# A Hazop Risk Assessment on the Persian Gulf Star Gas Condensate Refinery in Bandar Abbas

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## Abstract

**Introduction:** This research was undertaken to evaluate and determine the risk of gas fluids and leakage of Persian Gulf Star Refinery on the environment in Bandar Abbas

**Methods and Materials:** Through collection and compilation of research findings, we attempted to identify and work on factors leading to environmental risks. The risk factors were identified by HAZOP team and the risk score was calculated by multiplying the probability of intensity using the default PHA-Pro software. The intensity was calculated using Roline Geronsine. An environmental risk assessment is vital in terms of environmental safeties and protection. To determine the distribution of contamination PHAST software was used.

**Results:** According to the results of the assessment, seven units of the total 17 refinery units turned out to pose major hazards. In total, 28 risks factors were identified, of which 46% (12 risks) attributed to SRP. The fuel-gas unit had the minimum number of risks (1 risk, 4%). The study showed that 75% of the plant's environmental risks were caused by failure of equipment (OR poor performance of equipment) and the rest caused by human errors. In addition, we found that 24 risk factors (85%) were in grade 3, and the rest were in grade 2.

**Conclusions:** In HAZOP method, equipment and economic damages caused by unexpected events as well as the environmental damage are not of high priority, just as in the other methods of risk assessment that are based on process safety management. Hence, in this study, applying PHAST software, impacts of pollution on the region environment were identified. According to the results obtained in the Persian Gulf region, it was found that environment could be affected by unexpected events in terms of sensitivity together with PHAST output. Thus, vigorous controls need to be exercised to prevent accidents.

**Keywords:** Risk assessment, HAZOP method, PHAST software, condensation refinery, Bandar Abbas.

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## Introduction

Risk technology was recognized after World War II. Environment Risk and Environment Risk Assessment are the upshots of catastrophic occurrences such as factory explosion, oil tankers spill, derailment of chemical carriers off train tracks, fires by burning oil. They were there to cover issues regarding environmental pollution such as the mentioned catastrophic events. In 1992, more than 50 commercial banks stated that they were part of inventory, sponsoring domestic and foreign studies on EIA (Environment Impact Assessment) and ERA (Environment Risk Assessment)[1]. HAZOP technique was first introduced by Britain Imperial Chemical Industries in 1970 and was legalized later by T. A. Kletz. The techniques were used to identify and assess the risks of already-introduced processes, but now it can assess the other systems in different industries[2].

Recently, new methods of risk assessment are developed. For example, Stephen Heller introduced the technique of Expert Choice software MCDM (AHP) in the U.S., in 2006, to evaluate the risk of payment. This hierarchical structure was based on human, natural and technical events[3].

In a study in 2007, it was shown that technology of risk-based maintenance reduces equipment failure in working with tools, planning and decision-making. In addition, risk analysis methods were studied based on the care for risk factors in risk assessment. Three analysis methods were used to identify the risks (risk-based maintenance) and to reverse faults[4].

In 2009, RBI&M risk assessment was developed. This method contained six steps, which include: 1) Range identification, 2) Performance Analysis, 3) Risk assessment, 4) Risk evaluation, 5) Planning, 6) J-factor calculation (capital mark Euro to reduce any risk)[5].

In a study in 2010 a new method of risk assessment was developed, modeling BP Texas city refinery accident, which applies dynamic risk assessment approach. This probability is determined using a binomial distribution[6].

Model-based HAZOP study of real MTBE plant was published in the Journal of Loss Prevention in Industrial Process In 2007. The foundation of this approach is the integration of mathematical models, which uses HAZOP, and a mathematical model to identify some of the potential increases of adverse deviations in HAZOP. It decreased the time required to identify the risks[7].

In their study, Sekhavatjo and his colleagues (2005) revealed the hazards of working with ethylene oxide and ethylene oxide units in Arak Petrochemical, and the results of the HAZOP research project[8].

Dr. Adl et al. (2005), conducted a survey on HAZOP & FMEA risk assessment method, and aimed to assess the risks of equipment and process failures in a gas refinery, gas sweetening plant to determine the main hazards and defects of major equipment components by HAZOP & FMEA methods[9].

Dr. Karbasi et al. (2009), conducted a study on the environment in four stages: 1) Scope of study 2) Identification of the key aspects of the environment, 3) Review of the existing practices in the field of environmental management and scheduling prior environmental aspects and risks of using Matrix 4) Risk assessment and analysis of the results[10].

With 18% of the total oil production, Bandar Abbas Oil Refinery stands in the third place after Abadan and Isfahan. The refinery is going to be used for the first time after three years, and as a result, the

refinery will be a major export point for the country.

Meanwhile, the gas condensate production processes, makes the products, equipment and other variables significant potential risk factors. Furthermore, the amount of pollutants released in ecological environment is becoming substantially significant and out of control. Studying the risk assessment of environmental is a step toward risk assessment. Since risk analysis brings about complete understanding of the environmental sensitivity of the area, an analysis on particular ecological environment of the area is carried out.

