

# Accepted Manuscript

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PII: S1738-5733(18)30110-4

DOI: [10.1016/j.net.2018.03.007](https://doi.org/10.1016/j.net.2018.03.007)

Reference: NET 522

To appear in: *Nuclear Engineering and Technology*

Received Date: 11 February 2018

Revised Date: 5 March 2018

Accepted Date: 7 March 2018

Please cite this article as: K.H. Yoo, J.H. Back, M.G. Na, S. Hur, H. Kim, Smart support system for diagnosing severe accidents in nuclear power plants, *Nuclear Engineering and Technology* (2018), doi: 10.1016/j.net.2018.03.007.

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# Smart support system for diagnosing severe accidents in nuclear power plants

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**Abstract:** Recently, human errors have very rarely occurred during power generation at nuclear power plants (NPPs). For this reason, many countries are conducting research on smart support systems of NPPs. Smart support systems can help with operator decisions in severe accident occurrences. In this study, a smart support system was developed by integrating accident prediction functions from previous research and enhancing their prediction capability. Through this system, operators can predict accident scenarios, accident locations and accident information in advance. Also, it is possible to decide on the integrity of instruments and predict the life of instruments. The data were obtained using modular accident analysis program (MAAP) code to simulate severe accident scenarios for the Optimized Power Reactor 1000 (OPR1000). The prediction of the accident scenario, accident location and accident information was conducted using artificial intelligence (AI) methods.

**Keyword:** Artificial intelligence, Diagnosis, Operator support, Severe accident, Smart support system

## 1. Introduction

Nuclear power plants (NPPs) are designed in consideration of design basis accidents (DBAs). However, if the emergency core cooling system (ECCS) is not working properly in a loss of coolant accident (LOCA) situation, it can induce a severe accident that exceeds a DBA [1]. For example, the Fukushima accident was caused by a natural disaster exceeding the DBAs. The personnel of the Fukushima plant did not know the detailed situation inside the NPPs, leading to a severe accident. Therefore, accident diagnosis and prediction techniques are essential for understanding the progress of severe accidents.

After the Three Mile Island accident in 1979 and the Chernobyl accident in 1986, safety problems at NPPs have emerged as a global concern [1]. These accidents indicated that human error is the major contributor to accidents at NPPs [2]. For this reason, many countries are conducting research on safety problems and operator support systems at NPPs.

The early diagnosis of transients is an emerging issue in the operation of nuclear power plants [3]. During transients in NPPs, operators analyze the trends of several parameters indicated by measuring instruments in the main control room (MCR) [4]. Many alarms from many different systems often occur at the same time during transients in NPPs [4-5]. Therefore, it is difficult for operators to quickly recognize transient scenarios because there are so much information and warnings coming in all at once. If a transient occurs, operators can make wrong decisions and take improper actions, thereby leading to serious accidents [4]. Human error is one factor that can cause severe accidents in NPPs. This study focused on constructing a smart support system to resolve the current problem.

Recently, interest in the fourth industrial revolution has been increasing worldwide and artificial intelligence (AI) has been applied to various research fields. Due to data training, AI methods have very low prediction error, and the reliability of prediction data

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