** | Laminar Flow Booth |
| **USA** | United States of America |
| **OHC** | Occupational Health Center |
| **SHE** | Safety Health & Environment |
| **MSDS** | Material Safety Data Sheet |
| **SOP** | Standard Operating Procedure |
| **MOM** | Minutes of Meeting |
| **MPCB** | Maharashtra Pollution Control Board. |
| **IE** | Indian Electricity |
| **GW** | Guide Word |
| **P& IDs** | Piping and instrumentation diagram |

# INDEX

## CREDITS

**M/s. Assam Gas Company Ltd, Assam**, appointed **M/S. GREEN CIRCLE CONSULTANTS (I) PVT. LTD., VADODARA** to conduct HAZOP Study. Hazop team to plant site comprising **Mr. Pradeep Joshi** – Managing director from **M/S GREEN CIRCLE CONSULTANTS (I) PVT. LTD.** In presence of committee of **M/s. Assam Gas Company Ltd, Assam**

The auditors from **M/S. Green Circle Consultants (I) Pvt. Ltd.** Conducted the audit from **29th JUNE 2010** at Khopoli site with standard (**Reference Std. IS 14489:1998 – Code of Practice for Occupational Safety & Health Audit**) procedures & methodology including close interactions & interviews of the Employees of the plant.

## EXECUTIVE SUMMARY

Following recommendation should be implemented

- Control valve should be installed
- Safety inspection should be carried out
- Interlocking with PT to be done
- Activate DMP is required
- -Training should be done periodically
- Gas detection system should be installed
- Sprinkler system (dedicated system) should be installed
- Water monitors and Water curtain should be installed
- 3rd party C & T every 2 years
- Discharge gas temp needs to have TG/RTD

# INTRODUCTION OF HAZOP

## HAZARD & OPERABILITY STUDY

An important addition to the methods of hazard identification is the family of techniques known as Hazard & Operability (HAZOP) studies.

The following description is based on those given by Lawley (1974b) & by the CISHC HAZOP Study Guide.

A multidisciplinary team, who reviews the process to discover potential hazards & operability problems using a checklist approach, carries out the studies. They are essentially an application of the technique of critical examination & their origins in method study are extended by an early account by Elliott & Owen (1968).

The basis of such a study may be a word model, a process flow sheet, a plant layout or a flow diagram. There are different types of study which have different objectives & which are done at different stages of the project. The level of detail & the team composition are accordingly.

## Principles of examination

The basic concept of the hazard & operability study is to take a full description of the process & to question every part of it to discover what deviations from the intention of the design can occur & what their cause & consequences may be. This is done systematically by applying suitable guidewords.

## HAZOP STUDY SCOPE

HAZOP (Hazard & Operability) study was developed to identify hazards in plant & to identify operability problems, which though not hazardous, could compromise the plants ability to achieve design productivity.

Hazard Evaluation is carried out to identify the hazard that exists, the consequences that might occur as a result of hazards, the likelihood that events might take place that would cause an accident with such a consequence, and the likelihood that safety system, mitigating systems and emergency alarms and evaluation plan would functioning property and eliminate or reduce the consequences.

## HazOp Pre-requisite:

1. Process Flow Diagrams
2. Detailed process description
3. P&IDs
4. Purity of materials
5. Process Safety & Operation Manual
6. Maintenance Schedules & past history.

## HAZOP PROCESS

## A. BACKGROUND

HAZOP is a well recognized method of identifying hazards & problem which may prevent an efficient operation & lead to a hazard .HAZOP is a technique to critically examine a system, part by part ,in a very systematic manner ,to find out the cause and consequence of every conceivable deviations in the normal operation of the system .the method enables prediction of all possible ways in which a hazard or an operating problem could arise ,whether the design takes preventive care of them and if not , recommend changes may be necessary.

HAZOP is a qualitative assessment of a hazard or an operating problem occurring in a process plant while risk Analysis is a quantitative assessment of the consequences of a hazard.

The HAZOP study is carried out for all major equipment and/or each pipeline joining the equipment in a process through series of guide words around which a number of question are formulated to arrive at the possible deviations . In doing so, valve, instrumentation, nature of chemical process and unit operation involved are closely examined .The probable cause and the consequences of the deviation are listed and necessary corrective actions are suggested.

The main purpose of HAZOP is therefore to identify all possible deviations from the way the design is expected to work and probable causes and consequence of the hazard associated with these deviations together with recommended changes.

## B. Methodology

A HAZOP study is a formal systematic procedure used to review the design and operation of a potentially hazardous process facility. It is used to identify deviations from normal safe operation, which could lead, to hazards or operability problems, and to define any actions necessary to deal with these.

The study is performed by a team of people who are familiar with the plant design and operation, working under the guidance of a leader who is experienced in use of the HAZOP method.

