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Original Article

Safeguard and mitigation of hazard and operability during simultaneous production and drilling at oil and gas platform

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Abstract

Safety in the SIPROD platform design primarily relies on applying various codes of practice or design based on the broad experience and knowledge of professional experts and specialists in the industry. One technique used to study the potential hazards and consequences is the HAZOP study which is defined as the application of formal systematic critical examination to the process and engineering intentions of new or modified SIPROD facilities to assess the hazard potential of individual items of equipment and the consequential effect on the SIPROD facility as a whole. The application is backed up by local SIPROD platform managers, engineers, and operators with direct experience in the relevant plant operation. The HAZOP session describes the SIPROD process and systematically questions each design part by breaking it into pieces or nodes. Each node is assessed using guide words and deviations to discover how these deviations from the original design intent can occur and the resultant hazards and maintenance problems. There may be a deviation in identifying controls that need further investigation. This paper discusses the adequacy of the safeguards concerning safety and operations at the SIPROD platform, evaluates additional safeguards required for the system under study to address and minimize the consequence of deviation, and recommends ways to mitigate the consequences of deviations and return to normal and safe operations.

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1 Introduction

Hazard and Operability Analysis (HAZOP) is a systematic technique for system examination and risk management [1,2]. In particular, HAZOP is often used to identify a system's potential hazards and operability problems likely to lead to nonconforming products [3]. HAZOP is based on a theory that assumes deviations from design or operating intentions cause risk events [1,4]. Identifying such deviations is facilitated using sets of "guide words" as a systematic list of deviation perspectives [5]. This approach is a unique feature of the HAZOP methodology that helps stimulate the imagination of team members when exploring potential deviations [6,7]. Hazard and operability study (HAZOP) is applied worldwide to process hazard analyses for processing plants [8,9]. It is considered a proper, methodical, and critical examination used to evaluate the potential hazards obtained from malfunctioning equipment and property in terms of the resultant impacts of either new or existing process facilities [3,9]. Dunjó [8] observed that HAZOP is the most studied Preliminary Hazard Analysis (PHA) method; much research has focused on retrofitting HAZOP as process systems evolved [1,10].

Simultaneous production and drilling activities in oil and gas offshore involve concurrently implementing two or more hazardous operations such as drilling and production. This definition shows that drilling and production are hazards that must be controlled. In a journal from Dunjó [8], several incidents and severe accidents have been reported a few years while performing drilling activities and associated operations due to the unpredictable nature of the simultaneous operation. Wu [11], implementing a HAZOP study using a computer-aids method [12] is a must to understand the complexity of the oil and gas industry to improve its safety performance.

During simultaneous operations, risks and the probability of failure are substantially higher than in non-simultaneous activities because of increased personnel [13]. More personnel are concentrated in the same area, and jobs are carried out requiring interaction and coordination. The assets' value may be higher, the line of command may be a more complex, non-routine activity, and the entire operation is exposed to each activity's combined probability of failure. In the journal written by Paul Baybutt [14], a SIMOP review has been conducted to perform process hazard analyses such as HAZOP studies. Many accidents related to SIMOPs have been shown in history [15]. As a result of this journal, a plan has been produced using a result from SIMOP reviews [16,17].

For a SIPROD mode, a unique engineering design modification needs to be performed on the SIPROD platform to accommodate the rig [18,19]. It ensures that all safety and production systems are upgraded to manage the risks due to simultaneous activities on the platform [7,20]. As in the article by Diego [21], a SIMOP risk assessment is conducted during commissioning at a new petrochemical plant in numbers of the workshop, attended by multidisciplinary participants to ensure all risks are appropriately managed concerning 2-phases activities. Once the hazard has been assessed, preventive and mitigation of actions are identified and reviewed by progress to ensure its implementation is appropriately monitored [2,4].

2 Methodology

HEMP is a structured methodology for identifying HSE hazards, assessing the associated risks, and developing control and recovery measures to reduce HSE risks to as low as reasonably practicable. HAZOP study represents one of the methods available to be applied in the Hazard Identification phase of HEMP, which is the methodology employed to achieve demonstrably the HSE objectives managed by the HSE Management System (HSEMS), as shown in Fig. 2.1. The HAZOP study team consists of multidisciplinary personnel because the brainstorming methodology relies on the team's broad experience to identify potential hazards and operability problems.

