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Original Article

Risk Assessment of Ilam Gas Refinery Based on William Fine Method in 2012

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Abstract

Introduction: Industrial growth, development programs and infrastructure projects, in spite of numerous advantages and benefits, have been considered as the source of many hazards, risks and failures. Risk assessment is the organized and systematic methods to identify hazards and risk estimation of decisions ranking, in order to reduce the risk to an acceptable extent. The aim of this study was the risk assessment of Ilam gas refinery using William fine procedure.

Materials and Methods: Executive group, including managers of the gas refinery departments and agencies, was formed in order to identify the risks. The risks of units using the form HSE-FO-001 (0) -90 were identified and the risk assessment was recorded. This technique is based on the calculation and assessment of risks with a severity of the outcome, occurrence probability and exposure.

Results: 289 risks were found in this study, of which 5 risks (1.73%) had a level of urgency (urgent need for corrective actions), 40 (13.84%) had abnormal levels (need of immediate attention) and 244 (84.43%) had a normal risk level (should be deleted).

Conclusion: According to information obtained from the risk assessment tables, the major risks that threaten employees of Ilam gas refinery including the risks associated with working at height, inhalation of gas containing H_2S and exposure to excessive noise. Therefore, engineering measures must be conducted to reduce the level of risk in the refinery units.

Key words: Risk assessment, William fine method, Gas field, Refinery, Ilam

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Introduction

Industrial developments, application development and infrastructure projects, despite all the benefits they bring to humanity, are the source of many significant hazards, risks and failures [1].

With advances in technology and the increasing use of machinery, the hazards and potential accidents have increased in industrial environments [2]. The rapid industrialization of human societies and growing technologies in the world, innovation and newly-developed methods in industry, science, and technological inventions have occurred, bringing a risk to modern life by what people had created with their own hands. In this condition, the preservation of health, labor and other worthy assets is most necessary [3].

One of the consequences of accidents, especially in process industries, such as oil and petrochemical industries with a wide range of pollutants and hazardous chemicals, is the irrecoverable damage to the environment. This along with other environmental concerns such as global warming, destruction of the ozone layer, water pollution, and species extinction has become the most important global concern even more concerning than issues like terrorism [4].

Risk assessment is a systematic and organized approach to identify hazards and ranking for decisions, in order to reduce the risk to an acceptable extent [5]. Risk assessment can be performed in forms of qualitative and quantitative. In quantity risk assessment, better results are obtained. Quantitative evaluations work by focusing on risk factors and adopting preventive and control measures to eliminate or inhibit the risks [6].

In this regard, a scientific approach is required for decision-making and justifying the costs of eliminating the danger and the necessity of risk prompt control programs. One of the most common methods to achieve the above objective by safety experts is William Fine technique. The basis of this technique is calculation and risk assessment [7].

There are numerous criteria to identify the work-related accidents, but the most prominent concern in the present study is related to the human, environmental and economic criteria. Risks were assessed using William Fine method.

Materials and Methods

This descriptive - analytic study was conducted in 2012, in Ilam gas refinery. The study population of the study included all units at Ilam gas refinery. The number of Ilam gas refinery units was 18 units, out of which 9 units were randomly selected for research using a statistical formula (the process unit and general engineering unit have been merged). Statistical formula to determine the number of units was:

$$n = \frac{t^2 \times P(1-P)}{d^2}$$

$$t = 1.96 \quad P = 0.5 \quad d = 0.1 \qquad n = 9.6 \cong 10$$

At Ilam gas Refinery Company, before implementing this study, no risk assessment had been carried out. One of the main strengths of the present method is its emphasis on improving teamwork and innovation of the team members. Therefore, in order to identify the sources of hazard in Ilam gas refinery enterprise, experts group, composed of four people including occupational health expert (one person), Master holder of Environmental Management (one person), and specialist in industrial safety (two people). These people were chosen based on the expertise (familiarity with the method of choice) and experience (more than five years of experience at Ilam gas Refinery Company).

