A Feasibility Study on DB over the Level-3 PSA Information

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1. Introduction

As a part of nuclear safety research, a Korean specific Level-3 PSA code was set for development. Similarly, in the field of nuclear safety research, there have been many studies on improving the safety and reducing the risk based on simulation data and experimental data.

The results of various researches have been accumulated, along with large amounts of data. As a result, such data need to be managed for the meaningful data. In this study, the feasibility of database construction is studied using a proper scheme for the management of accumulated data.

2. Methods and Results

In the nuclear safety fields, various research methods are used to reduce risk. In this section, the recent status related the data management and database of PSA safety research is reviewed, and a research plan through a database is inspected.

2.1 Current Status for Level-3 PSA code

The Level-3 PSA is a field of assessment for an off-site consequence analysis of a radiation leakage accident using the probabilistic method. The execution of a Level-3 PSA is a somewhat complicated and enormous job, and is performed using a code (computer program) [1]. Most widely used code for a Level-3 PSA is the MACCS2 code, which was developed by SNL in USA. In addition, the OSCAAR code was developed by JAEA in Japan, and is utilized only for research. And COZYMA and CONDOR codes are also used.

Based on the instruction of the Fukushima accident, the necessity of Level-3 PSA execution has increased regarding radiation leakage and the off-site influence of radiation. In particular, a Korean specific Level-3 PSA is needed due to the demand of the latest technology, and social and legal requests for intensified safety.

The practical code to execute the Level-3 PSA is the MACCS2 code of the USA. The technology of MACCS2 as foreign has limitations compared to domestic environmental characteristics. Based on this insufficiency, a code for a Level-2 PSA needs to be developed with domestic technology reflecting environmental characteristics.

In particular, after the accident at the Fukushima NPP(nuclear power plant), enormous progress had been made in the field of application technology in a Level-3 PSA such as the atmospheric diffusion model and the radiation health analysis model. According to this, the need for the execution of a Level-3 PSA has arisen.

Recently, the international technical trends and the research status were considered and checked. The major technical fields are classified such as radiation source, NPP site information, atmospheric diffusion module, ocean diffusion module, exposure dose model, ecosystem model, emergency response assessment, health impact assessment, and economic impact assessment. Related to these technical fields, major important models and data are also classified [2].

Through this process, the 5 core models for the Level-3 PSA code were checked and compared: the diffusion model, exposure dose model, exposure pathway model, emergency response model, and health impact model. In addition, a roadmap was established and the strategies were set up.

As the first step for the code development, the requirements contained in the code were classified. Based on these requirements, the code design and implementation phase is being processed.

2.2 Database for Level-2 PSA

In the severe accident fields (Level-2 PSA), there are many requirements for the analysis of a severe accident. In addition, there are various methods related to this analysis such as accident management, Level-2 experimental data analysis, code simulation data, and an optimized strategy.

In the field of severe accident experiment, a TROI experiment had been performed for a long time on the damage impact and mitigation plan of the containment vessel. The experimental data need to be arranged systematically and have to be used for an easy and rapid data search. An integrated database system was constructed for the TROI experimental data [3].

For the optimum assessment of Level-2 risk, there were database constructions of uncertainty analysis related to early containment failure and late containment failure of severe accidents [4,5]. It contains the uncertainty analysis data for the containment pressure behavior in the case of a severe accident. The uncertainty analysis data were acquired from a MAAP code simulation, which was developed in NRC and widely used in severe accident analysis. Similarly, the database construction of a severe accident analysis exists. For the database system, the representative scenarios of a severe accident were selected, and thermal hydraulic and source term analyses have been performed using the MAAP code under different scenarios.

For the SFP(spent fuel pool) in an NPP, the database system of a severe accident risk assessment was constructed [6]. Because the safety of an SFP has also became an important issue after the Fukushima accident, the data for the risk assessment of an SFP are also needed in various scenarios. The assessment models were selected based on SFP LOCA(Loss of Cooling Accident) and LOPI(Loss of Pool Inventory).

2.3 Database for other nuclear fields

There was database construction of genetic resources of radiation breeding. Although the necessity for researches of genetic resources of radiation breeding has being increased, there are limits in consecutive researches. A database is needed on the genetic resources for the assurance of continuing research effectiveness [7].

In HRA (Human Reliability Analysis) fields of a Level-1 PSA, there is a database based on simulator training data. In a Level-1 PSA, reducing human error is a critical issue. Sufficient and reliable human performance data collection is a prerequisite for the safety of nuclear power plants [8]. For the systematic acquisition and management of the operator's performance data, the HRA database was constructed. Through the HRA database, the raw data were collected and stored for the HRA analysis and supported as a basis for the quantitative results, such as the proportional importance of human error probability or performance shaping factor.

2.4 Plan for database

In a Level-3 PSA, two kinds of database were considered. One is for the keyword contents of the referred document in the Level-3 PSA code. The other is for the results of the Level-3 PSA code simulation.

The keyword contents are used for conjunction with the Level-3 PSA code during the run-time of the code. The contents of the documents will be obtained, and processed as a proper type suitable for the code. For the results of the Level-3 PSA code simulation, similar to the Level-2 PSA code results, the result type and the purpose of usage for the simulation results will be considered in advance. According to the function of the code and the scope covered within the code, the code results can be diverse.

Because the results for the Level-2 PSA are related to the input of the Level-3 PSA, the relationship for the Level-2 PSA results needs to be considered. And for the technical aspects, the latest IT technologies related to the code development need to be checked. Based on these various considerations, the database for the Level-3 PSA will be analyzed and prepared.

3. Conclusions

According to the scope and the purpose of the data utilization, the construction processes of the database and the contents contained in the database are different. Moreover, in some cases, there are some requisites to produce results such as accident scenarios and accident characteristics. Considering the diversity of database, it needs to specify the database for Level-3 PSA.

Through these studies on databases related to the nuclear safety issues, previously constructed database systems were reviewed and compared.

To construct an effective and useful database, in conjunction with the developing Level-3 code, these reviewed results will be applied and newly acquired issues will be continuously complemented. With this, the Level-3 PSA related data assembled in a various method can be accumulated later in database. It can be used as an effective data, and used to improve the safety for the Level-3 PSA.

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