Journal of Chemical Health Risks

Journal of Chemical Health Risks (2015) 5(1), 39 – 44

ORIGINAL ARTICLE

Occupational Health Risk Assessment of Iranian Drilling Industry

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(Received: 16 November 2014 Accepted: 17 January 2015)

KEYWORDS

Occupational health
Risk assessment
Hazard analysis
Drilling industry

ABSTRACT: Drilling industry provides a significant potential for occupational health risks. Thus, health-related hazards (chemical, physical, ergonomic and biological) must be recognized, evaluated and controlled in order to prevent occupational illnesses which come from exposure to them. For these, a good occupational health risk assessment needs to be applied. Risk assessment monitors risks and provides guidance for decision-making. This project identifies all the occupational health risks and estimated risk levels. At last, the risk numbers are assessed their significance by the use of occupational health risk assessment techniques to minimize the risks. The main goal is to gain a level of risk protection which is acceptable with a good model. Therefore, the Occupational health risk assessment worksheet illustrates health hazards into four categories of every tasks of drilling industry. The risk categorized in the five levels and the high risks of Iranian drilling industry are those in the category of c.

INTRODUCTION

The development of petroleum and petrochemical industry has been and is currently associated with a number of healths, safety and environment (HSE) concerns [1]. Drilling of oil and gas involves risk of major accidents. One of the most important methods of decreasing the occurrence of accidents and their consequences is to employ risk assessment [2]. Risk management is the ongoing process of identifying these risks and implementing plans to address them [3, 4]. Identification of all possible hazards of the system is the first step in risk assessment. Hazard is defined as a situation that has the potential to cause harm to human health or the environment [5]. When hazards react with human or environment, the risks associated with that hazard can be assessed. Risk assessment is carried out after identification of hazards [6]. Risk can be defined as

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the combination of the probability of an event and its consequences [7, 8]. Occupational risk, specifically, deals with the probability of injury or illness occurring as a result of hazards within the workplace [9]. Workplaces have hazards, which present a risk of injury or illness from the dangers that exist. At times the hazards cannot be removed and the dangers exist and can result in an accident. Risk is the probability of an accident occurring. The amount of risk you deem as acceptable will do much to define the extent of your injury prevention effort. Risk related to health is often a judgment call. But, even a judgment call can be quantified if you develop criteria and place value upon them [10]. In 2001, Satersdal and Skeggs [11] used a model for health risk assessment in an oil drilling company. The theoretic approach had been similar to the safety risk analysis models, but the terms probability of events and the event severity (consequence) are replaced with exposure level and potential health effect severity. Besides, the term "health-risk score" was introduced which is the product of the two above mentioned elements. Mchugh et al. [12] integrated environmental, social and health impact assessment. Zainuddin et al. [13] illustrated the public health and medical resource assessments using the standard process in a remote drilling site.

This paper illustrates the use of a health-based risk assessment in the investigation of oil and gas drilling industry.

MATERIALS AND METHODS

Health Risk Assessment

Health-related hazards must be recognized, evaluated and controlled in order to prevent occupational illnesses which come from exposure to them.

Risk Assessment Methodology

For risk analysis, at first, the risk should be identified. Then, a consequence value for the existing hazard should be assessed, which indicates its effect on workers if contacted, as well as a value for the exposure potential that denotes how many times during any period workers could come into contact with the hazard. We also need to assess the probability that workers would be injured, become ill, or be killed if they contacted the hazard. At last, the level of risk should be categorized.

Data Collection

The process of data gathering includes site visiting and the experienced men who best know the operations in the form of Delphi group. The team was composed of industrial members including operation, process, maintenance and firefight engineering. For identifying criteria and number of risks, the number of Delphi rounds based on the study design should be chosen. Furthermore, the number of functions that the Delphi technique has to fulfill within the scenario study and the necessity for feedback should be considered.

The key design elements of the Delphi technique are anonymity, iteration, controlled feedback and participating experts. In most Delphi studies, a number of experts are each given an anonymous questionnaire to answer questions concerning their field of expertise [14].

Hazard Identification

Health-related hazards come in a variety of forms, such as chemical, physical, ergonomic and biological:

1. Chemical hazards arise from excessive airborne concentrations of mists, vapors, gases or solids that are in the form of dusts or fumes
2. Physical hazards include excessive levels of nonionizing and ionizing radiations, noise, vibration and extremes of temperature and pressure.
3. Ergonomic hazards include improperly designed tools or work areas. Improper lifting or reaching, poor visual conditions or repeated motions in an awkward position.