To collect information about safety in selected units, questionnaires were adjusted. Questionnaire data were obtained from six sections as follows:

• The first part related to the unit specification that includes the name of the unit, unit responsibility, work shifts status and summary of activities in units.

• The second section contains a preliminary checklist related to identifying the risks in each unit.

• The third section contains a list of chemicals that unit personnel deal with.

• The fourth section contains a list of personal protective equipment, distributed among staff.

• The fifth section contains the status of HSE rules and regulations governing its units.

• The sixth section contains a list of guidelines related to HSE units.

In order to assess the hazard with William Fine method, it is necessary to clearly rank the severity, probability and risk exposure of each aspect of its activities (Table 1).

A method of decision-making is well developed if the cost to correct a hazard is calculated and also how rapidly hazards should be corrected. This technique involves the use of risk.

A risk score, R, is computed from

$$R = C \times E \times P \qquad (1)$$

C is the consequence rating value,

E is the exposure value, and

P is the probability value.

Table 1: Values for Fine's judgment Process

Consequences, C (most probable result of potential accident)	
100	Catastrophe; numerous fatalities; damage over $1,000,000; major disruption of activities
50	Multiple fatalities; damage $400,000–1,000,000
25	Fatality; damage $100,000–400,000
15	Extremely serious injury (i.e., amputation, permanent disability; damage $1,000–100,000
5	Disabling injury; damage up to $1,000
1	Minor injury or damage

Exposure, E (frequency of occurrence of the hazard event)Hazard event occurs	
10	Continuously (or many times daily)
6	Frequently (about once daily)
3	Occasionally (once per week to once per month)
2	Unusually (once per month to once per year)
1	Rarely (it has been known to occur)
0.5	Remotely possible (not known to have occurred)

Probability, P (likelihood that accident sequence will follow to completion)Complete accident sequence	
10	Is the most likely and expected result if the hazardous event takes place
6	Is quite possible, not unusual, has an even 50–50 chance
3	Would be an unusual sequence or coincidence
0.5	Has never happened after many n years of exposure, but is conceivably possible
0.1	Practically impossible sequence (has never happened)

The risk score can be used to decide how quickly to act to correct hazards. One can compute a cost justification value, *J*, from

$$J = \frac{R}{(CF \times DC)} \quad (2)$$

CF is the cost factor and

DC is the degree of correction value.

The values for Eq. 1 and 2 are selected from tables (see Tables 1 and 2). Fine suggests that if J> 10, the cost is justified and if J< 10, the cost is not justified. Fine emphasizes that his method should be used as a guide only. The values used in the process and for decision making are somewhat arbitrary. Other definitions could be substituted, other values assigned, and an unlike value used for *J* in decision-making. However, the approach does supply a simple way to evaluate a variety of hazards and controls and presents them to management for approval [8, 9].

Table 2: Values for cost justification

Cost factor, CF (estimated dollar cost of proposed corrective action)	
10	>$50,000
6	$25,000–50,000
4	$10,000–25,000
3	$l,000–10,000
2	$100–1,000
1	$25–100
0.5	Under $25

Degree of correction, DC (degree to which hazard will be reduced)	
1	Hazard positively eliminated 100%
2	Hazard reduced at least 75%
3	Hazard reduced by 50%–75%
4	Hazard reduced by W-50%
6	Slight effect on hazard (<25%)

After calculating the risk score according to level of risk (Table 1) of William Fine model, ranking the risk levels are undertaken. These rankings determine the effective corrective actions that must be performed in the risk management process (Table 3).

