

Environmental Risk Management of Oil Products Transfer in Pipeline of Bandar Abbas-Sirjan by Using Bow_Tie Method

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Abstract

The current study was carried out with the aim of environmental risk assessment and management of 26 inch petroleum product pipeline from Bandar Abbas to Sirjan (273 km). For this purpose, the environmental risk assessment was performed using the method of Indexing System. Accordingly, identification of hazards and assessment of risks were performed by analyzing two indices; Sum index and Leak Impact index. Afterwards, the risk score was determined based on relative risk model of indexing system. Subsequently, a zonation was made of the pipeline route at three levels of high (0.08-0.26), medium (0.26–0.44) and low (0.44–0.62) risks using Arc GIS 9.3 software. For environmental risk management Bow-tie Method was applied. The method has the ability to display the relationship between all components applied in the analysis of potential harmful factors with control measures, activities and critical duties. This offers the clearest graphic illustration of the risk management. The obtained results indicated that 7% out of the entire route has a high-risk potential with a risk score range of 0.08 to 0.26. Designing features (potential for soil movement) and third party damage were identified as the most effective factors causing risk in the study area. To mitigate and control the identified risks some managerial strategies were presented in the form of Bow-tie Model. Some of the preventative and control measures are including installing warning systems, appropriate response to calls, applying maintenance equipment, quick disconnect of flow inside the pipe, quick informing and restoration and reconstruction of affected areas.

INTRODUCTION

The study ahead focuses on environmental risk assessment of Bandar Abbas-Sirjan petroleum product pipeline using Bow-tie Method. The risk management of the project aims at planning, organizing, directing and controlling the project activities and processes so that maximize the opportunities and minimize the impacts of the threats. Bandar Abbas-Sirjan pipeline located in Hormozgan Province has an approximate length of 273 km. Based on the designs, the pipeline origins from Bandar Abbas pump-station and after changing direction moves towards the east to the point where intersects the main road of Hajiabad-Bandar Abbas and goes along this road to the north of the province. The establishment purpose of the pipeline is transportation of 300,000 barrels of production per day from the refineries in Bandar Abbas, Hormuz to the center of the country. The useful life of the project is considered to be 25 years. The pipe is made of API-51-X52 and its diameter equals to 26 inches. The pipeline will use two pump-houses; Ghotbabad and Mehran to provide appropriate aerodynamic to transfer the fluid in the pipeline.

MATERIALS AND METHODS

In the study, the technical characteristics of the project and the affected environment were initially identified regarding the existing situation of the study area. The affected scope of the pipeline was determined in a radius of 1km regarding the international references. Likewise, the impact scope of the project on physical, environmental, biological and social areas was considered 1 km by the research team. Afterwards, indexing system was applied for environmental risk assessment. Arc GIS (9.3) software was used for zonation of the pipeline route. At the end, by means of Active bowtie software, control measures and monitoring were suggested based on Bow-tie Method in order to manage the environmental risks. Risk

assessment of oil and gas transmission lines is conducted using indexing system based on determining two indices; total hazards and impacts. In total hazard index, all factors that increase the risk of accident or danger are classified into four sub-indices including third party damage, corrosion, designing and incorrect operation. Achieving high scores in each of these sub-indices indicates that the pipeline status is desirable. The leakage impact index is calculated through factors such as product potential risk analysis, leakage rate, fluid release and the recipient environment factors. The index score is obtained by multiplication of the scores of the mentioned factors. Acquiring lower scores in each of the sub-indices resulting in lower score of leakage impact indicate the desirable status of the pipeline. In this method, scoring is performed by a subjective scoring system. The relative risk score is calculated based on Muhlbauer relative risk model by dividing the score of total hazard index on the score of the impact index. The bow-tie chart which is considered an attractive tool for risk identification and qualitative analysis, not only illustrates the possible paths between hazards and disasters (major and main events), but also reveals the distinction between preventive and reducing barriers of the impact. In Bow-tie model, the main risk is displayed in the center of the diagram, inside a circle-shaped symbol. Threats and obstacles are shown to the left-side of the diagram while the right-side demonstrates possible consequences and their control measures in the form of rectangles with vertical and horizontal color bands. In order to better reveal the distinction between the different components of the model, a specific color for each component can be defined.

RESULTS

In current study, the environmental risk of 26" products transmission pipeline of Bandar Abbas – Sirjan was assessed through analyzing the two indices; Table1 gives the scores of each sub-index in two sections of Index Sum and Leak Impact Index.

Table 1. The scores of the sub-indices in both indices of sum index and leak impact index

Index	Sub index	Sub index Score	Project Score
Index Sum	Third Party Damage	100	50
	Corrosion	100	79
	Design	100	30-40
	Incorrect Operation	100	88
Leak Impact Index	Product Hazard	22	13
	Dispersion Factor	12	4, 16
	Ecological Sensitivity	16	8-15

The Final risk score obtained from combining the scores of Index Sum and Leak Impact Index varies along the pipeline route. It is within the range of 0.62-0.08. Based on the scoring criterion in this method, higher scores indicate a lower risk. Fig.1 illustrates the score and risk level.

