Preliminary Safety Assessment of Wildfires in the Offsite Power System Near Hanul Nuclear Power Plant

Kyungmin Kim [a], Yeonwoo Choi [a], Seunghyun Eem [b*], Jinhee Park [c]
[a]*Major in Plant System Engineering, School of Convergence & Fusion System Engineering, Kyungpook National Univ., Gyeongsang-daero 2559, Sangju, 37224*
[b]*Department of Convergence & Fusion System Engineering, Kyungpook National Univ., Gyeongsang-daero 2559, Sangju, 37224*
[c]*Risk Assessment Research Division, Korea Atomic Energy Research Institute, Daejeon Republic of Korea, Daedeok-daero 989, Daejeon,34057*
** Corresponding author: eemsh@knu.ac.kr*

Keywords : wildfire, nuclear power plant (NPP), offsite power system, probabilistic safety assessment (PSA), wildfire hazard map

1. Introduction

Wildfires cause massive loss of life and economic damage. Wildfires can also affect the operation of NPPs (Nuclear Power Plants). Wildfires can disconnect the offsite power system near an NPP, causing LOOP (Loss of Offsite Power) event. In reality, reactor shutdowns at Hanul Unit 1 on April 7, 2000, and Hanul Unit 2 on April 11, 2000, and emergency diesel generator startup at Hanul Unit 6 on March 4, 2022, were all due to the disconnection of the offsite power system caused by wildfire[1]. In addition, incidence of wildfire is expected to be increased due to climate change [2]. Therefore, we conducted a partial preliminary safety assessment about one of the offsite power grids near Hanul NPP in response to wildfires in this study.

2. Probability of failure in offsite power system from wildfires

Nuclear power plants must continuously transmit and distribute electricity to the offsite. Wildfires can cause disconnection to the offsite power system and cause problems for the electricity supply of NPPs. A wildfire hazard map and geospatial information are required to conduct a safety assessment in response to wildfires about the offsite power system. Then, the probability of disconnection to the offsite power system was derived using the fault tree.

Kim et al., [3] created a wildfire hazard map with a frequency of 100,000 years near the Hanul NPP through MCS (Monte Carlo Simulation). Created wildfire hazard map is composed of 90m×90m cells, and the value that each cell has means the annual probability of burning in that cell. The wildfire hazard map near Hanul NPP is shown in Figure 1.

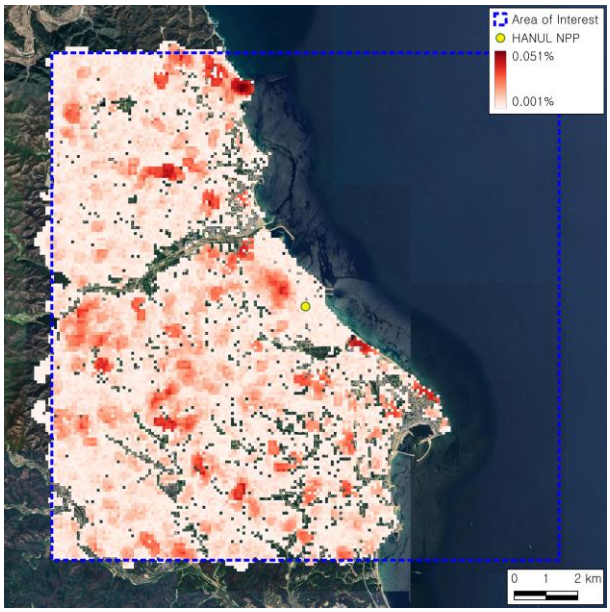

Fig. 1. 100,000-year frequency wildfire hazard map near Hanul NPP

Google satellite images and OpenStreetMap were used to generate geospatial information of the offsite power system near the Hanul NPP. Generated offsite power system consists of four transmission lines and three substations. Figure 2 shows the geospatial information of the offsite power system.