Table 3: Risk score summary and actions

Score	Action
200–1,500	Immediate correction required; activity should be discontinued until hazard is reduced
90–199	Urgent; requires attention as soon as possible
0–89	Hazard should be eliminated without delay, but situation is not an emergency

Results

In this project, risk assessment forms were completed for 10 randomly selected units out of 18 units (Table 4 for example). In this study, the level of risk for activities such as sampling of sour gas (sour gas inhalation) with a score of 450, working with oxygen cylinders and pure hydrogen with a score of 450, and working with flammable gases (fire) with a score of 750 in industrial laboratory unit has the highest level of risk (emergency) and activities such as sampling from the CBD (burned with hot water) in the utility unit with score of 180, activities related to cylinders (fracture and contusion in the fall) in the industrial laboratory unit with a score of 150, entering the equipment (Leaking gas or liquid in a confined space) in maintenance and Inspection Unit with a score of 125 and welding (inhaling fumes) in tenement units with score of 90 have moderate risk (abnormal) and activities such as visiting the site (loud noise exposure and damage to the auditory system) in General Engineering and Process Engineering units with a score of 15, Fire extinguisher recharge (contusion) in fire unit with a score of 9 and work with the machines (electric shock) in Central Workshop Unit with the score of 5, had the lowest risk (normal), respectively.

Table 4: Example of completed form risk assessment in industrial laboratory

Risk Commentary	RPN	E	P	C	Effect of damage	Cause	Hazard	Activity
Abnormal	135	3	3	15	Asphyxiation and poisoning	Failure to investigate, Maintenance improper connections	Sour gas	Sour gas sampling
Emergency	450	3	3	50	Death			
Normal	22.5	3	0.5	15	Burn	Failure to investigate, Maintenance improper connections	Flammable gas	
Normal	75	3	0.5	50	Death			
Normal	22.5	3	0.5	15	Fractures, Contusion, Injuries	Stop in an inappropriate place, on-use or inappropriate use of personal protective equipment	High pressure gas	
Normal	37.5	3	0.5	25	Death			

Finally, the level of risk with respect to the unit of work and number of risks in unit of the study subjects were calculated (Table 5 and Figure 1).

Table 5: The level of risk depending on the type of unit in Ilam gas Refinery Company

	Risk level		
	Normal	Abnormal	Emergency
Safety	%75	%25	0
Fire	%80	%20	0
Tenement	%62.5	%37.5	0
Industrial Laboratory	%78.1	%15.6	%6.3
Maintenance and Inspection	%86.2	%13.8	0
Central Workshop	%92	%8	0
General Engineering and Process Engineering	%92.3	%7.7	0
Utility (water, steam, tanks)	%78.1	%21.9	0
Storage	%72.7	%27.3	0

Reasonable costs for the purchase of two compressed air breathing apparatus in sour gas inhalation risks arising from sampling activity related to the laboratory according to the formula (J = R / CF × DC), where (CF = 3) and (DC = 1) is equal to (J = 450/3 × 1 = 150) and J> 10, so the cost of risk control is acceptable.

For the risks of exposure to noise at work, the control cost is as follows; J = R / CF × DC where (CF = 3) and (DC = 3) is equal to (J = 180/3 × 3 = 20) and J> 10, so the cost for control this risk is acceptable.

In the risks associated with work at height, the control cost is: J = R / CF × DC, where (CF = 2) and (DC = 4) is equal to (J = 90/4 × 2 = 11.25) and the levels J> 10, so the cost for risk control is acceptable.

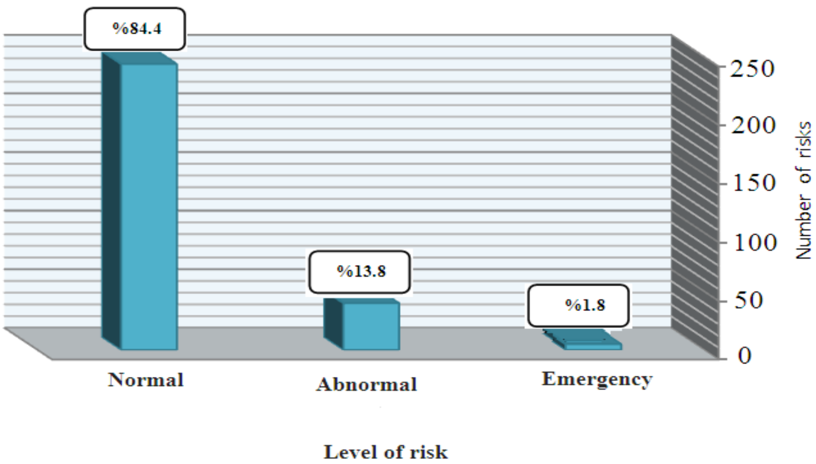

Figure 1: The level of risk According to the number of risk in the study units

Discussion

The results of this study showed that industrial laboratory units have a higher risk than other units in Ilam gas Refinery Company, but fortunately, risk is not at a critical level. However, with allocating the proper resource and scheduling, actions should be considered to reduce equipment and processes with the high risk in the company.

