Assessment of Health, Safety and Environmental Risks of Zahedan City Gasoline Stations

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***Abstract*—The purpose of this study was to assess the risk and determine the health, safety and environmental status of fuel stations in Zahedan. In this study, failure mode and effects analysis (FMEA) method was used for risk assessment in accordance with the HSE guidelines, national and international standards and laws. In this cross-sectional study, 2 governmental stations and 6 active private stations were evaluated after the necessary coordination with the relevant units. As a result of risk assessment, 27 health risks, 55 safety risks and 22 environmental risks were identified. From among all the identified risks, 67 risks had a Risk Priority Number (RPN) of less than 91, 31 risks had an RPN ranging between 91 and 201, and 6 risks had an RPN of over 201. The findings of the study indicated that compliance with the HSE requirements was 51.85%, in the area of health, 47.57% in the area of safety and 27.45% in the environmental area. Overall compliance with the HSE requirements was 42.54%. In order to distribute fuel considering health, reducing risk and increasing compliance with the requirements for safety improvement, health and environmental conditions of fuel supplies are essential.**

Keywords-fuel station; health; safety; environment

I. INTRODUCTION

The supply chains are important parts of the fuel distribution and supply [1]. A gas station is a place licensed by the National Oil Distribution Company of Iran and has standard reservoirs for storing oil products [2]. The purpose of the construction and operation of gas stations is to complete the production to consumption cycle of oil products, including gasoline [3]. The occurrence of any mistake or incident at the stations can destroy the result of a long-term endeavor in the fields of exploration, drilling, extraction, refining, distribution, etc. In recent years, these cases have included other dimensions, which could have irreparable effects on the environment and the residents. In particular, we are faced with a huge amount of chemicals that are considered to belong to toxic and hazardous groups [4]. Properties such as high flammability of oil products have caused the most attention to stations. Generally, oil industries attract attention in terms of providing security and maintaining financial and human resources and taking care of potential risks for the environment and health of the people. There are always environmental and health risks during the stations' operation [3, 5]. Fire and explosions at the city gas stations which are near the buildings are considered to be a threat, and people outside the gas station, including personal drivers and passengers, have augmented increase vulnerability to fire. By increasing the gas station staff and the quality of the limitations, the fire safety problem becomes seriously faced [6]. The existence of multiple risks, including the above, indicates the importance of risk assessment at gas stations. The risk management assessment is based on the management of the health, safety and environment of the personnel. "Risk" is a process that has an uncertain and unknown outcome in each field.

The main purpose of risk analysis and risk assessment is to determine the degree of uncertainty of the study system, its cost, and the proposed reduction strategies, as well as the cost of the corresponding solution [8]. Risk identification and determining its positive and negative outcomes are of particular importance to the objectives of the project [9]. The more accurate the risk identification is, the better the system performance [10]. Making a system safe, without the primary identification of risks or controlling risks is practically impossible. One of the common mistakes in safety engineering is ignoring this stage or paying insufficient attention to it. The next stage is the identified risks analysis. Risk analysis is a technique for studying the causes and consequences of a potential risk in the system [11]. Among the risk assessment techniques, the FMEA method is the only analytical method in risk assessment that can assess the potential risks within the assessment ranges and also identify and classify the causes and effects associated with it. Among the benefits of this approach we can refer to its appropriateness in quantitative risk assessment and the reliability of this approach to predict

problems and identify the most effective risk prevention solution [12]. FMEA is a systematic and a completely mental preventive approach based on teamwork which is used in defining, identifying, assessing, preventing, eliminating or controlling the states, causes and effects of potential errors in a system, process, project, or service (before a final product or service reaches its customer), and the prediction of errors and the way to prevent them is the prerequisite [13-15].

On the other hand, the HSE management system provides guidance for all work guidelines such as research and development, design, construction, operation, transportation and distribution, product management and work which is performed by employees and contractors in accordance with the health and safety standards [16]. In the Oil Products Distribution Company, the HSE guideline of oil products supply network have been prepared based on national and international standards for preventing accidents and creating safe conditions for performance and enhancement of safety factors [2]. This research was carried out with the aim of determining the health, safety and environmental risks of Zahedan fuel stations using the FMEA method. Health, safety and environmental aspects of fuel stations are provided in order to investigate their compliance with the HSE requirements of the stations particularly in the field of exploiting and identifying risks.

