Development of a Concept of Dynamic Integrated Safety Analysis for Accident Predictions

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1. Introduction

In nuclear related facilities, safety is one of the most significant issues for reliability and sustainability of the facility operations. In case of a fuel cycle facility, U.S. Nuclear Regulatory Commission (NRC) requests to conduct integrated safety analysis (ISA) for protecting public, facility workers, and the environment. The ISA has been conducted to examine potential hazards with relatively higher likelihood of occurrence and to prevent and mitigate accidents by designating items relied on for safety (IROFS), finally meeting a performance requirements of 10 CFR 70.61 [1].

Although the ISA has several advantages for applying to relatively smaller-scale nuclear facilities containing various types of chemical process equipment [2], it gives a natural limitation that the values of likelihood of occurrence are determined and fixed by vague engineering judgments comparing with a probabilistic safety assessments (PSA). In case of PSA, currently, dynamic-PSA has been developing by considering system dynamics with Monte Carlo simulation and dynamic event tree [3].

In this study, a concept of dynamic ISA(D-ISA) is devised for an accident prediction by utilizing internet of things (IoT) technologies. Recently, there are also similar researches especially for fire prediction, red tide detection and prediction, and disaster safety platform technologies.

2. Methodology

This D-ISA concept is based on a risk index matrix of the ISA (see Table 1). After conducting ISA for a smaller-scale nuclear facility, specific sequences of design basis accidents are examined. Then, a consolidated IoT system with several IoT sensors such as temperature, pressure, electrical current, water level, wind speed, radiation, and so on is connected to a central big data server system for calculating real-time likelihood of occurrence and consequence of each DBAs.

Table 1. 3x3 Risk Index Matrix

| | | Likelihood of Occurrence | | |
		Highly Unlikely [1]	Unlikely [2]	Not Unlikely [3]
Conseq-uence	High [3]	Acceptable 3	Not Acceptable 6	Not Acceptable 9
	Interme-diate [2]	Acceptable 2	Acceptable 4	Not Acceptable 6
	Low [1]	Acceptable 1	Acceptable 2	Acceptable 3

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REFERENCES

[1] NUREG-1520, Standard Review Plan for Fuel Cycle Facilities License Applications, U.S. Nuclear Regulatory Commission(2015).

[2] A Comparison of Integrated Safety Analysis and Probabilistic Risk Assessment, U.S. Nuclear Regulatory Commission, ML103330478 (2010).

[3] H. Lee, T. Kim, G. Heo., Application of Dynamic Probabilistic Safety Assessment Approach for Accident Sequence Precursor Analysis: Case Study for Steam Generator Tube Rupture, Nuclear Engineering and Technology 49, 306-312 (2017).