4. Biological hazards include insects, molds, fungi, viruses, vermin (birds, rates, mice, etc.) and bacterial contaminants [10].

Health Risk Factors

The assessment of risk considered was

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

Where P is probability factor, C is the consequence factor and E is exposure factor. The factors were scaled as shown in Table 1.

Table1. Risk factors for health risk assessment

Scale	Probability (P)	Consequence (C)	Exposure (E)
10	Certain	Death	Every Hour of the Day
8	Strong	Multiple Worker Injury or Illness	Every Day
6	Very likely	Very Serious Injury or Illness (permanent disabling)	Every Week
4	Likely	Serious Injury or Illness (lung damage, temporary disabling) lost workdays greater than one week	Every Month
2	Negligible	Other Injuries or Illnesses Requiring First Aid (sprains, headaches)	Once a Year

Table 1 shows the criteria of probability, consequence and exposure according to the Delphi group ideas, also the factors are scaled.

Health Risk Matrix

The study effort to implement a method for drilling human factor risk evaluation is based on quantifying risk values associated with drilling activities are shown in Table 2, the risk are categorized in five levels.

Table2. Risk Matrix of occupational health risk assessment

Risk Level	Risk Rating	Key Words
A	601-1000	Highest Risk
B	401-600	Higher Risk
C	250-400	High Risk
D	100-250	Lower Risk
E	1-100	Lowest Risk

RESULTS AND DISCUSSION

The Occupational health risk assessment worksheet illustrates health hazards into four categories. The risk assessment of every hazard according to the Table 3 shown in the worksheets then according to the Table 2, the risk categorized.

Table 3. Occupational health risk assessment worksheets

No.	Health Hazards	Task	Risk Assessment				
			S	E	P	Risk	Category
1	Chemical Hazards						
1-1	Emission of soot particles in the air	Setup Devices	4	8	10	320	C
1-2	Soot particle emissions from the engine	Drilling Operations	4	6	10	240	D
1-3	Gas emissions	Drilling Operations	4	6	6	144	D
1-4	Particulate of cement emissions	Cement Operations	4	6	6	144	D

Table3. Continued

1-5	Emission of H_2S	Drilling Operations	8	6	2	96	E
1-6	Particulate of mud emissions	Drilling Operations	4	8	10	320	C
1-7	Exposure to hazardous materials, especially thread lock compounds.	Installing Casing Accessories	6	6	10	360	C
1-8	Exposure to chemical hazards	Installing the Power System	6	2	10	120	D
1-9	Exposure to inhalation hazards	Preparing Drilling Fluid	4	8	10	320	C
1-10	Being exposed to chemical hazards (such as, silica, toxic liquids, and gases)	Cementing Operations	4	8	10	320	C
1-11	Being exposed to chemical hazards (such as, silica, toxics, asphyxiants)	Stimulation- Pumping	4	8	10	320	C
2	Physical Hazards						
2-1	Heat Stress (in harm season)	Drilling Operations	4	10	10	400	C
2-2	Noise Pollution	Drilling Operations	6	10	10	600	B
2-3	Being exposed to high noise levels	Cementing- Pumping	6	6	10	360	C
2-4	Being exposed to high noise levels	Stimulation- Pumping	6	2	10	120	D
2-5	Being exposed to temperature extremes	Stimulation- Pumping	4	2	10	80	E
2-6	Being exposed to radiation associated with radioactive tracer materials	Stimulation- Pumping	6	2	10	120	D
2-7	Bursting of the high-voltage lines	Drilling Operations	8	6	4	192	D
2-8	Bursting pressure Schelling	Drilling Operations	8	6	4	192	D
2-9	Impacts of radioactive rays	Drilling Operations	6	6	4	144	D
2-10	Vibration	Drilling Operations	4	10	10	400	C
2-11	Burning	cutting and welding	4	2	4	32	E
2-12	Falls or slips from ladders and stairs	Drilling Operations	6	10	4	240	D
2-13	Welding light flash temporary eye irritation	Welding	4	4	8	128	D
2-14	Pinched fingers	assembling equipment	6	8	8	384	C
2-15	Being shocked or electrocuted	Installing the Power System	10	4	4	160	D
2-16	Burns, or physical injury caused by contact with skin or eyes	Preparing Drilling Fluid	4	6	4	96	E
2-17	Release of excess drilling mud resulting in skin contact	Breaking Out Pipe	4	6	4	96	E
2-18	Flash burns or shocks when servicing motors, generators, and breaker panels	Generator, Electric Motors	10	4	4	160	D
2-19	Tripping on power cords and hoses	Drilling Operations	6	6	4	144	D
2-20	Being exposed to explosions or violent reactions from chemicals mixed	Preparing drilling fluid	8	6	4	192	D
2-21	Falling from monkey board	Drilling Operations	10	10	4	400	C
2-22	Receiving injuries to face and eyes from flying chips of metal	Maintenance activities	6	4	4	96	E
2-23	Burned by fluid contact	Maintenance activities	6	4	4	96	E
2-24	Receiving injuries caused by loss of well control.	Blowout	10	2	4	80	E
2-25	Being struck by wireline, lubricator, sheaves, or other equipment	Wireline Operations	6	2	4	48	E
2-26	Being exposed to an unexpected release of pressure	Wireline Operations	8	2	4	64	E
2-27	Being exposed to an unexpected release of pressure	Well Logging	8	2	4	64	E
2-28	Being exposed to radiation	Well Logging	6	2	4	48	E
2-29	Surface detonation of explosives	Perforating	10	2	4	80	E
2-30	Being struck by a pressurized line	Swabbing	8	2	4	64	E
2-31	Being burned by hot oil or hot oil line or frostbite injuries from contact with propane or propane lines	Hot Oiling	8	2	4	64	E
2-32	Unexpected release of pressure	Hot Oiling	10	2	4	80	E
2-33	Being exposed to an unexpected release of pressure, and loss of well control	Snubbing	10	2	4	80	E
2-34	Being exposed to an unexpected release of pressure	Coil Tubing	10	2	4	80	E
2-35	Getting struck by falling or shifting objects (such as suspended injector heads)	Coil Tubing	8	2	4	64	E

