

Current Research Status of KHNP for Site Risk

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1. Introduction

In Korea, by the geographical characteristics, many Nuclear Power Plants (NPPs) have been constructed and operated at a single site. This is above average level or number of plants per site in the world. For this reason, the public concerns for the safety of nuclear facilities increased after Fukushima Daiichi accident. As a result, comprehensive risk assessment and management for the site which have multi-unit NPPs were strongly asked. Currently, to solve it, many researches and projects has carried out by various Korean companies, research centers, and regulatory authorities. Especially, Korea Hydraulic & Nuclear Power (KHNP), as a sole company for constructing and operating the NPPs in Korea, has to be in charge of the center which is covering all kinds of R&D to assess and manage. In this paper, R&D plans of KHNP for multi-unit risk were summarized. Firstly, the needs of multi-unit PSA were reviewed. R&D activities and plans of KHNP were summarized in the last part.

2. Multi-unit Risk and PSA

PSA is practical method to quantitatively assess integrated risk of a systems using probabilistic method, it is internationally used to check whether the quantitative safety goal is satisfied or not. In particular, PSA has benefits in assessing the huge and complex facilities such as nuclear power plants.

Fukushima accident made many changes in the safety goal of NPPs and risk assessment. Before this accident, in terms of nuclear safety, both of nuclear utilities and regulatory authorities focused only on single-unit based risk. This is because there were no experiences of multi-unit accident and it was expected that they had negligible frequency. Hence, single-unit based nuclear safety goal and Quantitative Health Objective (QHO) were defined and used. So, PSA based on single-unit had been also developed and performed under an assumption that adjacent units near the assessment target unit are safe. However, as shown that existing assumption was inadequate by Fukushima accident, the concern for multi-unit accident and risk (site risk) increased. For this reason, many countries have made efforts to develop the safety goal, regulatory requirements, and assessment methodology for a site. Especially, in case of Korea, the issues related with multi-unit site have become more important because many NPPs have been constructed and operated in a single site comparing with other countries. So, it is asked to estimate multi-unit risk for planed NPPs as a

requirement of construction permit, and it will be extended to all nuclear power plant sites in Korea. This assessment is important and practical issue in both nuclear industry and the national energy policy. Currently, there are no clear and comprehensive methods for above issues such as safety goal and multi-unit risk. Therefore, many researches are needed to systematically and appropriately estimate the multi-unit risk.

3. R&D Plans of KHNP for Site Risk

The major purpose of multi-unit risk assessment is to improve the social acceptance for the comprehensive safety of nuclear facilities increased by Fukushima accident. In Korea, the multi-unit risk assessment for planed NPPs has been required, and it is expected that it will be extended to all sites. As a simple example, this issue is being magnified in regard to construction permits of new nuclear power plant, and both of nuclear industries and the governments (and local government) have been concerned with that. Currently, quantitative surrogates such as Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) have been used to check whether the safety goal is satisfied or not through PSA [1, 2]. However, it is expected that there are many difficulties to acquire the public acceptance using existing surrogates because they were established using single-unit risk information. Hence, the techniques for assessing and managing the risk in terms of the site should be developed to improve the safety and the public acceptance for NPPs.

Korea has carried out and updated PSA on all sites and nuclear power plant by various Korean companies and research centers such as Korea Atomic Energy Research Institute and KEPCO Engineering & Construction and so on, which is mainly driven by Central Research Institute of KHNP [3]. In Korea, KHNP has to be in charge of the center which is covering all kinds of researches to assess and manage the multi-unit risk. For that, KHNP have made an efforts focused on how to extend PSA up to Low Power/Shutdown and Level 3 PSA that have not been carried out before. In addition, many researches and projects for the systems of newly designed NPPs have been also performed.

Currently, KHNP began the research project "Multi Unit Risk Assessment of Pilot Plants based on Focused Probabilistic Safety Assessment Model" by various needs mentioned above. There are many difficulties to assess reliable risk as a result because of the technical limitations in current status. For this reason, the multi-

unit risk based on scenarios identified by analyzing causes which can affect multi-units will be firstly assessed. Using that, we have ultimately targeted the improvement of the safety in terms of the site.

This project consists of two parts (long and short term purpose). Long term purpose was the establishment of roadmap to systematically manage the multi-unit site. It was divided into two categories: (1) establish the roadmap for assessing and managing the multi-unit risk, and (2) analyze dependencies of systems, maintenances, operations which can affect multiple units. Short term purpose is to preliminarily assess the multi-unit risk based on scenarios. Details were followed.

- Multi-unit Risk Assessment Roadmap (long term)
 - Establish multi-unit risk metrics to manage the risk
 - Identify multi-unit accident and estimate their frequencies
 - Suggest the method for assessing the multi-unit risk based on scenarios
 - Identify and analysis the shared or common structures, systems, and components
 - Sensitivity study based on multi-unit dependencies
- Multi-unit risk assessment based on accident scenarios (short term)
 - Characteristic on multi-unit dependencies for expected multi-unit accident scenarios
 - Review Korea-specific multi-unit risk for expected multi-unit accident scenarios
 - Establish the safety improvement measures by the review of multi-unit risk
 - Estimate preliminary multi-unit risk based on accident scenarios

Using the results from above research project, multi-unit based emergency response plan could be preliminarily established. In the long term, it is expected that they will be used as a basic data to develop detailed risk models and regulatory framework which are considering Korea specific characteristics of NPPs site.

3. Conclusions

In this paper, we summarized the R&D plans of KHNP for assessing the multi-unit risk. Currently, multi-unit risk or multi-unit PSA are important and practical issues in both nuclear industry and national energy policy. After Fukushima accident, several countries stopped the construction and the operation of NPPs, other countries which is maintaining the NPPs are being strongly asked to assess the risk for multi-unit NPPs at the same site. Because of Korean geographical characteristics, the number of NPPs which are above average level or number of plants per site in the world is being constructed and operated at a single site. The population density nearby each site is considered to be higher than that of other countries. So, the needs for assessing the multi-unit risk are more highlighted

compared to that of other countries and hence, multi-unit PSA should be performed. These activities were important and necessary to not only to quantitatively assess the risk but also to correspond with the public concern for the safety of NPPs.

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