II. METHODOLOGY

In this cross-sectional study, the health, safety and environmental risks in the fuel stations of Zahedan City were investigated using the FMEA method. The status of the stations' compliance with the requirements of HSE was also investigated. At the time of the research, there were 11 stations in Zahedan, namely 3 government and 8 private stations. From among these stations, 1 governmental and 1 private station were under reconstruction, and 1 station was not ready to cooperate. Eventually, this study was conducted in 2 governmental and 6 private operational stations. In order to assess risk through the FMEA method, fuel stations were first supervised and the way they act was carefully monitored. Information on the collection process and all environmental, equipment, material, human, etc. risks that threaten health, safety and the environment were listed. In the next steps, the causes of risk, the effects of each risk, and then the existing control processes were examined. For this purpose, the conditions in the fuel stations were compared to the standards, requirements and rules governing the work environment. Rate of deterioration, probability of occurrence, rate of probability of risk discovery/call rank was determined and the RPN (risk priority number) was calculated based on them. In the last step, the risks were ranked based on the RPN [17]. In reviewing the requirements of the HSE, the basis for investigating was the HSE guidelines for the fuel products supply networks of the national oil refinery company which includes three parts of the requirements for construction, operational requirements, and considerations for the referrals. Based on this, a checklist was designed whose validity was confirmed by experts.

III. RESULTS

Table I indicates the number of risks in the three areas of health, safety and the environment in fuel station processes, and Table II indicates the division of risks into three acceptable, tolerable and unacceptable categories. Also, in Figure 1, the number of risks is displayed based on the specified ranges in the three domains.

TABLE I. THE NUMBER OF RISKS IDENTIFIED IN GAS STATIONS BASED ON DIFFERENT PARTS OF THE PROCESS

Risk / RPN	Emptying	Refueling	Lighting	Total
Health	11	16	-	27
Safety	20	30	5	55
Environmental	12	10	-	22

TABLE II. RISK SITUATION DECISION TABLE

Row	Risk number	Decision type
1	1 to 90	Acceptable
2	91 to 200	Unacceptable-tolerable
3	More than 201	Intolerable

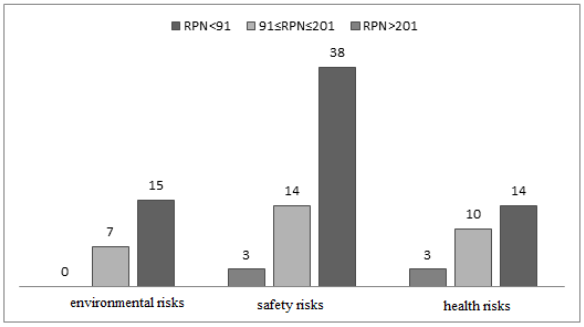

Fig. 1. Comparative diagram of the number of health, safety and environmental risks based on the RPN Rates

In assessing the risks of the oil product stations through FMEA, the highest levels of risks in the three considering areas are:

- Health: Car traffic (RPN: 486)
- Safety: Use of cigarettes during refueling and the lack of continuous sampling of product vapors (RPN: 280)
- Environment: lack of assessing the thickness of tanks (RPN: 112)

Based on the investigation results, the HSE requirements had the average compliance of 51.85% in health area, 47.57% in the safety area and 27.45% in the environmental area. The results of this assessment indicated that, there is 42.54% of compliance in the studied stations and 57.46% of the non-compliance with the checklist requirements. Chi-Square test was used to determine the compliance with the requirements at the stations and the results indicated that there are significant differences between the criteria and the positions in four stations (p-value <0.05).

