

# Study on the Selection of Evacuation Sites in the Event of a Chemical Accident

Min Seo Nam <sup>01</sup>, Jun ho Choi <sup>02</sup>, Byung-Tae Yoo <sup>03†</sup>

01 Korea National University of Transportation (Author Affiliation: Department of Safety Engineering, Korea National University of Transportation, Chungju, Republic of Korea)

02 Chungbuk National University (Author Affiliation: National Crisisontology Institute, Chungbuk National University)

03<sup>†</sup> Korea National University of Transportation (Author Affiliation: Department of Safety Engineering, Korea National University of Transportation, Chungju, Republic of Korea)

## Abstract

In facilities handling hazardous chemicals, it is required by the Chemicals Control Act to establish plans for prevention and response in advance, assuming the occurrence of chemical accidents. These plans are to be drafted and submitted in accordance with relevant regulations, and the contents are made available to the public. While some research has been conducted on the conditions and locations of evacuation sites, there is a deficiency in studies regarding the selection of evacuation sites for local residents.

This study reviewed whether the locations of evacuation sites used in the event of a chemical accident at the targeted facilities are suitable. Furthermore, an analysis was conducted to determine whether these locations are suitable for evacuation under meteorological conditions such as wind direction and speed. It is anticipated that the research findings and improvement measures derived from this study will contribute to strengthening emergency response systems in the event of chemical accidents.

**Key words:** Chemical accident, response plan, evacuation site, risk assessment, ALOHA

## I. Introduction

A chemical accident refers to incidents where damage occurs to humans, the environment, or property due to leaks or explosions of chemicals during handling or transportation processes. To prevent such accidents, prompt and appropriate responses are necessary. Facilities dealing with hazardous chemicals are required to establish plans for preventing and responding to chemical accidents in advance, assuming their occurrence. These plans are drafted and submitted in accordance with relevant regulations and are disclosed to the local community. One crucial aspect disclosed to the community is the evacuation site in the event of a chemical accident. Evacuation sites are essential for preventing casualties and ensuring the safety of local residents in the event of a chemical accident. However, research on evacuation sites for chemical accidents has been lacking. Therefore, this study aims to evaluate the suitability of evacuation sites disclosed to the community and assess whether they can protect local residents under meteorological conditions such as wind direction and speed.

## **II. Theoretical background**

### **1. Climate Crisis and Extreme Disasters**

Yoo et al. conducted a study on identifying approaches to establish effective indoor and outdoor decontamination plans in the event of a chemical accident. Choi et al. researched methods for effectively delivering information to residents regarding hazardous chemical notifications. Kim et al. analyzed the vulnerability of disaster victims with difficulties in evacuation during chemical accidents and conducted research on decontamination plans to protect these vulnerable individuals. Research on the selection and suitability of evacuation sites for chemical accidents is severely lacking. Considering the need for effective response and prevention in the event of chemical accidents, it is deemed necessary to conduct relevant studies.

## **III. Analysis of Evacuation Sites and Impact Range**

### **1. Analysis of Chemical Accident Evacuation Sites**

This study targeted facilities responsible for establishing chemical accident evacuation sites. The research was conducted to develop preventive measures and response plans for chemical accidents. An analysis was conducted on currently publicized chemical accident evacuation sites. Analysis of factors such as location and distance revealed that a total of four chemical accident evacuation sites are designated in the southeast direction. These locations are evaluated as suitable during the summer due to prevailing southeast winds; however, they are deemed unsuitable during the winter when northwest winds prevail. Therefore, this study aims to propose methods for selecting chemical accident evacuation sites, taking into consideration the seasonal characteristics of South Korea where distinct four seasons occur.

### **2. ALOHA Analysis**

Analyzing the weather conditions over the course of a year at Facility A's location yielded the following results. During the spring months of March to May, the average temperature was 11.37 degrees Celsius, with an average humidity of 66% and an average wind speed of 2.13m/s. These months are predominantly influenced by southeast winds. In the summer months of June to August, the average temperature was 23.8 degrees Celsius, with an average humidity of 79% and an average wind speed of 1.87m/s. These months also experience significant influence from southeast winds. During the autumn months of September to November, the average temperature was 14.97 degrees Celsius, with an average humidity of 76% and an average wind speed of 1.67m/s. Northeast winds have a significant influence during this period. In the winter months of December to February, the average temperature was 2.23 degrees Celsius, with an average humidity of 72% and an average wind speed of 1.77m/s. Northwest winds predominantly affect this season.