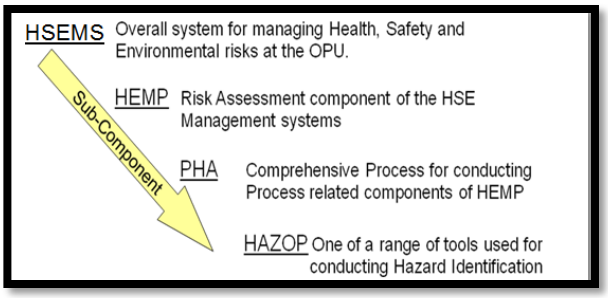

Fig. 2.1 HSEMS relations with HAZOP.

The SIPROD for the HAZOP scope covers the infill drilling and the SIPROD requirements for the Preparation Package, Rig Up Package, Well-Tie In Package, Rig Down, and Re-Instatement Package. However, for HAZOP modification work at SIPROD, the study of nodes only involved Well-Tie In and Rig Up packages and were segregated to allow for a focused discussion and ease of conducting the HAZOP study. The list of nodes for each node is tabulated in Table 2.1.

The individual design packages for Well Tie-in and Rig Up package required for a SIPROD drilling campaign are listed in Fig. 2.2.

Table 2.1 List of Nodes for HAZOP at SIPROD.

Node	Package	Description
Node 1	Well Tie-in	New Wells to Production Header
Node 2	Well Tie-in	Gas lift Header to New Wells
Node 3	Rig Up	Blowdown Route
Node 4	Rig Up	Instrument Air
Node 5	Rig Up	Emergency Shutdown Elevation during SIPROD

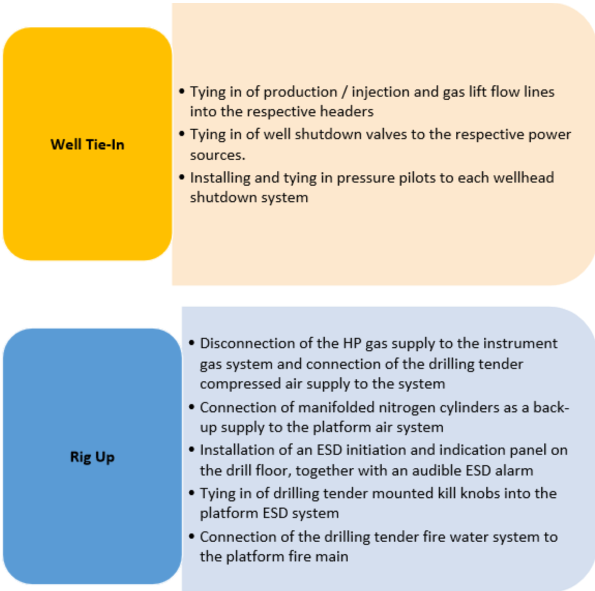

Fig. 2.2 HAZOP Scope of Work in SIPROD mode.

The HAZOP team shall identify the possible causes, potential consequences, and the existing safeguards already in place to prevent the realization of hazards due to deviation from the standard operation intent. The recommendations or additional safeguards have been raised for the hazards that were found with inadequate or inefficient safeguards. The causes, consequences, safeguards, and additional controls are documented.

The following sequential steps can summarize the HAZOP procedure:
Step 1: Determine the selection of the node sizes and the route through the systems;
Step 2: Define the node and its design intent (Parameters such as pressure, temperature, flow rate, and level);
Step 3: Select parameter and deviation relevant to the nodes, mode of operation, and HAZOP study technique applied;
Step 4: Identify all possible causes of a node guided by the parameter and deviation selected;
Step 5: Assess credible consequences of each cause by assuming there is no safeguard in place;
Step 6: Identify existing safeguards;
Step 7: Propose recommendations when the existing safeguarding system is not adequate to protect the system.

The overall HAZOP study workflow is summarized in Fig. 2.3.

The analysis of the workflow above is showcased in Table 3.1 - 3.5.

Before the HAZOP session, a HAZOP term of reference must be issued detailing the methodology, identified nodes, HAZOP session schedule, HAZOP report format, and other details about the HAZOP session. The HAZOP nodes for this workshop have been identified based on the Process and Instrumentation Diagrams. The guidewords selected and used in this HAZOP study are relevant to the system/ node under review. These selected guidewords and associated parameters are used during the study to assess the causes and consequences of each deviation from normal operating conditions. The guide words used are tabulated in Table 2.2.