IV. DISCUSSION

According to the results of the risk assessment, the most identified risks are related to safety, health and environment fields respectively. Risks with RPN of more than 100 are subject to the above order. In a study conducted on fire safety in 22 gas stations in Zanjan using the national review list, the findings of the analysis revealed that, on average, 70% of safety tips in these stations have been respected [18]. This is while the safety situation in the stations studied in Zahedan were consistent with an average of 47.57% of the criteria set out in the HSE guidelines for the fuel products supply network. Also, in assessing the environmental risks of oil products storage facilities through the FMEA method the risk number for oil tanker 210 was obtained [12]. According to the present research, the environmental risk number of this activity at fuel stations is 72. In [19], the use of a proper ventilation system and the proper equipment maintenance in order to prevent leakage in the joints and the reduction of people exposure, have been proposed as control measures in confronting chemicals. In this study, leakage from the valves, pipes and tanks at fuel stations also result in the introduction of pollutants into the environment, thereby increasing the risk of fuel leaks. According to [20], the lack of a three-way catalytic converter system on cars, the average car age, the low respect for regulatory requirements such as technical vehicle inspection, high engine set-up and spare parts costs, gasoline spills, new car prices, the low number of petrol stations in comparison to the car number are some of the main factors of pollution increasing near gas stations [20]. The results of this study indicated that the lack of attention to the HSE requirements of the stations and the existing regulations in this field resulted in increasing various health, safety and environmental risks.

In a study in a petrochemical industry, benzene earned a risk level of 5 with a coefficient of 5-6.5 [21]. This level indicates high risk and the need for corrective actions. However, in [22], conducted at Shiraz gas stations, the average exposure of gas station workers to BTX does not exceed the exposure limit values of these compounds, and the exposure to lead-free gas did not seem to be evident with blood damage. In [23] the average concentration of benzene in the air was higher than the one proposed by the National Technical Committee on Occupational Health (0.5 ppm) at the gas station in Yazd. At the same time, the concentration of toluene, ethyl benzene and xylene was lower than the allowed limit [23]. In [24], which was conducted regarding gas stations in Ahwaz downtown, the results indicated that the concentration of benzene in the gas stations and the surrounding streets was averagely higher than that of respiratory air. In [3], the calculations indicated that about 14 tons of gasoline (ordinary and super) is evaporated from the reservoirs of Tehran's Vali'asr gas station per year. This rate of evaporation can have an impact on the air pollution in the surrounding environment and increases health, safety and environmental risks. According to the results of this study, increasing control measures to reduce exposure to benzene in Zahedan fuel stations is necessary.

According to [25], conducted at gas stations in Kenya, the employers and customers are encouraged to adhere to standards that ensure the safety of the workplace. However, our study indicated that in total, 57.46% of the studied stations have non-compliance with the checklist requirements, and in terms of compliance with the HSE guidelines for the fuel products supply networks, the visited stations are almost identical.

V. CONCLUSION

There are various health, safety and environmental risks, and numerous cases of non-compliance with the criteria under consideration, something that clarifies the need for more supervision on the stations at construction time and during operation. The use of technical and managerial methods to eliminate and reduce risks is recommended. Holding training classes in all three areas of health, safety, and environment in a compiled form for staff, internal auditing, continuous maintenance, installation of instructions, guiding and warning boards and general training of the drivers of all types of vehicles will be helpful. In general, compliance with the health, safety and environmental requirements of the HSE guidelines for fuel supply networks can be effective in risk reduction. The attention of experts to the implementation of the requirements is as necessary as the attention of the authorities. It should be noted that the use of proposed solutions in each of the health, safety and environmental areas can also be effective in other areas and ultimately lead to a general reduction of risks.

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REFERENCES

[1] National Iranian Oil Products Distribution Company, Office of Health, Safety and Environment, Environmental considerations product supply stations, Public Relation Publication, (in Persian), 2008

[2] National Iranian Oil Products Distribution Company, Instructions HSE ducts supply of petroleum products, (original in Persian), 2010

[3] A. Karbasi, F. Kavyanifar, "Estimate the rate of Heavy due to gasoline evaporation In the stations via software, Case study: the ValiAsr", Technical Seminar on Oil ,Gas and the Environment, Iran, Vol. 1, No. 4, pp. 23-35, 2008

[4] F. Ahmadi, Gasoline vapor recovery, National Iranian Oil Engineering Company, 2006

[5] R. D. Harbinson, M. M. Bourgeois, G. T. Johnson, Hamilton & Hardys Industrial Toxicology, Mosby, 1998

[6] EPA, Preventing Leaks and Spills at Service Stations: A Guide for Facilities, Available at: https://www3.epa.gov/region9/waste/ust/pdf/servicebooklet.pdf, 2003