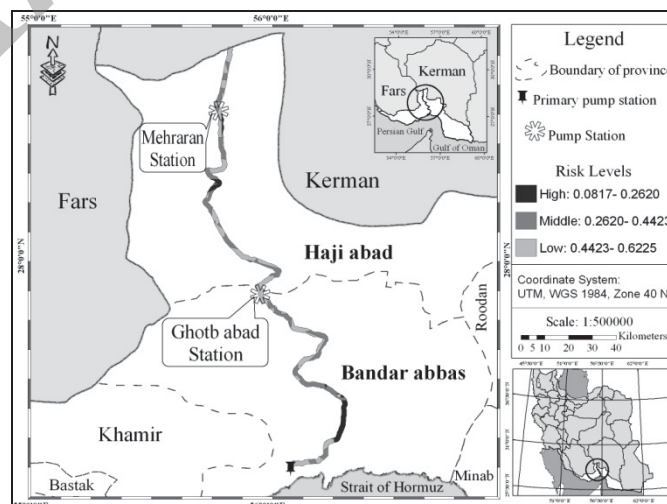


Fig.1. zoning the scores and risk classes

Subsequently, using the results of the risk assessment, the environmental risks of the project were managed.

The product leakage was considered as the identified operational risk of the pipeline and the main event whereas; the most severe environmental risk is resulted from potential leakage of the material from inside the pipes to the surroundings. Parameters that are presented in in Bow-tie Model are include: Threatening factors identified in this study, the major consequences caused by leakage of petroleum, effective factors proposed to prevent and reduce probability of risk occurrence resulting from each of the threatening factors, and recommended strategies for controlling and reducing the consequences of the leakage.. Fig.2 shows the Bow-tie Model plotted for environmental risk assessment of the pipeline.

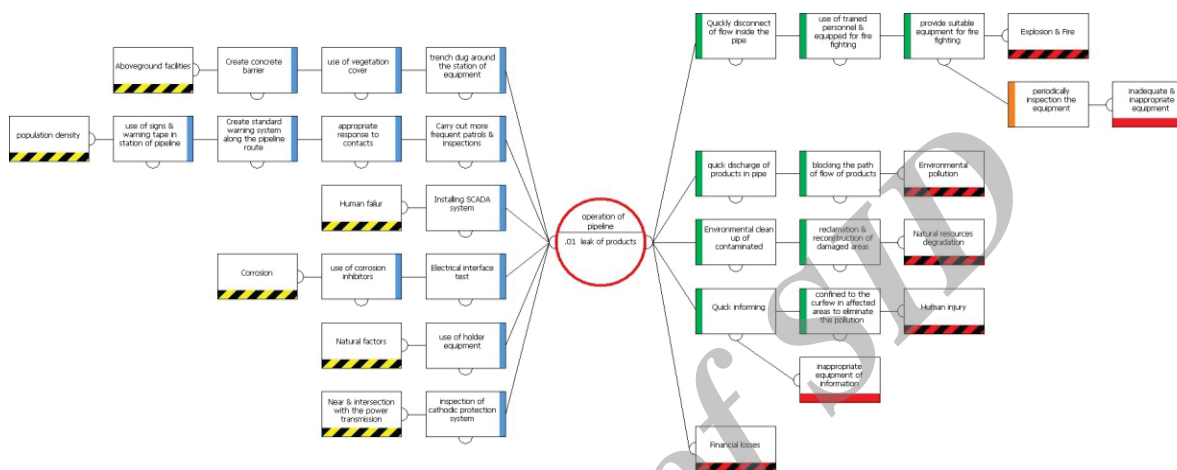


Fig.2. Bow-tie Model of environmental risk management of Bandar Abbas – Sirjan pipeline

In this model, Threats have been specified as a rectangle with striped yellow and black. Moreover, the recommended measures to prevent the occurrence of any of the threats are presented among the relevant factors and the main event. It is worth noting that they are specified in the form of a rectangular with blue stripes. The right-side of the diagram includes potential consequences resulting from product leakage which are illustrated with a red and black hachure. There are some rectangles with green strips which include retrieval and corrective measures following the occurrence of the main event. In this diagram, the factors which cause the incompetence of the retrieval actions are illustrated through rectangles with red strips. They are connected to the retrieval measures with a diagonal line. The effective measure that can be considered to prevent failure of retrieval measures are represented in front of failure factor which is specified by an orange strip.

CONCLUSION

The research findings in relation to the identification and assessment of environmental risks indicated that the final risk score of the project is within the range of 0.08 to 0.62. Based on the zonation of the risk score classes, 7% out of the entire pipeline route has the high risk potential. In this study, the risk level at different parts of the pipeline was compared by mapping and allocating a numerical value to the raster cells using Arc GIS 9.3 software. The result of this study suggests that damages may be caused by third-party have a significant fraction of the pipeline incidents. In the current study, the result of the risk management was offered by Bow-tie Model. Some of the useful features of the method are including: clarifying the distinction between preventive and reactive barriers for removal or reduction of risk occurrence of a specific incident, capabilities of the Bow-tie Method in simplifying, determining and recognizing “cause and effect” factors, and summarizing and converting large amounts of quantitative data to relatively few common scenarios. Consequently, Bow-tie approach can be considered as an effective way to present and communicate the risk project and management which is understandable for all levels of project managers and staff.

Keywords: Bandar Abbas-Sirjan Pipeline, Bow_Tie model, environmental risk management, indexing system, risk.