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Health- Safety and Environmental Risk Assessment of Refineries Using of Multi Criteria Decision Making Method

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Abstract

Growing importance of environmental issues at global and regional levels including pollution of water, air etc. as well as its outcomes such as global warming and climate change has been led to consider environmental aspects as effective factors for power generation. Study ahead aims at examination of risks resulting from activities of Refinery located in Iran. Method used in this research is analytical hierarchy process. After identification of factors causing risk, the analytical hierarchy structure of the Refinery risks were designed as well as weight of criteria and sub-criteria were calculated by intensity probability product using Eigenvector Method and EXPERT CHOICE Software. Results indicate that in technological, health-safety, biophysical and socio economic sections of the Refinery, factors influenced by the Refinery activities like fire and explosion, hearing loss, quantity of groundwater, power generation are among the most important factors causing risk in the Refinery. Groundwater level drop is the most important natural consequence influenced on Refinery activities.

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1. Introduction

There is often a negative attitude among the population in the society about the risk concept. They have

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considered it as a sign of damage, danger and negative effects as well as fail probability toward achieving the predefined goals of the considered project [1]. While Britain Standards Institute, knows risk as combination of occurrence and results of a hazardous event [2]. Risk assessment determines the qualitative analysis of risk potential regarding the sensitivity or vulnerability of the surrounding environment [3]. In general, there are currently more than 70 risk assessment methods in the world which are divided in to two qualitative and quantitative groups [4]. Among researches have been done around the world on risk assessment of power plants a study carried out in the Harvard Center can be mentioned. In this research air emissions data (antimony, arsenic, barium, chromium, and so on), geographic information of the area, plant profile, speed and direction of dominant wind were used as the input of mathematical models to calculate the pollutant concentration in 50 km radius of the power plant [5]. Also a research was conducted by Chatzimouratidis and Pilavachi (2008) on 10 types of the most important power plants. Finally, five types of power plants operating with renewable energy were classified in the first 5 ranking positions [6]. Akash et al. in 1999 used analytical hierarchy process to select an optimal system for electricity generation. In this study, costs and benefits hierarchical structure of various plants were designed and collected separately and using the comparison of different kinds of costs and benefits, wind, solar and aquatic power plants were respectively diagnosed the most suitable power plant for energy generation in Jordan [7]. In 2002, Twardowska and Szczepanska conducted a study regarding environmental risk assessment of solid waste in a power plant fly ash. Result indicated that waste should not be treated as the same way as a natural raw material even those considered non-hazardous [8]. Vaurio(2009) described human factors as well as human reliability assessments performed as a part of a nuclear power plant operating license. And also showed how risk assessment can be used to control errors and enhance human factors [9].

2. Material and methods

2.1. Tests conducted in safety and health Section of Yazd Refinery

In order to sound measurement of Yazd combined cycle Refinery with the aim of determining the personnel exposure to noise, CEL-440B2 Octave Band Sound Level Meter with analyzer (made in UK), A-weighted network and spatial distribution method were applied. Measured parameters include L eq (equivalent sound level) and L max (maximum sound pressure level in each measuring courses), Noise measurement stations and the main sources of sound in Yazd .To investigation of plant equipment vibration and its effect on personnel, first of all vibrating environments were identified and then measured using TV300 Time oscillator device. To analyze and calculate thermal stress of the power plant personnel, the WBGT (Wet Bulb Goysan Temprature) index and the Mini Lab Machine Manufactured by UK were used.

$$WBGT = 0.7Tnw + 0.3Tg \quad \text{Roofed environment} \tag{1}$$

$$WBGT = 0.7Tnw + 0.2Tg + 0.1Ta \quad \text{Non-roofed environment}$$

where;

Tg *is Goysan Thermometer temperature value*
Tnw *is Natural Wet Bulb Temperature*
Ta *is Amount of ambient temperature*

2.2. Analytical Hierarchy Process (AHP)

Study ahead was carried out with the aim of investigation of Yazd Combined Cycle Refinery health, safety and environment.Therefore after identifying the plant activities and situation it was determined that the plant activities cause some risk on the plant personnel and the surrounded environment.The environment imposes some hazardous and risks on the plant activities as well. So, in the study, the criteria and sub-criteria were determined based on the indoor as well as the surrounding environment risks. Both qualitative and quantitative sub-criteria were included to carry out evaluation which reflects advantages of AHP method in dealing with combination of qualitative and quantitative criteria [9]. Pair wise comparison is base of this method. Pair wise comparison in different numeric, graphical and verbal forms could be done using EXPERT CHOICE software [2]. As regards the purpose of the current study is risk assessment of Yazd Combined Cycle Power Plant considered risks available in indoor and surrounding environment of the power plant, sub-criteria including health-safety risks, technological risks, the affected environment risks as well as the environmental factors influenced the power plant were selected. Ultimately, each sub-criterion was divided into the sub-sub-criteria. Safety and Health risks include risks and diseases caused by thermal stress, hearing loss, skeleton and muscular disorders, skin and respiratory diseases, vision loss, accident, electric shock and illness caused by exposure to magnetic field in the long term. Technological risks, considering sensitivity of the power plant performance and equipment include deposition and corrosion of the equipment, fuel contamination leading to reducing the life of the equipment, the plant foundation subsidy due to equipment vibration, the error of the control system as well as the operator, fire and explosion.