In general, the present study attempted to identify the risks that lead to environmental pollution.

## Methods and Materials

Various steps and tools used in each part of this paper is presented in diagram (1)

Identification of risk factors:

In this paper, the Environmental Risk Assessment of gas condensate refinery in Bandar Abbas operation phase is discussed. With the help of the project and HAZOP experts, project risks and risk factors leading to the explosion or termination of the unit were identified.

HAZOP groups generally comprised of four to eight people, a leader, a receptionist and professionals with different areas of specialization. Such expertise can be used to process engineering, maintenance, systems rotator, safety, instrumentation and operations noted. The team leader should have at least 5 years of experience in oil industry or related industries. He also has to have the experience and education to lead the HAZOP method[12].

Three teams of eight people, including two Italian and one Iranian team, worked for 8 months to identify causes of risk. The first step was to divide the HAZOP method P & ID drawings for the specified region (node). Instrumentation Engineering Association of America with views of the surrounding equipment is at least one node. The deviations or errors that may have come into existence at each node are determined. The errors included procedural errors, human, instructions and software. Outcomes or consequences of any deviation, and finally the assessment of the risk were addressed.

Risk Assessment:

**A- Determining the severity and likelihood:**

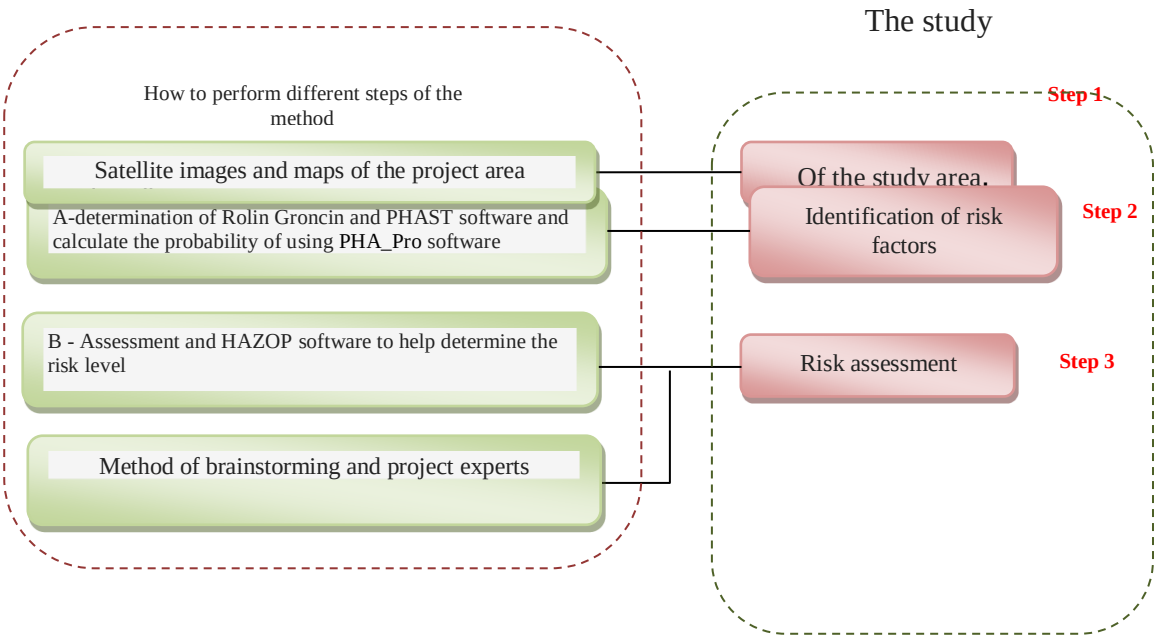
Using the classification system for determining potential impacts and likelihood of risk were assessed and analyzed. Risk factors indicate the possibility of a hazard in a given time period. As we know, explosion of a tank leads to fatal consequences, therefore in this study, modeling of thermal radiation is considered for safety risk. The classification presented in Table 1 indicates the occurrence of an event in a quantitative segmentation of control risks. This table can be used as the basis to realize the importance of the incidents.

From an environmental aspect, risk assessment is important since any damage to the environment has a direct correlation with the amount of pollution dispersed. Therefore, to determine the distribution and extent of pollution caused by an explosion, PHAST software was used. The software is also able to show the areas affected by pollution concentration. Considering that the aim of this project is environmental risk assessment, HAZOP studies of adverse effects is not able in demonstrating the areas under the study. The integration of the software HAZOP will help in the assessment of environmental risk. Rolin Geronsin is used to grade the severity, as shown in Table 2, considering that tank explosion resulting in

casualties is due to the modeling of thermal radiation which can result in safety.

**B - Risk assessment and placement:**

A mentioned earlier, in order to determine the occurrence and severity HAZOP (PHA-Pro) is used (Table 3). Then, the level of risk is addressed. The risk matrix of software PHA_ Pro uses the intensity values, as shown in Figure 1. Risk matrix clearly shows the extent of the risk in a specific area (environment). As it can be seen in the figure, risks are indicated as low risk (7-1), medium (9-8) and high (16-12).