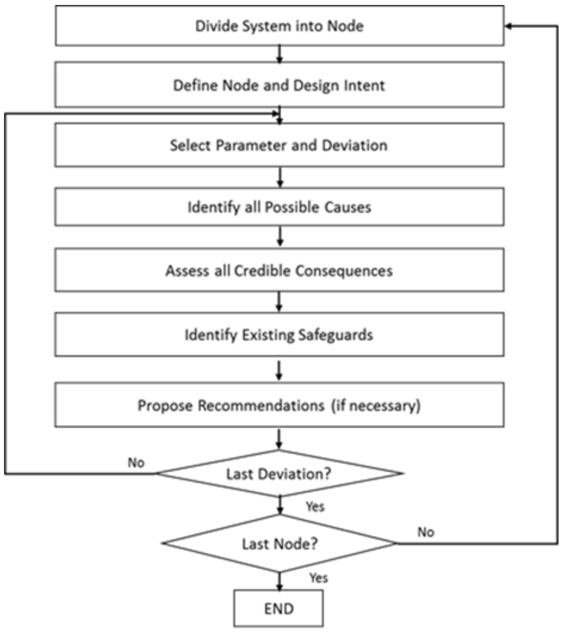

Fig. 2.3 HAZOP study workflow.

Table 2.2 HAZOP guidewords.

No.	Deviation	Guideword	Parameter
1.	No/ Less Flow	No/ Less	Flow
2.	More Flow	More	Flow
3.	Reverse/ Misdirected Flow	Reverse/ Misdirected	Flow
4.	More Pressure	More	Pressure
5.	Less Pressure	Less	Pressure
6.	More Temperature	More	Temperature
7.	Less Temperature	Less	Temperature
8.	More Level	More	Level
9.	Less Level	Less	Level
10.	Composition/ Contamination	As well as	Composition
11.	Instrumentation/ Sampling	Other than	Operation
12.	Abnormal Operation	Other than	Operation
13.	Maintenance	Other than	Operation
14.	Corrosion/ Erosion	More	Corrosion/ Erosion
15.	Relief	Other than	Operation
16.	Ignition Source	Other than	Operation
17.	Service Failure	Other than	Operation
18.	Others (Commissioning, Maintenance, Startup, Shutdown)	Other than	Operation
19.	Drawings	-	Drawing
20.	Operability Issues	Other than	Operation

For a selected guide word, the HAZOP team has identified the possible causes, potential consequences, and the existing safeguards already in place to prevent the realization of hazards due to deviation from the normal operation intent. The recommendation for the hazards identified with inadequate or inefficient safeguards has been raised. When applying these assumptions, careful consideration should be taken so that significant hazards will not be overlooked.

3 Results

HAZOP discussion shall be recorded in the HAZOP worksheet. The record shall be complete and accurate. This includes recording all deviations discussed even though the deviation does not cause significant consequences and no recommendation is generated. HAZOP study Leader shall establish the scope of the study stated in Terms of Reference (TOR), the appropriate HAZOP study technique, and the assumptions with an agreement with team members to be applied throughout the studies. The basis of the HAZOP study for SIPROD is as shown in Fig. 3.1.

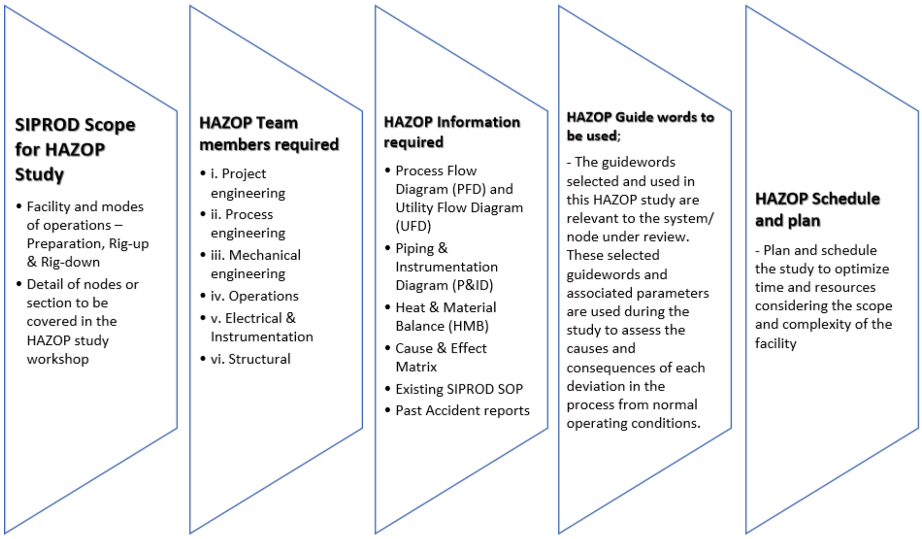

Fig. 3.1 HAZOP approach in SIPROD mode.