3. Result and discussion

3.1. The environmental tests results of Yazd Refinery

Results of tests done on the production environmental standards suggested that according to the following tables, the amount of CO in most measuring stations of air pollutants in different parts of Yazd combined cycle Refinery as well as comparison with, including the gasses exhausted from Alstom G13 and G14 chimneys, diesel emergency Alstom 1 and 2, emergency diesel of gas house fire pump no. 1 and 2 are higher than standard limits. The highest and lowest CO concentration are respectively equaled to 156 and 496 ppm related to emergency diesel of gas house fire pump no. 1 and Alstom G14 (gas fuel), the amount of Nox (382ppm) is higher than standard limit (350ppm) just in emergency diesel of gas house fire pump no. 1 occurred due to usage of fossil fuels. Experiments were carried out with different techniques including atomic absorption, Photometry, titration, bar graph etc. on the compounds and industrial wastewater pollutants of the power plant during the years 2008 and 2009, considering the breadth of information (52 pollutants), mentioning the names of the pollutants were avoided. Results of the measurements were done on 52 pollutants in industrial effluent of power plants through 2008-2009 as well as compared them with each other suggest that the amount of cyanide, the form Aldehydes, lithium, manganese, nickel, molybdenum, selenium at the beginning of the evaporation pond (input of effluent in to the evaporation ponds) were increased in 2009. The amount of free chlorine, form Aldehydes, cyanide, cobalt, chromium, fluoride, molybdenum, nickel, ammonium at the end of the evaporation ponds has been increased during the year. Comparison of pollutants with standard for discharging to the absorbent wells indicate that levels of copper, free chlorine, cadmium, zinc, arsenic, magnesium, phosphate, sulfate, and the parameters of BOD and COD are higher than standard. These pollutants are caused by washing of the power plant equipments such as boilers, converters, condenser and cooling tower.

4. Conclusion

As a result, the most important risk of Yazd combined cycle power plant according to the different environments was obtained as follows:

In technological, safety - health, biophysical, economic and social sectors, factors including fire and explosion, hearing loss, groundwater quantity and power generation with weights of 16.32, 12.96, 25.74 and 1.9 respectively are considered among the most important factors caused risk in the power plant. Moreover the drop in the underground water levels with weight of 51.7 is the most important natural consequence influenced the power plant activity. Considering the results of the study ahead all control and mitigation measurements could be prioritized using determined risk rate and rank in the different sectors. Therefore to control the most important risk of the power plant in technological sector, installation of warning systems such as automatic fire alarm system in susceptible areas of power plants, the use of protective equipment and electricity scissors as well as periodic visits and preventive maintenance toward the fire and explosion safety can be suggested. Also in order to control the hearing loss of the power plant personnel identifying people who are sensitive to noise and reduce the time exposure to sound, usage of personal protective equipments and appropriate selection and proper maintenance of devices is essential. On the other hand to control the underground water drop, continuous monitoring of the underground water table level during the plant activity, implementation of executive and educational programs to reduce the water consumption as well as the construction of aqueduct and flood wall system is advised.

References

[1] Kerzner H . Project management a systems approach to planning, scheduling and controlling, John Wiley & Sons, New York, 2003

[2] Wright A . Risk and Un certainty in Construction 2003. http://www.construction.ualberta.ca[Accessed March 2005].

[3] Muhlbauer W . Pipeline Management Manual, 2nd Editio. Gulf Professional Publishing, 1996, P. 438.

[4] Mathews M , Karydas D , Delichatsios M . A performance-based approach for fire safety engineering: A comprehensive engineering risk analysis methodology, a computer model, and a case study, Fifth International Symposium on Fire Safety Science, International Association for Fire Safety Science,1997, 595-606.

[5] Gray G.M . Toxic Pollution from Powerplants: Large Emissions, Little Risk. Harvard Center for Risk Analysis. 1999.

[6] Chatzimouratidis A , Pilavachi P.A . Multicriteria evaluation of powerplant impact on living standard using the Analytic Hierarchy Process, J. Energ. Pol. 36 (2008) 1074-1089.

[7] Akash B, Mamlook R, Mohsen M . Multi-criteria Selection of Electric Power Plants Using Analytical Hierarchy Process, J. Electr. Pow. Syst. Res. 52,1999, 29–35.

[8] Twardowska I , Szczepanska J. Solid waste: terminological and long-term environmental risk assessment problems exemplified in a power plant fly ash study, J. Scie. Total Environ. 285 (2002) 29-51.

[9] Vaurio J. K . Human factors, human reliability and risk assessment in license renewal of a nuclear power plant, J. Reliab. Eng. Syst. Safety . 94 (2009), 1818-1826.

[10] Dai L , Wei H , Wang L . Spatial distribution and risk assessment of radionuclides in soils around a coal-fired power plant: A case study from the city of Baoji, China, J. Environ. Res. 104, 2007, 201-208.