The method involves several repetitive steps (Reference is invited to Figure 3.1 on next page):

1. Identify a section of plant on the P&I diagram.
2. Define the design intent and normal operation conditions of the section.
3. Identify a deviation from design intent or operating conditions by applying a system of guidewords.
4. Identify possible causes for, and consequences of, the deviation. A deviation can be considered meaningful if it has credible cause and can result in harmful consequences.
5. For a meaningful deviation, decide what action, if any is necessary.
6. Record the discussion and action.

Step 3 to 6 is repeated until all the guidewords have been exhausted and the team is satisfied that all meaningful deviations have been considered. The team then goes back to step 1 and repeats the procedure for the next section of the plant.

In the HAZOP method, the guidewords are systematically applied to a segment of process equipment in order to promote discussion on possible deviations from the design intention. The guidewords represent deviations to the design intent and their use leads to systematic highlighting of hazards and operability problems.

### HAZOP Worksheet

The HAZOP worksheet that was discussed during the HAZOP sessions included the following details:

- Guideword
- Parameter
- Deviation
- Causes

- Consequences
- Safeguards
- Recommendations
- Remarks

## Guideword

A guideword provides the team with a starting point to identify issues. Using a comprehensive list of guideword is important to achieve maximum benefit from the HAZOP study. A HAZOP checklist shall be used to act as an ad-memoir to identify any hazards that may have been over-looked during the brainstorming session. For each hazard, the root cause, the consequence, any safeguards already implemented in the design will be identified.

## Parameter

Parameter is an aspect of the process that describes it physically, chemically or in terms of what is happening.

## Deviation

Deviation is defined as unreasonable / undesired change in the parameter. Deviation is formed by a combination of the parameter and guideword.

## Cause

For each hazard, the root cause is determined, such that the appropriate safeguards for the causal events are determined.

## Consequence

In assigning a level of consequence to the hazards, the HAZOP team took into consideration the following factors:

• The present design status of the safeguards and controls
• Physical and working environment conditions
• Levels of training, experience, skills, education etc of the facilities personnel

## Safeguards

The study identified the existing design safeguards for each hazard. The types of safeguards commonly include:

• Preventive safeguards, which aim to prevent the event cause from occurring

• Detective safeguards, which aim to improve the response time to an event

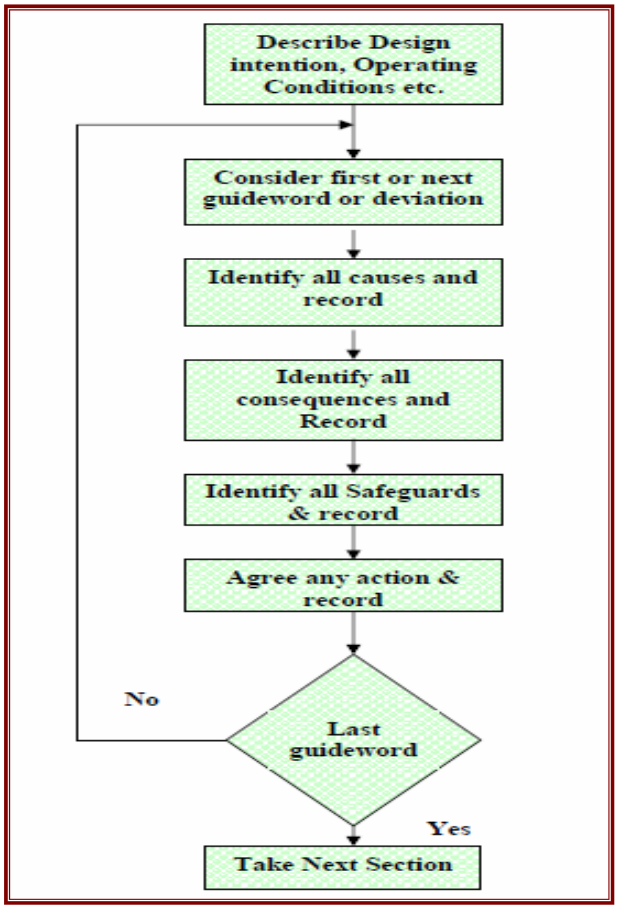
• Protective safeguards, which aim to protect from the escalation consequences and are always used regardless of whether the event has occurred

•Mitigation safeguards, which aim to reduce the severity of the escalation consequences and are activated once the event cause and escalation consequences have occurred.

## Actions / Recommendations

Where the associated safeguards are not adequate, further recommendations are proposed.

The method identifies the causes of a deviation from the design intent by application of the guidewords. The ultimate consequences are then identified and recorded without reference to the safeguards, which are in place (examples of safeguards are plant design, control systems, and procedures). The consequences are then compared with the safeguards and the HAZOP team then decides whether the current safeguards are adequate. If the team considers them inadequate, then a recommendation is made to consider or add further safeguards.




