Technical Journal of Engineering and Applied Sciences
Available online at www.tjeas.com
©2013 TJEAS Journal-2013-3-23/3405-3409
ISSN 2051-0853 ©2013 TJEAS

Qualitative risk assessment approach based on HAZID method in Sirri Island gas compression and export facility

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ABSTRACT: Today the identification and control of hazards in coastal and offshore petroleum industries be a major concern of managers in the oil industry for their sensitive marine ecosystems. Various methods are used for prediction, detection and control of hazards and assessing existing risks associated with these hazards in the petroleum industries. It seems more important in coastal and offshore areas due to water, aquatic and extensive environment. The objectives of this study are identifying potential hazards in Sirri gas compression and export facilityin Sirri Island in Persian Gulf and assessing risks in this facility. To achieve this objective, HAZID methodology is used. This approach focuses on identifying hazards in the system to determine factors that can release a hazard, events and their consequences.Finally qualitative risk assessment was implemented based on a risk matrix in four categories (people, environment, asset, reputation). Risk assessment in this study consists of two stages which are without control risk and with control risk.Risk assessment result for facility shows that for before control measures there were 286 cases low risks, 127 cases medium risks and 95 cases high risks and for with controlrisk results showed there were 462 cases low risks, 40 cases medium risks and 2 cases high risks.Highest risk output was identified in “pig receiver” node for “condensate” and “oil and gas under pressure” hazards in people category. Lowest risk outputs were in company reputation node with 100% low risks.

INTRODUCTION

Sirri gas compression and export facility due to the nature of its materials, equipment and processes is the scene of accidents. There were many potential hazards which should be identified and controlled. Also risks in facility should be assessed and categorized.

Hazard identification (HAZID) is the first and most important step in a risk assessment. HAZID method is a qualitative risk assessment method. Hazard identification is the process of systematically identifying hazards and associated events that have the potential to result in a significant consequence (IEC/FDIS 31010, International standard). Graf and Traub (2000) used HAZOP methodology for hazard identification of chemical plant. Cameron et al., (2008) used HAZID method for identification of advanced diagnostic systems hazards. Paltrinieriet al., (2011) used HAZID method in Liquefied natural gas (LNG) tankers for identifying its hazards. Iscan (2004) prepared a study for hazard identification for contaminant. He did his study on toxicants and their by-products. Bahn (2013) did workplace hazard identification with action research method. In this study the case study was underground mining operation. Kianmehr et al., (2013) used HAZID method for identifying environmental hazards in gas compression unit.

According to surveys for coastal and offshore area hazard identification methods didn’t conducted detailed and with consideration all aspects of hazards.

The aim of HAZID is first to produce a list of all possible hazards and second to evaluate them in order to priorities them. In order to support the evaluating procedure we propose HAZID as a tool the multi criteria decision analysis. The reason is that the final decision depends on criteria, which correlate the potential hazardous scenarios with different consequences (Georgios, 2008). An overlooked hazard is likely to introduce more error into the overall risk estimate than an inaccurate consequence model or frequency estimate. The aim of the HAZID is to produce, therefore, a comprehensive list of all hazards (Georgios, 2008).

The study area is Sirri gas compression and export unit in Sirri Island in Persian Gulf(see fig 1). The island is almost 5.6 kilometers long with a width of about 3kilometers. It covers an area of 17.3 km². The highest point on the island is 33m above sea level. Like the other islands in the Persian Gulf it enjoys a warm and humid climate.