[7] D. Hillson, Effective opportunity , management for projects – exploiting positive risk, Marcel Dekker, 2004

[8] V. T. Covello, J. Menkes, J. Mumpower, Risk Evaluation and Management, Plenum Press, 1986

[9] R. Yarahmadi, P. Moridi, "Risk assessment and management of health, safety and environment in vitro research sites", Occupational Health and Safety, Vol. 3, No. 3, pp. 11-26, 2012

[10] A. Jafari, "Job safety analysis in Abadan Oil Refining Company", 2nd National Conference on Safety Engineering and HSE Management, Iran, 2007

[11] N. J. Bahr, System Safety Engineering and Risk Assessment, CRC Press, 2014

[12] S. Naghavi, D. Salehi Rahmatollah "Environmental risk assessment of FMEA storage facilities", Sixth National Conference and Specialized

Exhibition of Environmental Engineering, Iran, Vol. 1, No. 8, pp. 201-236, 2012

[13] J. S. Krouwer, "An improved failure mode effects analysis for hospitals", Archives of Pathology & Laboratory Medicine, Vol. 128, No. 6, pp. 663-667, 2004

[14] M. G. Gressel, J. A. Gideon, "An overview of process hazard evaluation techniques" American Industrial Hygiene Association Journal, Vol. 52, No. 4, pp. 158-63, 1991

[15] R. J. Cody, "Anticipating risk for human subjects participating in clinical research: application of Failure Mode and Effects Analysis", Cancer Investigation, Vol. 24, No. 2, pp. 209-214, 2006

[16] HSE Management System, Sustainability Report, Available at: http://www.inpex.co.jp/english/csr/pdf/sustainability2014-e12.pdf, 2014

[17] E. Habibi, Applied Safety and Performance Indicators in the Industry, Fanavaran Publishing, 2005

[18] S. Arghami, H. Zahiriangh, A. Ruhani, M.Aflatooni, "Presentation of a practical approach for prioritizing preventive Actions", Seventh National Conference on Health Occupational, 2011

[19] M. Jahangiri, M. Jalali, C. H. Saeidi, "Assessment of Occupational Exposure Exposure to Chemicals in order to provide control strategies (Case Study in Polyurethane foam industry)", Occupational Medicine, Vol. 5, No. 4, pp. 33-41, 2012

[20] A. Bahrami, A. Heydari Jafari, "Single-ring aromatic compounds are taxi drivers exposured compared with emissions to petrol pump stations in the city of Hamedan", Ninth National Conference on Environmental Health, Iran, 2006

[21] F. Golbabaee, D. Eskandari, M. Rezazadeh Azari, M. Jahangiri, A. Rahimi, "Health risk assessment of exposure to chemical pollutants, with emphasis on the risk of leukemia at a Petrochemical Industry", Iran Occupational Health Journal, Vol. 9, No. 3, pp. 11-21, 2012

[22] M. Neghab, K. Hoseinzadeh, J. Hasanzadeh, "Assessment hematotoxic effects of occupational exposure to unleaded gasoline", Iran Occupational Health Journal", Vol. 9, No. 4, pp. 1-12 , 2012

[23] M. Mosadegh Mehrjerdi, N. Tahmasbi, A. Barkhordari Firoozabadi, H. Falahzadeh, S. Esmaeel, K. Soltanizadeh, "Evaluation of exposure to benzene, toluene, ethylbenzene and xylene (BTEX) by solid phase micro extraction and gas chromatography in the gas station city of Yazd", South Medical, Vol. 16, No. 6, pp. 419-427, 2013

[24] M. Fooladi, G. H. Goodarzi, M. Mohamadi Roozbahani, "Measuring and comparing the composition BTEX of the filling stations in the city of Ahvaz in the morning and afternoon and assessing their infection transmission radius", Second National Conference on Planning and Environmental Protection, Iran, 2013

[25] M. James, I. M. Fedha, Safety and Health Assesment in Kenyan Petrol Station: Case Study of Nairobi Highway Stations, Mechanical Engineering Conference on Sustainable Research and Innovation, Vol. 4, No. 3, pp. 211-213, 2012