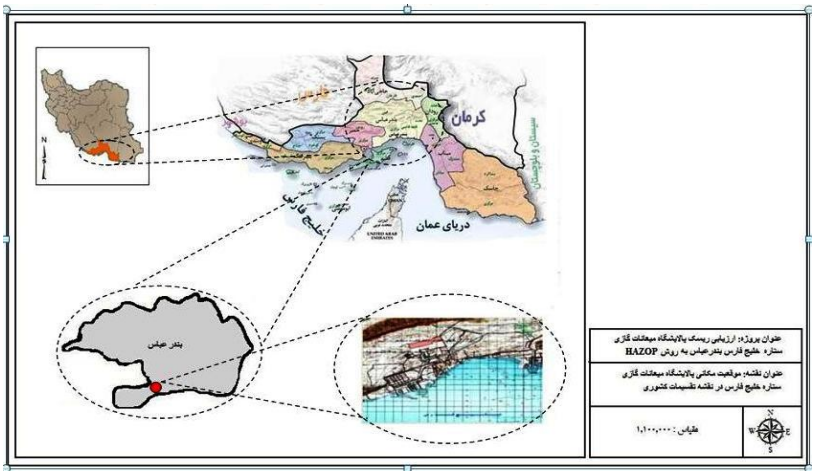



**Chart 1: The steps, tools and techniques of project related to the study area**

**Map 1- Located in the Persian Gulf, the map demonstrates condensates refinery. The studying area according to instruction manuals Persian Gulf Star gas condensate refinery in 2800 and located in areas with high risk seismic design basis acceleration is a = 0.35g[11].**

**Map 1--Location of Bandar Abbas Gas Condensate Refinery**

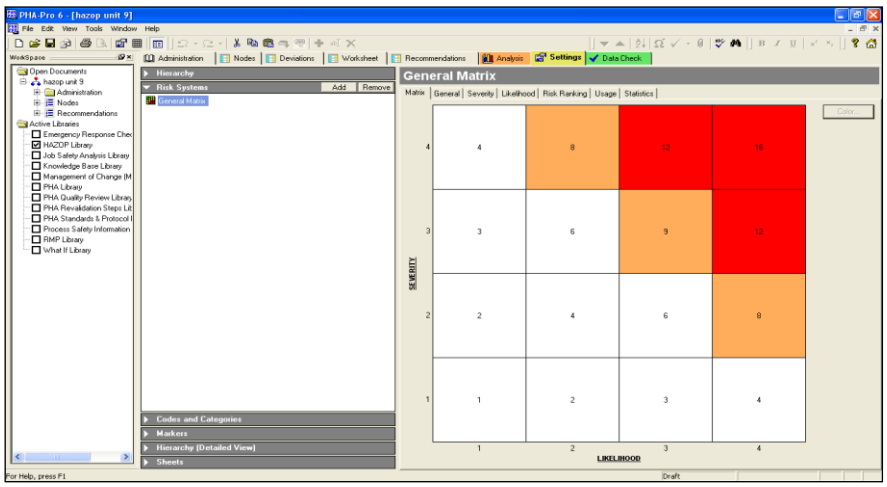



**Figure 1: Risk Matrix of PHA-Pro software**

## Results

Results indicated that the most important project in terms of units of production risk was "sulfur recovery unit". Hence, in order to avoid all risks, control methods were applied in this unit.

Risks leading to the explosions of tanks were found to be Feller emissions. Using PHAST software in stable and neutral atmospheric conditions, these factors were modeled. The areas affected and the severities of the identified areas were shown. However, due to the multitude modeling in the present study, offsite example seems sufficient to provide storage and loading of plant modeling as. The total refinery HAZOP tables are presented in Table 4.

The results of the risk assessment in offsite unit

This unit is located outside the factory. One of the areas in which the unit is located is the loading dock of exporting products. In this section, spherical tanks of butane gas are stored. If the operator forgets to close the inlet valve, the overflowing butane tank will explode with a spark. Hence, the distribution of the pollution caused by the accident is modeled.

As seen in Figure 2, maximum emission of neutral atmospheric conditions with the wind speed of 5 m/s is shown at the top. Red range (up to150 meters away from the scene) emission in 93000 ppm can be seen in the yellow range (the distance of 150 yards to 500 yards away from the incident). Concentration in 16000 ppm pollution and green range (the distance of 600 meters to 1020 meters event), and blue box in 8001 ppm pollution levels (up to 50,000 feet away from the accident), and the degree of contamination is 1000 ppm. Therefore, the blast will produce cloud with 50,000 feet (2600 m) width and length. It is worth noting that given that this event occurs in the dock, the water quality of the Persian Gulf and consequently aquatic organisms are strongly affected by the incident. Therefore, the most important pollution caused by the accident is the water quality of Persian Gulf, which inevitably results in pollution, and mortality of aquatic organisms.