Table3. Continued

3	Ergonomic Hazards						
3-1	Knee injury and lumbar disc	Drilling Operations	6	8	8	384	C
3-2	Neck and spine injury	Drilling Operations	6	8	8	384	C
3-3	Muscle strain from improper lifting technique	Break out pipe Setting Slips	4	8	8	256	C
3-4	Muscle strain from improper lifting technique	Setting Slips	4	8	8	256	C
3-5	Having feet pinched or crushed	Setting up the pipe racks	6	6	8	288	C
3-6	Getting sprains, strains or suffering from overexertion	Wireline Operations	4	2	8	64	E
3-7	Overexerting, or receiving sprains and strains while handling materials	Cementing Operations	4	4	8	128	D
3-8	Overexerting or receiving sprains and strains	Stimulation- Rig up and down	4	2	8	64	E
4	Biological Hazards						
4-1	Create solid waste	Drilling Operations	2	6	10	120	D
4-2	Create wastewater	Drilling Operations	2	6	10	120	D
4-3	Inappropriate water storage tank	Drilling Operations	4	2	4	32	E
4-4	Unhealthy waste disposal	Drilling Operations	4	2	6	48	E

According to the Table 2, the risk categorized in five levels if the risks are in categories A, B and C, they should be controlled. The high risks of drilling industry according to the level of risks in Table 3 are those in the C level. Thus, The hazards of emissions of particulate of soot and mud, exposure to hazardous materials and chemical, heat stress, being exposed to high noise levels, vibration, pinched fingers and falling from monkey board and knee, neck and spin injury, muscle strain and feet crushed, should be considered as a high level risk and the risk must be reduced. The D and C level also should be checked during the period of auditing because they can be changed after a time period.

CONCLUSIONS

The high occupational health risks of Iranian drilling industry consist of:

- In chemical hazards category the emissions of particulate of soot and mud, exposure to hazardous materials and chemical.
- In physical hazards category heat stress, being exposed to high noise levels, vibration, pinched fingers and falling from monkey board.
- In ergonomic hazards category knee, neck and spin injury, muscle strain and feet crushed.

ACKNOELEDGMENTS

The authors would like to express their gratitude and appreciation for the drilling office of National Iranian South Oil Company (NISOC). Also, the research has been funded by drilling industry within NISOC and Abadan institute of technology (AIT).

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