Given that South Korea experiences four distinct seasons, it was observed that wind directions vary by season. Therefore, this study conducted ALOHA simulations based on seasonal weather conditions.

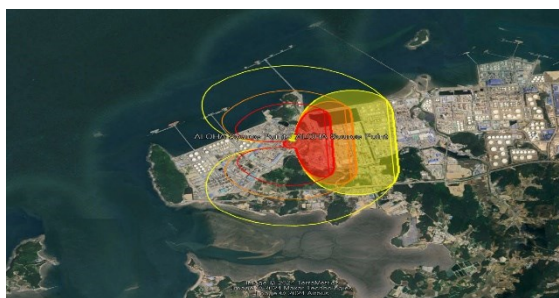


Fig. 1. Spring



Fig. 2. Summer



Fig. 3. Fall

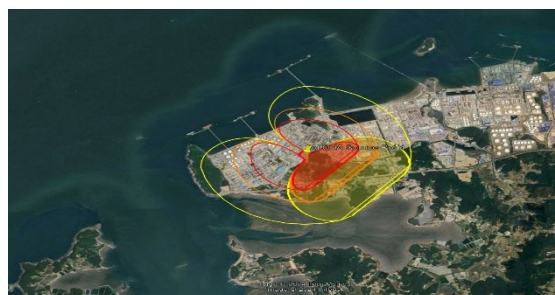


Fig. 4. Winter

## IV. Conclusions

This study conducted an analysis of previous studies and assessed impact ranges, leading to the following conclusions. During the spring season, chemical substances dispersed predominantly towards the west and northwest due to the influence of southeast winds. In the summer, dispersal occurred towards the north and northwest under the influence of southwest winds. During autumn, dispersal towards the south was observed under the influence of northeast winds, while in winter, dispersal towards the southeast occurred under the influence of northwest winds.

Thus, it was observed that the direction of chemical substance dispersion varies according to seasonal winds. Considering the designated chemical accident evacuation sites located in the southeast direction, it is deemed that these locations may not be appropriate depending on seasonal weather conditions. Therefore, there is a need to reconsider evacuation site locations, taking in to account wind direction, and provide evacuation site recommendations tailored to each season. This could minimize secondary damages and lead to a more systematic plan than the current approach.

## V. Acknowledgement

This work was partially supported by the 2024 Chemical Substance Specialization Graduate School Support Project of the "Chemical Safety Management Expert Training Project" (Government Business Number: B0080531001698) sponsored by the Korean Ministry of Environment.

## References

Yoo, Byung Tae, and Moon, Myung Hwan. 2018. Improvement Measures for Establishing Emergency Response Plans for

- Chemical Accidents Using ALOHA. Journal of the Korean Society for Crisis and Emergency Management, vol. 18, No. 3, pp.311~319.
- Choi, Yoon Jung, Kim, Hong Kwan, Chun, Young Woo, and Lee, Ik Mo. 2023. Study on Improvement Measures for the Content of Resident Notification of Hazardous Chemicals. Journal of the Korean Society of Hazardous Materials, Vol. 11, No. 1, pp. 01~09.
- Kim, Seo Eun, Shin, Ga Young, Lee, Ik Mo, Hwang, Young Woo, and Chun, Young Woo. 2019. Study on Improvement Measures for Shelter Plans Targeting Vulnerable Populations in the Event of Chemical Accidents. Journal of the Korean Society of Hazardous Materials, Vol. 7, No. 1, pp. 10~18.
- Jeong, Won Il, Kim, Yeon Jin, Ryu, Tae In, Cho, Seung Beom, and Kim, Kyung Bae. 2023. Study on the Selection of Targets for Compliance Checks of Chemical Accident Prevention and Management Plans Based on Big Data. Journal of the Korean Institute of Communication Sciences, Vol.48 No.10, pp.1247~1253.
- Lee, Hyung Seop, and Lim, Ji Pyo. 2017. Study on the Establishment of Preventive Measures through Analysis of the Causes of Chemical Accidents. Vol. 32, No. 3, pp. 21-27.
- Park, Gyo Sik, Kim, Tae Ok, Kim, Ji Yoon, and Yoo, Bang Hyun. 2013. Study on the Analysis of Results of Hydrofluoric Acid Leakage Accidents in Gumi. Vol. 1, No. 1, pp. 13~19.
- Go, Min Wook. 2017. Study on Prediction of Damage from Hydrofluoric Acid Leakage in Gumi Using Daewadong Simulation. Bachelor's Thesis, Pukyong National University.
- Chemical Safety Agency. 2021. Manual for Writing Chemical Accident Prevention and Management Plans.