In summary of the HAZOP approach, a clear scope containing detailed sections in each SIPROD facility, including preparation, rig-up, and rig-down, is required to identify new potential or recurring hazards related to SIPROD operations. Numerous hazards have been identified but not addressed in the current SOP for the control measures and corrective action. Failure to identify the existing operational hazard during the activity may contribute to the workplace incident (occupational injury or illness). The team's key members should include experienced personnel from the following disciplines; project engineering, process engineering, mechanical engineering, operations, electrical & instrumentation, and structural.

A SIPROD work package will be provided to all participants containing the necessary information for the workshop. This work package in the figure below shall include; the Process Flow Diagram (PFD) and Utility Flow Diagram (UFD), Piping & Instrumentation Diagram (P&ID), Heat & Material Balance (HMB), Cause & Effect Matrix, Existing SIPROD SOP and Past Accident reports.

HAZOP Leader shall ensure the following are available as shown in Figure 3.2;

i. Update and finalize the information package (P&ID, PFD, H&MB, Existing SIPROD SOP, Cause and Effect Matrix.)
ii. Tools (briefing package, software)

The typical worksheet used for recording the HAZOP study for SIPROD mode discussion and findings is enclosed in Table Table 3.1 - 3.5. The guidewords selected and used in this HAZOP study are relevant to the system/ node under review. These selected guidewords and associated parameters are used during the study to assess the causes and consequences of each deviation from normal operating conditions.

Once the HAZOP analysis is complete, the study outputs and conclusions should be documented commensurate with the nature of risks assessed in the study and per individual company documentation policies. As part of closure for the HAZOP analysis, it should be verified that a process exists to ensure that assigned actions are closed satisfactorily.

Several typical recommendations have been identified and raised during the HAZOP session, as shown in Table 3.6. The identified responsible parties need to ensure these recommendations are implemented before or during the project duration.

Table 3.1 Node 1 Well tie-in - new wells to production header.

NO.	GUIDEWORD (DEVIATION)	POSSIBLE CAUSES	POTENTIAL CONSEQUENCES	SAFEGUARDS
1	More Flow	Hydrocarbon Control Valve stuck open	Higher flow from well, no adverse consequences.	No issues identified
2	Less/No Flow	1. Surface Control Sub Safety Valve closed	No flow from well, production deferment. No adverse consequences.	No issues identified
		2. Hydrocarbon Control Valve closed	No flow from well, production deferment. No adverse consequences.	No issues identified
		3. Manifold isolation valve closed	No flow from well, production deferment. No adverse consequences as the system upstream are fully rated.	No issues identified
3	Reverse/Misdirected Flow	Check valve on flowline to header stuck open	Potential backflow from production header to flowline, high back pressure on flowline resulting in production deferment. No adverse consequences.	No issues identified
4	More Pressure	The system is fully rated to Closed In Tubing Head Pressure. No issues were identified.	No issues identified	No issues identified
5	Less Pressure	Line rupture scenario.	Loss of pressure containment leads to fire/ explosion if ignited, resulting in potential personnel injury/ fatalities.	1. Pressure Safety Level triggers flowline shutdown 2. Check valve on flowline minimizes leak inventory
6	More Temperature	Flowing Tubing Head Temperature of wells at maximum temperature	Potential personnel injury due to burns	Flowline provided with heat cage to prevent direct contact to piping
7	Less Temperature	Wax is not expected based on production from the same reservoir	No issues identified	No issues identified
8	More Level	No issues identified	No issues identified	No issues identified
9	Less Level	No issues identified	No issues identified	No issues identified
10	Composition/ Contamination	1. Incomplete well-unloading process	Potential carryover of well completion debris causing damage to topside equipment and instrumentation	1. Strainer connected upstream of the choke valve 2. Procedure to sample the well completion fluid
		2. Introducing well-unloading fluid into the topside process via Test Separator	Internal corrosion due to possible introduction of brine into the system	No issues identified
11	Instrumentation/ Sampling	No sampling point was indicated for flowline	Inability to measure the well fluid composition	No issues identified
12	Abnormal Operation	No issues identified	No issues identified	No issues identified
13	Maintenance	No issues identified	No issues identified	No issues identified
14	Corrosion/Erosion	1. No sand production is anticipated.	No issues identified	No issues identified
		2. Corrosion management strategy	Potential corrosion issues during operations	No issues identified
15	Relief	No issues identified	No issues identified	No issues identified
16	Ignition Source	No issues identified	No issues identified	No issues identified
17	Service Failure	No issues identified	No issues identified	No issues identified
18	Others (Commissioning, Maintenance, Start-up, Shut down etc.)	No new issues identified	No issues identified	No issues identified
19	Drawings	No issues identified	No issues identified	No issues identified
20	Operability Issue	No issues identified	No issues identified	No issues identified