Saving and loading the results of the risk assessment

In this section, propane, butane and LPG produced in the processing unit, are stored to provide LPG. Propane and butane are stored in spherical tanks. Each of the spherical tanks consists of two valves that control the pressure in the range 8/18 times holds. If it overflows due to operator's negligence, any flame will explode the tank. Stable dispersion of pollutants in the atmospheric wind speed of 2 meters per second, is modeled on the model output Figure 3.

Figure 3 shows the analysis of the pollution concentrations 500 m from the site of the accident to be 95000 ppm. This rate gradually decreases as the distance of 19km from the contamination reaches 1000 ppm. Based on a standard result, the amount of pollution caused by the accident is much higher than the permissible limit.

Because this refinery is located in a completely industrial area and devoid of vegetation, and since in all seasons the dominant wind direction is from the sea to the land, and the refinery is located on the north side of the mountain crossbow, dirt and damage caused by the accident would affect the adjacent refinery and the refinery workers. However, if the prevailing wind direction at the time of the accident is toward the city of Bandar Abbas the amount of pollution reaches 1000 ppm.

Figure 4 indicates the amount of radiation from the explosion occurred at distances up to 3500m from the emission source in stable atmospheric conditions. The results show that the radiation ranges 550 meters KW/m2 5/37. Therefore, the equipment will be damaged in this area and the employees will lose their lives. Those between 550 and 1900 meters away from radiation will need rescue efforts to survive. The blue zone is safe and the staff will be able to escape from that area. The modeling was done to determine the extent of damage caused by explosion.

The results showed that of the 17 refineries, seven face risks of emissions, which are outside the factory cause serious harm to the workers. According to the investigations, the risks identified in this unit is about 28, of which the sulfur recovery unit is 12, and that is equivalent to 46% of the total risks. Risk of the highest potential for gas and fuel is equivalent to 4% of the total liquid safety risks. The amount of potential risks per unit are shown in Figure 5.

It is worth noting that all the risks identified in the sulfur recovery cause the unit to be shut down, when it is subsequently transported 40 tons of gas condensate Feller.

Distortions caused by transmission of gases such as H2S, SO2, PM and hydrocarbons is Feller. Feller obviously increases the transmission of materials and exceeds the emission of pollutants to the environment. Another consequence of adverse deviation is the release of flammable substances in the event of an accident causing fire and explosion, and consequently, hazardous toxic emissions to the environment. Thus, the occurrence of these risks will diminish air quality and pollution. According to the prevailing wind direction (south and southwest), pollution in industrial area will have negative impacts on the workers. The risks identified in a single tank explosion in an offsite unit have a highly negative impact on the water quality and aquatic life in Persian Gulf.

Figure 6, reveals that 75% of the total environmental hazards in Persian Gulf Star Refinery are caused by malfunctioning units and 25% of the risk occurs by human error. Similarly, Figure 7 shows that 85% of the total risk of 24 hazards, which is 15% of the total risk, is third and fourth level.