The HAZOP study was based on a set of P&I diagrams for the sections to be covered by study. (A copy of the P&I diagrams used for the study are compiled in Appendix I). The following back-up documents were also used during the HAZOP sessions:

## HAZOP RECORDING

Two methods of recording of a HAZOP study can be employed:

1. Complete - in which details of all discussion points are noted. &
2. By Exception - in which only those deviations that require action are recorded.

Recording of this study is 'complete recording' wherein all discussions of significance were recorded.

The discussion from the study is recorded on log sheets. Information is recorded in columns on the log sheets as follows:

- **Guide Words**
- **Parameters**
- **Deviations**
- **Causes**
- **Consequences**
- **Safeguards**
- **Recommendations**

## C) NODE, GUIDEWORDS & DEVIATION

The main guidewords & their meanings are summarized below.

### TABLE 1 MEANING OF GUIDEWORDS

| Sr.No. | Guideword | Meaning |
|---|---|---|
| 1. | NO or NOT | Quantitative increase |
| 2. | LESS | Quantitative decrease |
| 3. | AS WELL AS | Qualitative increase |
| 4. | PART OF | Qualitative decrease |
| 5. | REVERSE | Logical opposite of intention |
| 6. | OTHER THAN | Complete substitution |

The application of these guide words may be illustrated by the example already described: TRANSFER A, The guide words may be applicable to either the word TRANSFER or the word A. Thus for this case, the meaning might include the following:

**NO or NOT** No Flow of A.

**MORE** Flow of A more than design flow.

**LESS** Flow of A less than design flow.

**AS WELL AS** Transfer of some component additional to A.
Occurrence of some operation/event addition to transfer

**PART OF** Failure to transfer all components of A.
Failure to achieve all that is implied by TRANSFER**.**

After having listed all the deviation under each guide word, possible causes for the deviation are identified & consequences are assessed.

Finally, the study of each pipeline or equipment carried out is document in the form of a worksheet. Worksheets indicate particular deviation leading to potential hazards and/or operating difficulties

which may not have been anticipated during design stage & incorporates recommendations to prevent or ameliorate the consequences of a deviation.

## HAZOP WORKSHEETS

### Hazop worksheet for compressor

| | |
|---|---|
| **Plant : Compressor ( Unit 5)** | **Process Section :** |
| **Node :** | **Phase :** |
| **Process Line/Equipments :** Suction line to outlet of scrubber | **Date :** **Time :** |

**Parameter: Pressure**

| GW | Deviation | Causes | Consequences | Existing Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| Less/No | | - From supplier<br>-Valve partly or completely closed<br>-Human error<br>-Strainer is choked<br>-Leakage or puncture in the pipeline<br>-Breaking of gasket<br>-Presence of Oil & condensate in the pipeline | -Business loss<br>-damage compressor<br>-Rise in temp<br>-Fire & explosion<br>-Maintenance problems | -PM<br>-PG<br>-Suppliers inf<br>-Half hrly monitoring<br>-Periodic Draining | -Training<br>- Gas detection system<br>-Sprinkler system (dedicated system)<br>- Water monitors<br>- Water curtain | 1 | |
| More | | - From supplier/line<br>- Shut down, the trapping of gas in the | - Popping of PRV (set pressure 175 PSI,20 PSI more than the | -PRV is provided<br>-PM<br>- Calibration | - 3rd party C & T every 2 years | 1 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | scrubber | suction pressure)<br>- Hazardous | & testing of PRV | | | |

| GW | Deviation | Causes | Consequences | Existing Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| **As well as** | | - Vent is open & suction is on by human error | - Suction will drop<br>- Process delay<br>- Abnormal sound | - WI<br>- | - Training is requires | | |
| **Part of** | | Air ingress | Not hazardous till no leak takes place | | Gas detection system | | |
| **Other than** | | | | | | | |
| **Maintenance** | | Crude oil & condensate | Maintainability | Liquid level is maintained in scrubber Level of scrubber is interlocked with shut down | - PM<br>- Drain | | |

| GW | Deviation | Causes | Consequences | Existing Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| **As well as** | | - Entry of scrubber media into the suction valve | - Malfunctioning valve<br>- sludge formation | 3rd party check every year NDT like US test is carried out | | | |

| | |
|---|---|
| **Plant : Compressor** | **Process Section :** |
| **Node : Discharge** | **Phase :** |
| **Process Line/Equipments :** | **Date :** **Time :** |