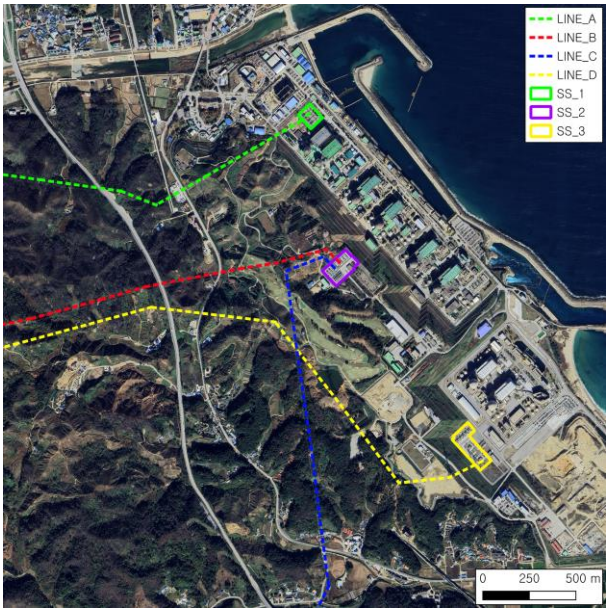

Fig. 2. Offsite power system near the Hanul NPP

The probability of failure to each offsite power system component was extracted from the wildfire hazard map to obtain the probability of burning of cells through which the offsite power system passes. If an offsite power system was burned, it was assumed to have failed. Based on this, we used MCS to derive the probability of failure for each component.

In this study, a preliminary safety assessment was performed based on substation SS_2. Substation SS_2 is connected to transmission lines LINE_B and LINE_C. Therefore, the fault tree that causes the cut off to substation SS_2 due to wildfire is shown in Figure 3. And derived value was 0.0027/yr.

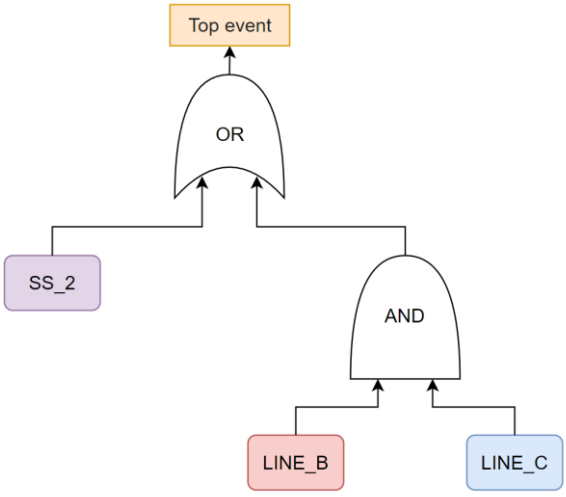

Fig. 3. The fault tree of offsite power system near the Hanul NPP

3. Conclusions

A preliminary safety assessment of wildfires in the part of offsite power system near NPP is conducted. The target plant was Hanul NPP, which was affected by wildfires in the past. The probability of failure to two transmission lines and substation was derived from the wildfire hazard map and geospatial information of the offsite power system. Then, organizing the fault tree according to the connection of the offsite power system, the probability of failure to the offsite power system were successfully derived. As the risk of wildfires increases due to climate change, the necessity of wildfire safety assessment is also growing. The safety assessment methodology presented in this study is expected to help analyze the wildfire risk of NPPs.

Acknowledgement

This work was supported by Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government (MOTIE) (No. 20224B10200050) and National Research Foundation of Korea (NRF) grant funded by the Korean government (Ministry of Science and ICT) (No. RS-2022-00154571).

REFERENCES

[1] Nuclear Safety Information Center, https://nsic.nssc.go.kr/information/reguDataActive.do?nsicDtaTyCode=nppAccient, 2024,03,07.
[2] YJ. Bae, HJ. Lee, BW. Jung, Korea Climate Change Assessment Report 2020, Ministry of Environment, 2020.
[3] KM. Kim, JH. Park, SH. Eem and SY. K, Methodology for Generating Wildfire Hazard Map for Safety Assessment of Off-Site Power Systems Against Wildfires, Submitted