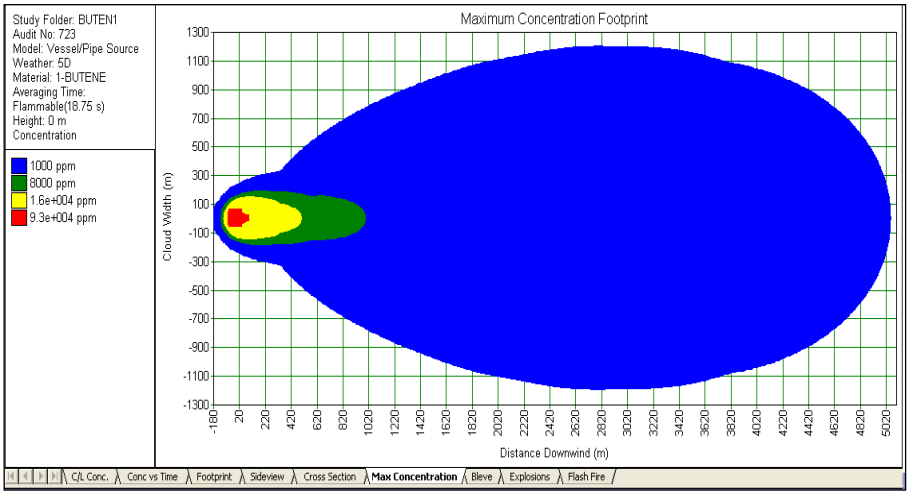



**Figure 2: Distribution of neutral l atmospheric pollution**

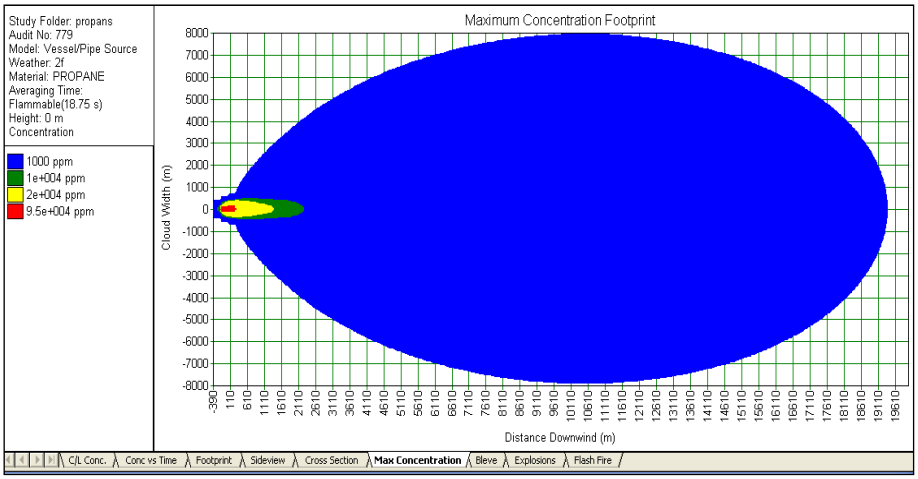



**Figure 3: Distribution of the maximum amount of pollution caused by exploding propane tanks.**

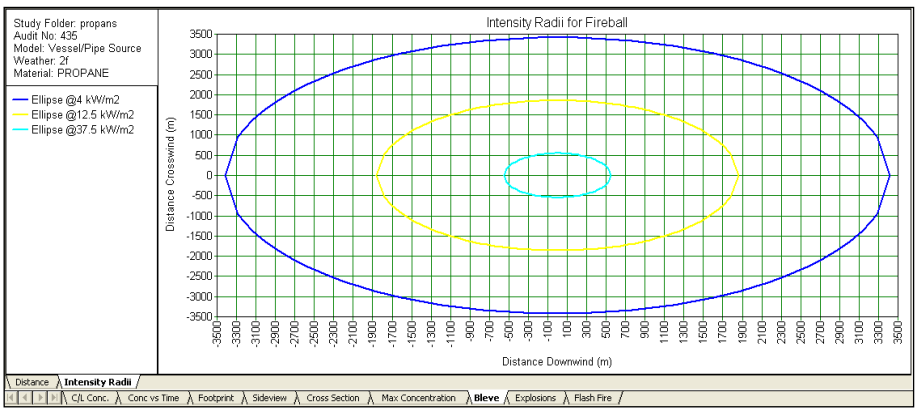



**Figure 4: Thermal radiation from an exploding propane tank in stable atmospheric conditions**

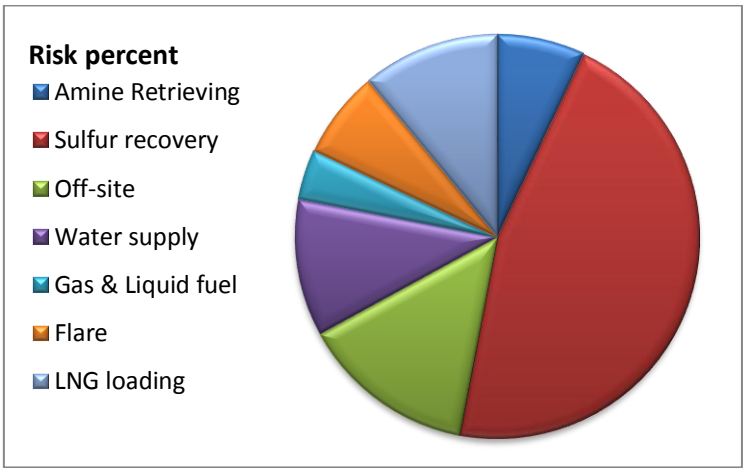



**Figure 5: the amount of risk per unit**

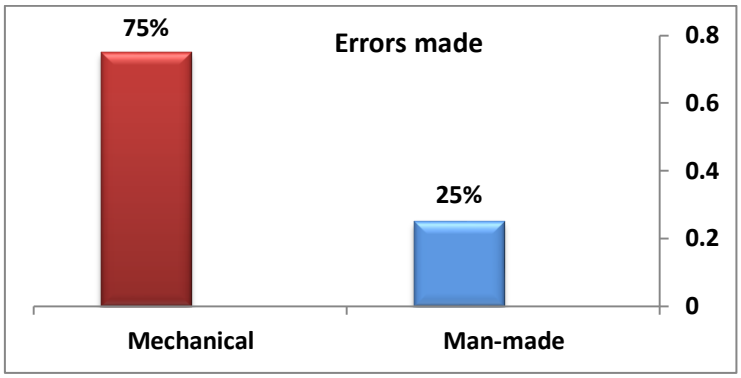



**Figure 6 : Percentage of the errors made**

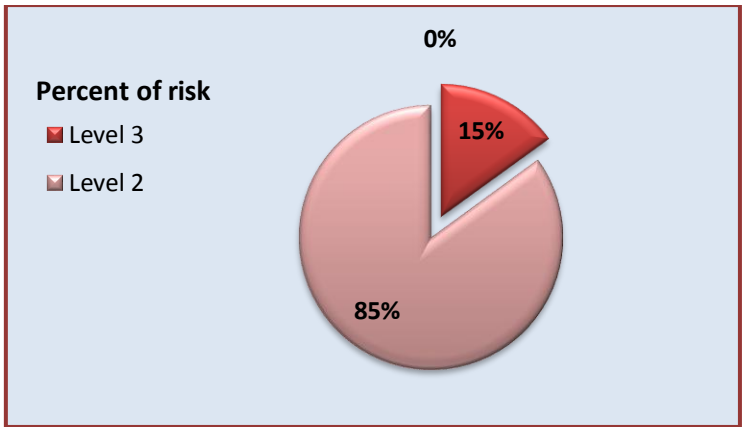



**Figure 7: Percent level of risk**

## Discussion

Refining risk assessment methods vary from method to model, each has been developed with specific goals, for example in order to predict the consequences of the accident at the refinery accurately, a dynamic risk method and to calculate the probability of occurrence of the distribution, binomial method are used.

Maintenance and risk assessment are based on a different method to determine the amount of investment proposed to reduce risk. In this way, the risk assessment measures to reduce risk factors will be presented and j-factor is calculated:

$$\text{(j} = \textit{the secondry risk} - \text{ The primary risk )} \over \text{The cost of the euro}$$

Multi-criteria decision-making techniques are also applied and to assess the risk, Expert Choice software is used.

In this method, the hierarchical structure of the identified risk-based criteria is plotted. In this way, the risks identified in three humans (human Manndkhtahay), technical (Manndkhtahay system) and natural (such as earthquakes) are split up in order to determine the criteria for paired comparison. Darkhovin Oil Refinery venture in 2009 was reviewed. The environmental aspects of the proposed operation of Darkhovin (air pollution, noise and waste) were identified.

Analyses of air pollutants allowed in the parts units are manifold, separating, heating and cooling, storage tank and oil

pits fuel turn out to be the single greatest risk Feller with a score of 80[13]. Such routine risks of daily activities that cause pollution to the environment have been studied. However, unexpected dangers of environmental pollution have not been studied. As was stated in the risk assessment, the methods do not consider environmental aspects and they are studied in routine situations.

In this study, we tried to analyze and assess unexpected risks that may cause environmental pollution. This study is based on a comparison of existing methods. HAZOP method was chosen for this study because it is the best way to identify a direct cause of danger or disruption of the process. This method is common and most experienced engineering consulting companies in oil, gas and petrochemicals use it in various stages of design. HAZOP method is based on