Table 3.2 Node 2 well tie-in - gas lift header to new wells.

NO.	GUIDEWORD (DEVIATION)	POSSIBLE CAUSES	POTENTIAL CONSEQUENCES	SAFEGUARDS
1	More Flow	Hydrocarbon Control Valve stuck open	More flow to the well, potential reduction of gas injection to other wells. However, this is limited as the new infill well maximum gas lift consumption from the stuck open choke	No issues identified

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			valve is limited to 1 MMSCFD. No adverse consequences.	
2	Less/No Flow	1. Gas lift manifold valves isolated	Potential loss of production from the well. No adverse consequences.	No issues identified
		2. Hydrocarbon Control Valve stuck close	Potential loss of production from the well. No adverse consequences.	No issues identified
		3. Automatic General Valve stuck close	Potential loss of production from the well. No adverse consequences.	1. Valve position indication
		4. Isolation valve downstream of Automatic General Valve isolated	Potential loss of production from the well. No adverse consequences.	No issues identified
3	Reverse/Misdirected Flow	Check valve on gas lift line from header stuck open	No adverse consequences as the gas lift header pressure are higher.	No issues identified
4	More Pressure	No issues identified	No issues identified	No issues identified
5	Less Pressure	Line rupture scenario.	LOPC leads to fire/ explosion if ignited, resulting in potential personnel injury/ fatalities.	1. Pressure Safety Level triggers gas lift shutdown 2. Check valve on flowline minimizes leak inventory 3. Gas lift header isolation
6	More Temperature	No issues identified	No issues identified	No issues identified
7	Less Temperature	No issues identified	No issues identified	No issues identified
8	More Level	No issues identified	No issues identified	No issues identified
9	Less Level	No issues identified	No issues identified	No issues identified
10	Composition/ Contamination	No issues identified	No issues identified	No issues identified
11	Instrumentation/ Sampling	No issues identified	No issues identified	No issues identified
12	Abnormal Operation	No issues identified	No issues identified	No issues identified
13	Maintenance	No issues identified	No issues identified	No issues identified
14	Corrosion/Erosion	No issues identified	No issues identified	No issues identified
15	Relief	No issues identified	No issues identified	No issues identified
16	Ignition Source	No issues identified	No issues identified	No issues identified
17	Service Failure	No issues identified	No issues identified	No issues identified
18	Others (Commissioning, Maintenance, Start-up, Shut down etc.)	Check valve on gas lift header not installed	Potential reverse flow to the riser	Individual gas lift line has a check valve
19	Drawings	No issues identified	No issues identified	No issues identified
20	Operability Issue	API 6D spec on a check valve and Automated General Valve, which is different from existing gas lift piping design (API 6A)	No consequences recorded	No issues identified

Table 3.3 Node 3 rig up - blowdown route.