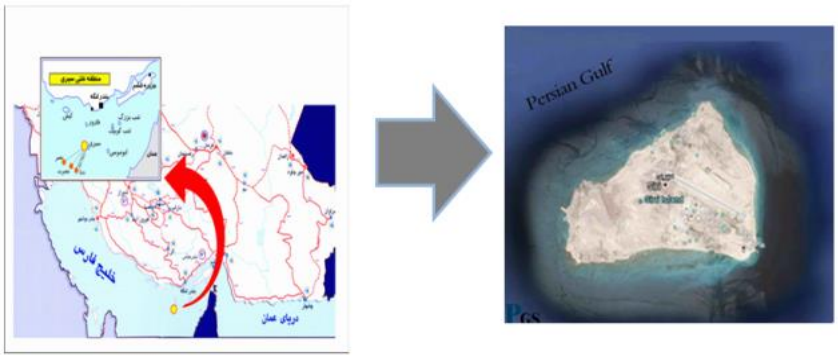

Figure 1. Sirri Island

MATERIALS AND METHODS

Hazard identification (HAZID) is a common and frequent used technique within the petroleum industry. It is commonly used on a great variety of areas, projects, and operations (Doley, 2011). HAZID is a method usually carried out in groups where the objective is to reveal potential hazards in an early stage of a project. The most common application is technical system reviews, also for reviews of operational procedures. A description of potential causes, effects and seriousness of possible accidents are given to each hazard identified. Improvements or preventive acts are suggested. It is essential to have a certain amount of experience with similar equipment or situation to obtain applicable results (Rausand, 2000). The HAZID process must identify hazards that could cause a potential major accident for the full range of operational modes. These modes including normal operations, start-up, shut down, and also potential upset, emergency or abnormal conditions. At the commencement of the HAZID, the complete system of environment, assets, materials, human activities and process operations within the boundaries of the study should be clearly defined and understood.Also account of the original design, subsequent changes and current conditions should be taking. Typically, the system should be divided into distinct separate components or sections to enable manageable quantities of information to be handled at each stage. In this study Sirri gas compression and export unit is divided in 9 areas and 25 nodes according to piping and instrumentation diagram (P&ID) and meeting with experts.

In next step all of hazards existed in Sirri gas compression and export unitshould be determined. It is important at this stage to think as widely as possible in order to ensure that no foreseeable hazards are overlooked. International standard ISO 17776 for petroleum and natural gas industries is used to grouped hazards in main headings (International standard, ISO 17776, 2000). In this study, a checklist wasprepared and used for HAZID conducting (Soroosh F.F.F HSE Case, 2001; Kianmehr, 2013).

This checklist consists of 12 columns and one header. The header showed the properties of each node consist: the P&ID number of each node, existing temperature in nodes (design temperature and operation temperature), each node pressure (design pressure and operation pressure),the flow passes through the nodes. Its columns contain HAZID key terms. Successful HAZID and risk require an in depth understanding of the meaning and relationships of the following terms. First column include existence hazards in certain node, a hazard is any situation with the potential for harm to People, Environment, Assets and Company Reputation. Second column contains ISO number of each hazard, according to ISO 17776 each hazard represented with a special number which acts as a code to recognize hazards (SorooshF.F.F HSE Case). Fourth column is potential effect of hazards, potential effect can be defined as the inherent characteristics of hazards that cause to harm. Fifth column includes threats. A threat is any factor that can release a hazard in an unplanned or uncontrolled way. Sixth column contains events. An event is the first thing that happens when a threat is successful and a hazard is released. Next and seventh columns demonstrate consequences of event. Consequence is an outcome of an event affecting objectives. Eighth column show control elements which prevent event from happening.

In this study controls are separated in two subsets. The first subset contains controls which decrease the probability of event and second subset controls which decrease severity of consequences. The next four columns

contain qualitative risk assessment for people, environment, assets and company reputation. Risk can be explained as the combination or product of the likelihood of an HSE related Hazard release (top event) with the Consequences if it was released.

For evaluating risk, risk matrix was used(see fig 2). Risk Assessment Matrix shall be used to assess and evaluate HSE risks (Moonis, 2010).This matrix shows risk as the product of likelihood (or probability) and consequence (or impact).

CONSEQUENCE					INCREASING PROBABILITY				
					A	B	C	D	E
Severity	People	Environment	Assets	Reputation	Never heard of in industry	Heard of in industry	Incident has occurred in Industry	Happens several times per year in Industry	Happens several times per year on Facility
0	No Injury	No Effect	No Damage	No impact					
1	Slight Injury	Slight Effect	Slight Damage	Slight impact					
2	Minor Injury	Minor Effect	Minor Damage	Limited impact					
3	Major Injury	Localised Effect	Localise Damage	Considerable impact					
4	Single Fatality	Major Effect	Major Damage	National impact					
5	Multiple Fatality	Massive Effect	Extensive damage	International impact					

LOW - Manage for continuous improvement

MEDIUM - Incorporate risk reduction measures

HIGH – Intolerable, urgent risk reduction controls required to move assessment to incorporate risk reduction measures category

Figure 2. Risk Matrix (SorooshF.F.F HSE Case)

After area classification, hazard determination and preparation checklist HAZID method implemented in Sirri gas compression and exportfacility.

At first expert team for HAZID were selected. The HAZID team had 28 experts. The entire group was male. The field of study was divided in four parts by percentage with chemistry engineering 39%, electrical engineering 39%, mechanical engineering 15% and HSE officers 7%.HAZID was conducted node by node by expert team in Sirri gas compression and export facility.

Risk assessment included two steps in this study. At first riskswere assessed before consideration of control elements, in fact risks assumed if the event occurred and there is no control to prevent occurrence of top event and its consequences what's the risk level.