The main risks in company are related to the inhalation of gas and falling from height.

The corrective actions on forecasting and more accurate implementation of individual arrangements to prevent inhalation of toxic gases and falling from a height are necessary.

A study by Joazi et al found out that the risk of induction furnace operating activities (epoxy pert) with a score of 300, testing the water (for noise pollution) with a score of 300, Grinding in tube with a score of 240 and test of tube with water pressure with a score of 200, has the highest level of risk (emergency) and activities such as chamfer grinding in head and the bottom of the tube (around the microchip) with a score of 192, operation of the rotary saw (collision of tubes with individuals) with a score of 180, the welding process with a score of 160, washing by phosphoric acid with score of 120 have average risk (abnormal) and activities like falling the people (Prifer) with a score of 16, the test of water (pipe bursting) with a score of 9 and Slither of coil with score of 5 have the lowest risk (normal), respectively [10].

Another study was done by Moradi and Pirsaheb using William Fine method in 2011 (Case Study in National Iranian Drilling Company), in which the risk level environmental aspects of activities with a score of 384, working by acid with a score of 240, drilling with air, cement working, testing and productivity wells with 216 scores, survey and start drilling wells with a risk score of 200 have the highest levels of risk [7].

Jafari conducted another study using William Fine method. The results showed that the level of risk in commissioning activities and the outside of generators at service (electric shock) with a score of 300, visiting the boiler (noise pollution) with a score of 300, grinding on boiler tubes with a score of 240 and inspection, control and monitoring of the compressor (explosion) with a score of 200 have the highest level of risk (emergency) and activities such as monitoring and maintenance of pumping stations (body contact with the hot fluid) with a score of 192, refueling the tanks (risk of collapse in a pool of waste water) with a score of 180, welding process with a score of 160, chemical injection with a score of 120 have a medium risk (abnormal) and activities such as production and distribution of air (inhalation of oil vapors in the environment) with a score of 16, receiving and injection of steam (thermal energy dissipation) with a score of 9 and breaking pathways of water and boiler tubes and accumulate at the site of perforation with a score of 5 have the lowest risk (normal), respectively [11].

According to previous research findings, it is noted that the risk score of noise pollution, for example in the study of Joazy and Jafari, was 15 (normal), while it was 300 (emergency) in this study. This can be attributed to the severity and probability of occurrence and the extent of exposure and also the nature of the activity. Joazy showed that welding process has a risk score of 160 (abnormal), which is similar to the result of the present study with a slight difference (risk score of 90) [7]. Risk score of falling in the study by Joazy was 16 (normal) [7], while it was 160 (abnormal) in Jafari's study [11] and 180 (abnormal) in the present study, which can be due to the difference in severity, probability and exposure.

Conclusion

The results showed that the company is in relatively safe conditions. The reason could be that HSE department, with specialists and experts in Ilam gas refinery at the relevant fields of health, safety and the environment, has done great efforts toward providing a relatively safe working environment for staff during the last few years.

Therefore, 10 activities with risk scores of lower than 89 do not require monitoring or correction at the moment and are not a priority.

Cases with a risk score of 90-199, including 14 activities, have emergency condition. If the score is more than 199, it corrective action should be considered at the shortest possible time. During the present risk assessment process, a relative reduction occurred in risk due to an increase in staff awareness. Learning the proper use of protective equipment by personal can help safer working at heights, noise control, and codification of policies, safety goals and plans to achieve annual goals, identifying areas of risk, periodic monitoring of contractors and monitoring these measures by senior managers.

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