



International Oil Spill Response Technical Seminar

## Research on Oil Spill Risk of Port Tank Zone Based on Fuzzy Comprehensive Evaluation

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### Abstract

For the purpose of early discovering of tank zone oil spill accidents and making up the shortfall, the fuzzy comprehensive evaluation method was used to construct the oil spill risk fuzzy comprehensive evaluation model. Firstly, the historical data of oil spill accidents in China National Petroleum Corporation (CNPC) was collected and analyzed, and the questionnaire was conducted to the field staff and managers to select and confirm the evaluation factors. Secondly, the analytic hierarchy process (AHP) combined with experts scoring method was used to set the weight of each factor. Lastly, the fuzzy factors were quantified based on the membership function to determine the risk factors matrix. The oil spill risk of CNPC port was researched as a case study, the result of which is  $V=3.85$ , indicating that the state of the tank zone is approximately well. The result and conclusion consist with the actual conditions.

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### 1. Introduction

With the rapid development of our country's economy, the demand for oil is increasing. In 2002 the China's oil consumption has become the world's second largest oil consumer and importer after the United States. The increasing of port tank zone and oil throughput makes the oil spill accident probability more and more large, at the same time pollutes the port environment, and destroys the marine biological resources and ecological environment.

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On July 16, 2010, the pipeline of PNPC port tank zone of Dalian new port occurred explosion accident, the fire burned for 15 hours, and the pollution sea area near 50 square kilometers, economic losses more than 220 million yuan; On October 24, 2010, near the port tank zone of PNPC of Dalian new port occurred fire accident, and three people were killed in the fire; On August 29, 2011, the number of 875 diesel fuel tank suddenly caught fire accident, and the fire was extinguished burning for three hours; On November 22, 2011, the number of 31 and 32 original tank's sealing ring on fire caused by lightning, fire under control after 1 hour, but luckily no one was injured.

At present, more people care for the study on ship oil spill risk assessment, while with less port tank zone research. Therefore, port tank zone of the oil spill risk assessment and preventive measures of research more and more important. Risk assessment mainly includes index method, safety check list method, probability method, synthesis methods and so on. In this paper, based on the fuzzy mathematics theory, establish the risk evaluation model, using fuzzy mathematics comprehensive evaluation method for risk evaluation on the PNPC port tank zone, to determine their level of risk, and then provide the reference for port tank zone risk analysis and risk management.

## 2. Fuzzy Comprehensive Evaluation

Fuzzy comprehensive evaluation is according to fuzzy relationship synthetic principle, and on the basis of determined factor sets, weight sets and evaluation sets, use membership function quantitative process the fuzzy boundary and not easy to quantitative factors, through the multi-level integrated computation, eventually determine the level of evaluation objects (Lv yan, et al, 2012).

### 2.1. Basic elements of fuzzy

The fuzzy comprehensive evaluation mainly includes the following elements:

#### (1) Factor sets

The factor set is the foundation of evaluation, that is the various factors influencing the evaluation objects of common set, and can indicated as:

$U = \{u_1, u_2, \dots, u_n\}$ ,  $u_i$  ( $i=1, 2, \dots, n$ ) is the indicator of influence factor.

#### (2) Weight sets

According to the important degree of each factor, give different weights, then establish the weight sets.

$W = \{w_1, w_2, \dots, w_n\}$ ,  $0 \leq w_i < 1$ ,  $\sum_{i=1}^n w_i = 1$ .

#### (3) Evaluation sets

Evaluation sets is composed of evaluation object judgment result sets, and can indicated as:

$V = \{v_1, v_2, \dots, v_n\}$ ,  $v_i$  ( $i=1, 2, \dots, n$ ) is the indicator of various possible total evaluation results.

Fuzzy comprehensive evaluation is based on the purpose of considering all factors affecting the evaluation object, obtain an optimal evaluation results from the evaluation sets  $V$ . Evaluate the fine grade, the more accurate, but its evaluation process the less tedious, so should give full consideration to the nature of the evaluation factors characteristics of unfavorable carefully divided (HAI Pu-bi, et al, 2012).

### 2.2. The establishment of the fuzzy evaluation mode

The general process of fuzzy comprehensive evaluation establish mode (Xiang Dong, 2010; Yu Jianxing, et al, 1998). (1)Collect project information at home and abroad;(2) According to the data and project management personnel select the evaluation object of risk factor sets;(3) According to expert opinions screen the risk evaluation indexes, establish the risk evaluation index system;(4) According to the important degree of each evaluation index, using the analytic hierarchy process (AHP) to give different weights, then to determine the fuzzy weight sets,

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