Next step was assessing the risk after consideration the existence of control elements and called "without control risk". It's obvious that controls decrease likelihood and severity of event and its consequence thus decrease risk level.This is the risk that remains when all practicable control have been taken and called residual risk (Moonis, 2010).

RESULTS AND DISCUSSION

In this study hazards were identified and risk outputs were assessed based on HAZID method. Finally total of 20 nodes were selected during several meeting with experts.Maximum number of hazards was identified in pig receiver node (12 hazards) and minimum number of hazard was identified in hydrate inhibitor node (one hazard).
"Condensate" and "oil and hydrocarbon gas under pressure" have maximum frequency and "pyrophoric materials", "high level noise", "SO_2", "corrosion inhibitor", "equipment with moving or rotating part", "engine and turbine exhaust system" and "temperature greater than 150 ˚C" have minimum number of frequency of hazards.
Finally we evaluate 1016 qualitative risk outputs (with control, without control) for our facility.
There are 508 outputs for "without control" risk and 508 outputs for "with control" risk. Risk results for before control measures showed that there were 286 cases low risks, 127 cases medium risks and 95caseshigh risks.

After consideration control measures risk results showed there were 462cases low risks, 40cases medium risks and 2 caseshigh risks. Fig 5 shows “with control” risk results in Sirri gas compression and export facility.

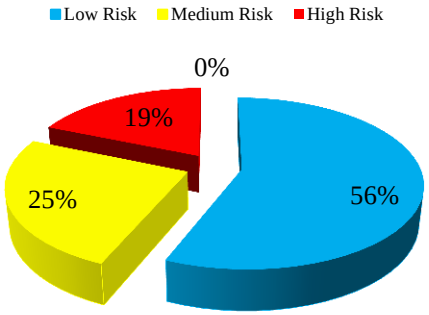

Figure 3. Qualitative risk output result for without control risk

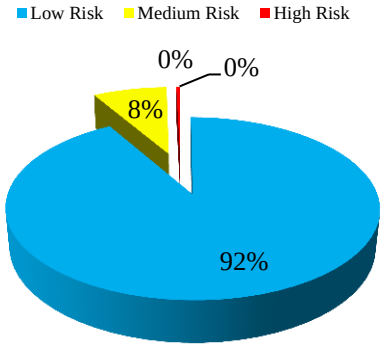

Figure 5. Qualitative risk output result for with control risk

Risk assessment result for four categories (people, environment, asset &reputation) showed

Risk output results for people shows that without consideration control measures there are 15% low risk, 54% medium risk and 31% high risk and for “with control” risk results shows there are 80% low risk, 18% medium risk and 2% high risk.After consideration control measures high risks and medium risks decrease 29% and 36% respectively. This reduction represents effective control measures in Sirri gas compression and export facility. For “with control” risk there is two high risks with the value of 3E. These risks were assessed in pig receiver node for “condensate” and “oil and hydrocarbon gas under pressure” hazards.Risk output for Environment shows that without consideration control measures there are 74% low risk, 16% medium risk and 10% high risk and for “with control” risk results shows there are 99% low risk, 1% medium risk and 0% high risk. For “with control” risk there is no high risk, also medium risk declined by 15% in comparison with “without control” risk. Highest risk was assessed in “slug catcher” nodes with the value of 2D.Sirri gas facility is in coastal area of Persian Gulf and has sensitive marine ecosystems. For this reason effective control measure are taken in facility to prevent event which can cause harm for environment.For asset category risk outputs shows that without control measures there are 66% low risk, 13% medium risk and 21% high risk and for “with control” risk results shows there are 87% low risk, 13% medium risk and 0% high risk.In asset category highest risk was assessed in four nodes with the value of “4C”. The nodes includes: “CCV”, “HP separator”, “Suction scrubber” and “Metering and gas export”.For company reputation subset risk output shows; without control measures there are 72% low risk, 18% medium risk and 10% high risk and for after control risk results shows there are 100% low risk, 0% medium risk and 0% high risk.Iranian Offshore Oil

Company (IOOC) is a state-owned company, thus the accidents aren't reflected completely in media. For this reason accidents and their consequences don't affect company's reputation.

CONCLUSION

In this study HAZID method was used to identify hazards in Sirri gas compression and export facility. HAZID method is a comprehensive method to identify hazards and a high level qualitative risk assessment technique with the purpose of understanding and qualitatively estimating risks. Hazards identification based on HAZID method shows that there were 127 hazards in Sirri gas compression and export facility. These hazards consist of 29 different hazards with different frequency in facility.HAZID method is a comprehensive hazard identification methodology and can cover all aspects (people, environment, asset, company reputation) for identifying of hazards. People category had the maximum number of high risk and medium risk with two high risks and 23 medium risks. Company reputation had no high risk and medium risk.

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