**Parameter : Pressure**

| GW | Deviation | Causes | Consequences | Existing Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| Less/No | | - Low suction<br>- Customer higher consumption<br>- Low RPM<br>-Human error<br>- Low lubrication in piston<br>- Engine fails | -Business loss | - SOP/WI<br>- Training<br>- PM | | | |
| More | | - Higher RPM<br>- Sudden Less consumption by the consumer<br>- Valve completely or partially closed | - Discharge valve will blow ( 320 PSI,22 Kg/cm3)<br>- Problems towards customer side, hazardous | -Flare are provided | | | |

**Parameter : Temperature**

| GW | Deviation | Causes | Consequences | Existing Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| Less/No | | -Seasonal effect | No hazard | - TG | | | |
| More | | - Insufficient cooling<br>- Suction pressure low<br>- Summer | | -<br>- | - Discharge gas temp needs to have TG/RTD | | |

## Wroksheet for Pipelines

| | |
|---|---|
| **Plant :** | **Process Section : BVFCL(LP)16"(10.5 Kg/cm2 to Customers 6 Kg/cm2) 1.4 mmscmd** |
| **Node : 1-1'** | **Phase :** Gas |
| **Process Line/Equipments : Flow meters(orifice) ,Drain pots, vents, line valves, pig trap ( MS )** | **Date : 24/6/2010** **Time : 9.40 am** |

**Parameter : Pressure**

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| More | | -from supplier<br>-Human error & valve is closed<br>-Malfunctioning of valve | -Chances of leakage fire & explosion(haz) | -Isolation valves<br>-Inf from supplier<br>-PG<br>-Orifice meters are observed | Control valve | 1 | |
| Less/No | | -From supplier<br>-Leakage or puncture in pipeline<br>-Gasket failure<br>-Sabotage<br>-Terrorist attack<br>-Damage due to public activity/erosion | -Business loss<br>-Hazardous situation, fire & explosion<br>-Public at large may be affected<br>-Air pollution | -Inf from supplier/consumer<br>-Public/police intimation<br>-PG<br>-PM<br>-Hydro tests<br>-Calibration & testing | -Safety inspection<br>-Interlocking with PT<br>-Activate DMP | | |

**Parameter : Flow**

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| More | | -From | -Haz(high | -Orifice is | -Control valve/PT | 1 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | supplier | pressure) | provided | | | |
| Less/No | | Same as Low pressure | | | | | |
| Reverse | | -Human error & valve is closed | -Business loss | -Orifice<br>-Training<br>-Signage | -NRV<br>-Training<br>-Display of WI | | |

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| **As well as** | | -Crude oil & condensate with gas | -Fire/explosion (haz)<br>-Water pollution<br>-Damage gauges(PG,RTD)<br>-Decreases the pipeline<br>-Less flow<br>-Business loss<br>-Environmental pollution | -Tech specs<br>-Drain points & collection | To discuss with suppliers | 1 | |
| **Other than** | | - From supplier | Change of composition | Lab checks from supplier | | | |

| | |
|---|---|
| **Plant :** | **Process Section :** |
| **Node : 2-2'** | **Phase :** Gas |
| **Process Line/Equipments : BVFCL (20")LP - From LPG To compressor(PG,RTD,Orifice)** | **Date :** 24/6/10 **Time :** |

**Parameter : Pressure**

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| Less/No | | -More suction from compressor | | -Manned | | | |

**Parameter : Flow**

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| More | | -Higher suction from compressor | Overflow | | | | |

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| **Other than** | | Same as oil/condensate | | | Hydro tests/pigging Drain point may be provided | 1 | |

| | |
|---|---|
| **Node : 7-7"** | **Phase :** |
| **Process Line/Equipments : Dulaiajan to NTPS (Namrup Thermal Power Stn) 20"/HP** | **Date :** **Time :** |

**Parameter : Pressure**

| GW | Deviation | Causes | Consequences | Existing Safety Controls | Recommendations | Risk Ranking | Remarks |
|---|---|---|---|---|---|---|---|
| More | | - No consumer off-take, with no inf - | - Pressure build-up, Haz. -Leakages/fire/ explosion | -Inf from customers -Gauges -Manned & logbook in compressor | | | |

# RECOMMENDATIONS

## Some Recommendation for Compressor Area

- Gas detection system should be provided
- Sprinkler system (dedicated system) should be provided
- Water monitors at Suction line to outlet of scrubber
- Water curtain at Suction line to outlet of scrubber
- Discharge gas temp needs to have TG/RTD

## Pipeline Area

- Control valve should be provided on 16" pipeline
- Interlocking with PT along the 16" pipeline
- Hydro tests/pigging should be carried out
- Drain point may be provided on 16" pipeline.

## General Recommendation

- Safety inspection should be carried out
- Training is required
- 3rd party C & T every 2 years
- Activate DMP

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## AMENDMENT SHEET ( To Issue 01 )

| Sl. No. | Section No. | Page No. | Amendment Particulars | Effective Date | Signature (Amendment incorporated) |
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