NO.	GUIDEWORD (DEVIATION)	POSSIBLE CAUSES	POTENTIAL CONSEQUENCES	SAFEGUARDS
1	More Flow	No issues identified	No issues identified	No issues identified
2	Less/No Flow	Two (2) CO2 bottles were provided for CO2 snuffing, and no issues were identified.	No issues identified	No issues identified
3	Reverse/Misdirected Flow	No purge gas for local vent piping	Potential air ingress into vent piping, the potential for detonation/ deflagration	1. System design setting pressure to accommodate potential detonation/ deflagration 2. Flame arrestor
4	More Pressure	Blowdown scenario onto temporary vent piping	Unsupported piping may be exposed to vibration/ fatigue issues leading to loss of pressure containment/ piping damage during a relief event	No issues identified
5	Less Pressure	No issues identified	No issues identified	No issues identified
6	More Temperature	No issues identified	No issues identified	No issues identified
7	Less Temperature	Minimum design temperature caters to minimum blowdown temperature from the gas	No issues identified	No issues identified

		lift header. No issues were identified.		
8	More Level	1. Passing Blowdown Valve	Liquid buildup in the vent collection system, if prolonged, may lead to carrying over liquid hydrocarbon to the vented tip	Level Switch High (LSH) will trigger platform Emergency Shutdown Pressure
		2. Tote tank for liquid collection adequate for maximum peak flow rate. No issues were identified.	No issues identified	No issues identified
		3. Vent Collection System low point not indicated	Unable to adequately drain liquid from Vent Collection System, potentially leading to higher back pressure during relief.	No issues identified
9	Less Level	Vent Collection System drain valve to Tote Tank left open	During blowdown, potential uncontrolled liquid vibration to Tote Tank	No issues identified
10	Composition/ Contamination	No issues identified	No issues identified	No issues identified
11	Instrumentation/ Sampling	No issues identified	No issues identified	No issues identified
12	Abnormal Operation	No issues identified	No issues identified	No issues identified
13	Maintenance	No issues identified	No issues identified	No issues identified
14	Corrosion/Erosion	No issues identified	No issues identified	No issues identified
15	Relief	Lock the open isolation valve located on the end of the vent header towards the vent stack that is inadvertently closed.	No relief path leading to escalation of the event	No issues identified
16	Ignition Source	No issues identified	No issues identified	No issues identified
17	Service Failure	No issues identified	No issues identified	No issues identified
18	Others (Commissioning, Maintenance, Start-up, Shut down etc.)	No issues identified	No issues identified	No issues identified
19	Drawings	No issues identified	No issues identified	No issues identified
20	Operability Issue	CO_2 snuffing activation location	1. Vent tip in the event of it being ignited may impact personnel from reaching CO_2 snuffing activation location	No issues identified

Table 3.4 Node 4 rig up - instrument air.

NO.	GUIDEWORD (DEVIATION)	POSSIBLE CAUSES	POTENTIAL CONSEQUENCES	SAFEGUARDS
1	More Flow	No issues identified	No issues identified	No issues identified
2	Less/No Flow	No issues identified	No issues identified	No issues identified
3	Reverse/Misdirected Flow	1. Shutdown Valve bypass valve inadvertently opens during instrument air online	1. Potentially not meeting positive isolation requirement	No issues identified
4	More Pressure	No issues identified	No issues identified	No issues identified
5	Less Pressure	No issues identified	No issues identified	No issues identified
6	More Temperature	No issues identified	No issues identified	No issues identified
7	Less Temperature	No issues identified	No issues identified	No issues identified
8	More Level	No issues identified	No issues identified	No issues identified
9	Less Level	No issues identified	No issues identified	No issues identified
10	Composition/ Contamination	No issues identified	No issues identified	No issues identified
11	Instrumentation/ Sampling	No issues identified	No issues identified	No issues identified
12	Abnormal Operation	No issues identified	No issues identified	No issues identified
13	Maintenance	No issues identified	No issues identified	No issues identified
14	Corrosion/Erosion	No issues identified	No issues identified	No issues identified
15	Relief	No issues identified	No issues identified	No issues identified
16	Ignition Source	No issues identified	No issues identified	No issues identified
17	Service Failure	No issues identified	No issues identified	No issues identified

18	Others (Commissioning, Maintenance, Start-up, Shut down etc.)	No issues identified	No issues identified	No issues identified
19	Drawings	No issues identified	No issues identified	No issues identified
20	Operability Issue	No issues identified	No issues identified	No issues identified

Table 3.5 Node 5 Rig Up - Emergency shutdown elevation during SIPROD.