a logical and efficient way of identifying hazards and operational problems. This method can be used throughout the project, and is especially effective to detect risks early in the design process. Although this method is a time-consuming process, the cost is affordable[10]. Providing that HAZOP is done quickly and in time, most part of the cost in improving the design or setting up operating conditions can be reduced. HAZOP method is based on a safety management process. It mainly focuses on the economic damages caused by an incident, as well as industrial safety aspects of planning and environmental damages. Therefore, to overcome such an issue in this study, instead of the severity of the HAZOP procedure, Rolin Gerons tables were used, in a way that environmental aspects were considered in the risk assessment. In addition to using PHAST software, environmental effects caused by pollution were identified. As the results of the PHAST software indicated, the most sensitive region of Persian Gulf Sea ecosystem is influenced by the water front. Hence, it is necessary to apply more controls to prevent the accident.

## Suggestions

It is evident that to reduce the risks identified, all factors have to be taken into account to reduce the likelihood and impact of the loss.

To reduce the risks associated with the control buttons, switches must be interlocked. Some ways to reduce the risk of unexpected events are presented below:

-All equipment and hazardous areas must be equipped. Proof-coating to resist and fight fire should be conducted.

-Provide adequate water pressure in case of flame.

-Flare Gas Recovery.

-Prevent entry of oil into the Persian Gulf coastal waters.

Vermiculite fireproof coating, base-Cement, in 1947 by an American company in one of the oil refineries in the United States was conducted. Since then, the company introduced his own compositions. Vrmyfayr is based on Iranian oil standard of ps-c-ce-260. It is made by mixing cement and required additives. The main advantage of Vrmyfayr is that it does not produce any smoke or toxic gases in case of fire[13].

As shown in Table 4, this is considered as one of the most important consequences of sulfur recovery unit. It is transferred from the condensate Feller-to-Feller excess gas recycling; it is the best environmental solution. Biological recovery method is the most effective ecological way. In this method of using bacteria and a decomposition reaction column, gas is decomposed into its constituent elements[14].

The most important water quality guidelines for the protection of the environment in Persian Gulf region is as follows:

-Berth network for the collection of surface water, human waste, human sewage, and drainage systems for surface treatment should be separated Dayrgrdd. The treatment system will be able to separate the waste oil before it enters the sea.