No	GUIDEWORD (DEVIATION)	POSSIBLE CAUSES	POTENTIAL CONSEQUENCES	SAFEGUARDS
1	More Flow	No issues identified	No issues identified	No issues identified
2	Less/No Flow	No issues identified	No issues identified	No issues identified
3	Reverse/Misdirected Flow	No issues identified	No issues identified	No issues identified
4	More Pressure	No issues identified	No issues identified	No issues identified
5	Less Pressure	No issues identified	No issues identified	No issues identified
6	More Temperature	No issues identified	No issues identified	No issues identified
7	Less Temperature	No issues identified	No issues identified	No issues identified
8	More Level	No issues identified	No issues identified	No issues identified
9	Less Level	No issues identified	No issues identified	No issues identified
10	Composition/ Contamination	No issues identified	No issues identified	No issues identified
11	Instrumentation/ Sampling	No issues identified	No issues identified	No issues identified
12	Abnormal Operation	No issues identified	No issues identified	No issues identified
13	Maintenance	No issues identified	No issues identified	No issues identified
14	Corrosion/Erosion	No issues identified	No issues identified	No issues identified
15	Relief	No issues identified	No issues identified	No issues identified
16	Ignition Source	No issues identified	No issues identified	No issues identified
17	Service Failure	No issues identified	No issues identified	No issues identified
18	Others (Commissioning, Maintenance, Start-up, Shut down etc.)	Chemical Injection system shutdown logic maintain at Unit Shutdown during the SIPROD period	No consequences were recorded. To maintain shutdown logic at Unit Shutdown level.	No issues identified
19	Drawings	No issues identified	No issues identified	No issues identified
20	Operability Issue	No issues identified	No issues identified	No issues identified

Table 3.6 List of HAZOP recommendations for SIPROD mode.

REC NO.	DEVIATION	RECOMMENDATION	ACTION PARTY
NODE 1 - Well Tie-In - New Wells to Production Header			
1.1	More Temperature	Provide temperature gauge for new flowlines	Engineering Design
1.2	Less Temperature	Provide in Design Basis that wax is not anticipated based on historical production profile	Engineering Design
1.3	Composition/ Contamination	Evaluate the adequacy of the strainer provided against the potential for well-unloading fluid to damage topside equipment and instrumentation	SIPROD Platform Owner
1.4	Composition/ Contamination	To check the suitability of routing well-unloading fluid into the topside process with consideration of drill and complete strategy	SIPROD Platform Owner
1.5	Instrumentation/ Sampling	Evaluate the need and function of the sampling connection for each new flowline.	SIPROD Platform Owner
1.6	Corrosion/Erosion	Develop/ update Corrosion Management Plan for new infill wells	SIPROD Platform Owner
NODE 2 - Well Tie-In - Gas lift header to new wells			
2.1	Others (Commissioning, Maintenance, Start-up, Shut down etc.)	Review the need to reinstate the check valve on the gas lift header	SIPROD Platform Owner
2.2	Operability Issue	Review with Piping Technical Authority on valve type used (API 6D vs. 6A)	SIPROD Platform Owner
NODE 3 - Rig Up - Blowdown Route			
3.1	More Pressure	Ensure adequate pipe support is to be designed for (e.g. via Pipe Stress Analysis)	Engineering Design
3.2	More Level	Portable Container to be located such that Vent Collection System piping low point can be drained to the Tote Tank. It is temporarily used during the SIPROD campaign.	SIPROD Platform Owner
3.3	Less Level	Provide level containment arrangement for drain valves on Vent Collection System into Tote Tank	Engineering Design

3.4	Relief	Remove Lock Open valve located at vent piping near vent stack	Engineering Design
3.5	Operability Issue	Verify CO2 Snuffing System activation location concerning potential radiation impact from vent tip	Engineering Design
		NODE 4 - Rig Up - Instrument Air	
4.1	Reverse/Misdirected Flow	Ensure positive isolation from the gas lift line is achieved when utilizing instrument air for instrumentation	Engineering Design

4 Conclusions

A high trend can be seen in several HAZOP applications for assessing the oil and gas platform at SIPROD mode with a massive number of scenarios in one HAZOP study by prioritizing identified scenarios. At the end of the HAZOP session, the design should be finalized and the HAZOP Study exercise completed. The HAZOP workshop shall be conducted effectively with adequate participation and involvement from personnel present throughout the sessions. All of the recommendations are to be followed by the nominated party and closed out as soon as possible. An action plan must be developed and distributed to the responsible parties to ensure these recommendations are reviewed and closed. The approved construction drawings should be finalized once the recommendations of this study have been reviewed and incorporated.

Declaration of Conflict of Interest

The authors declared that there is no conflict of interest with any other party on the publication of the current work.

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