-Environmental management center in the port should be set for the handling, transportation, storage, loading, unloading and monitoring. In the event of an accident and oil spill in the coastal areas of the Persian Gulf, the removal of pollution or the use of biotechnology should be conducted. In this method, a microorganism that is capable of hair development in certain types of auto and oil degradation products becomes easier to use. This way oxygen needs to decompose quickly. For an analysis of 320,000 gallons of crude oil to dissolve in the water, gallons of compressed air are required. In regions where the oxygen content in the water is low, slow oxidation occurs. Use of adsorbents for the removal of oil pollution seems necessary. For straw and sawdust, polyurethane foam and other inorganic adsorbents can be used. A ton of oil can be 50 cubic feet per floor. There are several materials that make the oil suspend, these include detergents and emulsifier[15].

**Table 1: Determination of the possibility of using the default software PHA-Pro (Source: Google, 1384)**

| Probability | Definition |
|---|---|
| 1 | There is no occurrence during the system lifecycle |
| 2 | Once occurs during the system lifecycle |
| 3 | Several times during the cycle of the system occurs |
| 4 | Frequently occurs in the system lifecycle |

**Table 2: Determination of the method Roline Geronsin (Source: Habibi 1386)**

| Severity | Environmental aspects | Safety aspects |
|---|---|---|
| 1 | Minimal environmental impactor no impact<br>Public opinion is not concerned | Minor injury or no injury |
| 2 | Environmental effects of mild and reversible<br>No effect on public opinion | Environmental effects of mild and reversible<br>No effect on public opinion |
| 3 | Irreversible effects on the environment within the company<br>Possibility of negative public opinion | Organ damage, chronic, irreversible disease |
| 4 | Emissions from refineries and irreversible effects on the environment<br>Strongly negative | Death or amputation |

**Table 3: Worksheet HAZOP**

| Risk Matrix | | | Consequences | Causes |
|---|---|---|---|---|
| R | L | S | | |
| | | | | |

| Risk Matrix | | | Consequences | Causes | Unit |
|---|---|---|---|---|---|
| R | L | S | | | |
| 9 | 3 | 3 | - The sudden arrival of a tank of gas to a mine absorber tower, the pressure in the tank increases. The result is a line from the tank to the open Feller and toxic gases are released into the environment. | Wrong finish to hydrocarbon absorber tower discharge. | **AMINE TREATING UNIT** |
| 12 | 3 | 4 | - Increased pressure in amine absorber resulting in rupture and release of toxic and flammable substances. | - External Fire<br>- Malfunctioning device PIC (controller and pressure indicator) sulfur recovery unit pressure valve closure<br>- Local power outage<br>- The temperature rises in input rich amine | |
| 12 | 3 | 4 | - The transmission fluid goes from ko-drum spill may result in a rise to amine acid. Condensate carrying the torch will turn off resulting in explosion (gas enters the burner)<br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | LT liquid level transmitter does not work correctly, the pump does not start the amine acid gas in ko-drum liquid level rises. | Sulfur recovery unit |

| | | | | | |
|---|---|---|---|---|---|
| 1<br>2 | 3 | 4 | - Cut off the flow of natural gas to the burner reactor thermal reactor beyond the accumulation of flammable materials Azkntrlis because of the risk of explosion.<br><br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | Natural gas pressure upstream of the falls. | |
| 1<br>2 | 3 | 4 | - Increasing the gas pressure and the bursting of the ko-drum and its breakdown.<br>- Ko-drum liquid into the outlet and turn off the burner flame and heat will damage the torch.<br><br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | - Reservoir upstream pipe outlet obstruction drum-ko.<br>- Dehumidifiers obstruction(a mesh which attracts droplets, connected to a gas)<br>- External fire around the tank ko-drum | |
| 1<br>2 | 3 | 4 | - Condensate that carries the torch will turn off resulting in explosion (gas enters the burner should be).<br><br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | The operator does not increase the level of ko-drum to drain. | |
| 1<br>2 | 3 | 4 | - Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | - Improper operation of control devices to regulate combustion air inlet gas flow indication.<br>- Loss of air flow control valve device.<br>- Combustion air | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | flow control valve malfunctioning on-line | |
| 12 | 3 | 4 | - Rising above the thermal reactor system damage. Increase the potential break-liquid separating device, leading to the entry process, the gas will collect sulfur(contaminated gases entering the atmosphere)<br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | - Catalyst terminal sulfur condenser foulingorde humidifier<br>-Blocked tubes of liquid sulfur | |
| 12 | 3 | 4 | Increase exhaust flow to the burner sheathe reactor is shutdown or the reverse flow of combustion air or gas line is acidic.<br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | Increasing pressure on combustion air blower outlet. | |
| 12 | 3 | 4 | - The chemical reaction in the reactor out of control, resulting in a reduction of the catalyst is damaged (uncontrollable reaction to the sudden arrival of SO2), which causes the residual gas recovery unit sulfur dioxide greater air pollution is the result of two incinerators of waste to be transported. | Development of heat generation in the reactor, for example ,high concentrations of SO2 feed or by reactive Mtanasyvn due to high concentrationsCO2 /CO | |
| 12 | 3 | 4 | - Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | External fire exposure | |
| 12 | 3 | 4 | The remaining gas is diverted directly to the incinerator, which causes the release of hydrogen sulfide over a short period.<br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | - Incorrect operation of the control unit and the level of the liquid level control valve is closing at the end of the amine absorption line.<br>- Loss of air in the | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | system level control valve<br>- Block Pump | |
| 1<br>2 | 3 | 4 | - Condensate carries the torch will turn off and the resulting explosion (gas enters the burner should be). Ko-drum causes the increase in fuel incinerators are directed to a condensate.<br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | - LT causes incorrect operation of warning time is increased.<br>- The operator when unloading liquefied natural gas ko-drum level rise does not apply. | |
| 1<br>2 | 3 | 4 | Increased pressure in the fuel gas ko-drum rupturing it.<br>- Weekly interval in the process of production of 40tons per day of condensate and Feller. Emissions will increase. | - Top tube tank outlet obstruction ko drum<br>- Eclipse dehumidifiers<br>-External fire near the tank | |
| 1<br>2 | 3 | 4 | - Increased rate of fuel flow to the main burner and pilot flame in the combustion chamber of the incinerator is increased.<br>- Excessive temperature is in the combustion chamber of the incinerator and the refractory material damage to the unit Shvdaz general Feller stops resulting in the air pollution. | Improper operation of the temperature controller VnshanBrmhfzh incinerators burning fuel flow at the maximum rate will increase. | |
| 1<br>2 | 3 | 4 | - Damage in the arms of the loading pier is poured kerosene and increases the risk of explosion or fire.<br>- Water quality, marine animals and microorganisms are threatened in the Persian Gulf. | All the three pumps work together | **Outside Unit** |
| 1<br>2 | 3 | 4 | - The opening pressure of the safety valve on the propane to the media and the consequences of such fires and explosions if there is a spark.<br>- Water quality, marine animals and microorganisms are threatened in the Persian | The operator forgets to close the inlet valve. | |

| | | | | | |
|---|---|---|---|---|---|
| | | | Gulf. | | |
| 12 | 3 | 4 | - The suction caused by the LPG tank will result in the release of substances into the atmosphere. Caused by fire, smoke and toxic materials out of the refinery will be released. | The liquid level control valve will close the supply line to the gas tank and it will be fluctuating. | Unit of gas and liquid fuels. |
| 12 | 3 | 4 | - The opening pressure of the safety valve on the propane to the media and the consequences of such fires and explosions if there is a spark.<br>- Water quality, marine animals and microorganisms are threatened in the Persian Gulf. | The operator forgets to close the inlet valve. | Saving and loading units. |
| 12 | 3 | 4 | - The opening pressure of the safety valve on the propane to the media and the consequences of such fires and explosions if there is a spark.<br>- Water quality, marine animals and microorganisms are threatened in the Persian Gulf. | The operator forgets to close the inlet valve. | |
| 12 | 3 | 4 | - The opening pressure of the safety valve on the Butane to the media and the consequences of such fires and explosions if there is a spark. | The operator forgets to close the inlet valve. | |
| 12 | 3 | 4 | - Increasing levels and transitions in ko-drum causing it to overflow liquid of Feller. Feller will shed from the liquid itself leading to the production of a flammable cloud. | The power is cut off in all the boxes. | |
| 12 | 3 | 4 | - The loss of level of ko-drum and the vacuum pump leads to the HC emissions causing fires. So the release of hydrocarbons and other toxic substances into the environment. In addition, due to shutdown feller increases risk of explosion. | Incorrect operation of the device at start up LI pump block off the pump at a low level. | |

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| 9 | 3 | 3 | - If the water level at the inlet of the vacuum pump is low, the main basin leads to vacuum of the cooling water-circulating pump. All or part of the water needed for consumption, leads to disruption of the refinery process unit and a shut down to the refinery. Therefore, there is such possibility for some units. The release of toxic substances into the environment occurs through Feller. | - The sea water pump inlet valve closed or returned to the sea.<br><br>- Slide valves, water levels will go wrong. | |
| 9 | 3 | 3 | - The loss of spinal fluid pressure in the tank (water reservoir that sends high definition devices) will cause the vacuum pump inlet. Thus, the cooling water will be lost in the process of rotating mechanism. This will lead to disruption of the refinery process unit and a shut down to the refinery. Therefore, there is such possibility for some units. The release of toxic substances into the environment occurs through Feller. | - Improper operation of the transmission system as shown above due to wrong way of valve closing. | |
| 9 | 3 | 3 | - Water desalination in the vacuum pump inlet.<br>- It leads to disruption of the refinery process unit and a shut down to the refinery. Therefore, there is such possibility for some units. The release of toxic substances into the environment occurs through Feller. | The very bottom of the tank where water is drawn. | |

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