The Status of Database Construction for RCAP Code Supporting Function

Sunhee Park*, Seok-Jung Han, Seunghwan Kim
KAERI, 111, Daedeok-Daero 989Beon-Gil, Yuseong-Gu. Daejeon, Korea, 34057
**Corresponding author: shpark2@kaeri.re.k*

1. Introduction

As a part of nuclear safety research, a Korea specific Level-3 PSA (Probabilistic Safety Assessment) 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. On the other hand, with the simulation code, a supporting database for the user might be need. And in case of lots of data for support features, it needs to construct database for the supporting. In this study, the research fields and a database related to the level-3 PSA are studied, and the status of the user supporting database are reviewed.

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 Level-3 PSA code

The Level-3 PSA is a field of assessment for an off-site consequence analysis of a radiation release 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 release and the off-site consequence of radiation. In particular, a Korea 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-3 PSA needs to be developed with domestic technology reflecting environmental characteristics.

In particular, after the accident at the Fukushima nuclear power plant (NPP), 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 effects 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 effects 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, RCAP, were checked and compared: the diffusion model, exposure dose model, exposure pathway model, emergency response model, and health effects 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 of the Nuclear Field Research

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]. It contains the uncertainty analysis data for the containment pressure behavior in the case of a severe accident. The uncertainty analysis data was obtained from MAAP code simulation that was developed by EPRI and is widely used in serious 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 [5]. 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).

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 [6]. 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. As such, the database in the nuclear safety field has been studied and constructed as diversely as various data.

2.3 Database Construction

In a Level-3 PSA, two kinds of database were considered. One is for a database of user supporting functions for document referenced in the Level-3 PSA code, RCAP (Radiological Consequence Analysis Program) code. The other is for the results of the Level-3 PSA code simulation.

As a first one, the user supporting database are used for conjunction with the RCAP code during the run-time of the code. And as second one, similar to the Level-2 PSA code result, the RCAP code simulation results are utilized according to the data type and purpose of use. According to the function of the code and the scope covered within the code, the code results can be diverse.

The scope of the supporting database is around the execution of the RCAP code. The 'HELP' function for the users of RCAP code helps code execution. The supporting database consist of keyword and its descriptions. The descriptions mean an auxiliary description referenced by the 'HELP' function during code simulation. An example of supporting database is shown in Fig. 1. The key documentation for the description to be used in the supporting DB has been obtained. And some documents are surveyed for more trustful description.

For the 'HELP' function, the frequently used keyword must be selected. And the modification of keywords selected for future use should be applied.

For the technical aspects, the latest IT technologies related to the database need to be checked. For document types, HTML types and XTML types are considered as descriptive content. And for the implementation tool, Visual Basic and Python are considered.

Based on these various considerations, the implementation of a Level 3 PSA-supported database is under construction. More specifically, the conversion to editable files of key documents has been in progress. And the keyword selection in document file is in progress. Subsequent steps involving more diverse and larger numbers of keywords will be processed one after another.

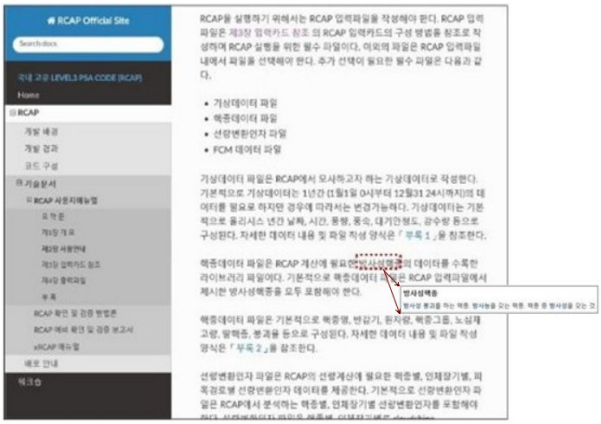

Fig. 1. An example of user supporting database

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 case by case. 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. The supporting database focused on building a database for Level 3 PSA code users.

To construct an effective and useful database, in conjunction with the developing Level-3 code, as a first step, keyword and descriptions as Korean character to support the code user are reviewed and are being applied to database construction. With this, the Level-3 PSA documents assembled in various methods can be accumulated later in database. It can be used as an

effective data, and used to support the Level-3 PSA code user.

REFERENCES

[1] Seok-Jung HAN, Joon-Eon Yang, and Sung-Yeop Kim, A Technical Roadmap for Korean Specific Level 3 PSA Code Development, KAERI, KAERI/TR-6778/2017, Daejeon, 2017.
[2] Sora Kim, Byung-Il Min, Kihyun Park, Byunh-Mo Yang, Kyung-Suk Suh, Preliminary study in developing a Korean code system for assessing off-site consequences of severe nuclear accident, KAERI, KAERI/TR-6111/2015, Daejeon, 2015.
[3] Beongtae Min, S.W. Hong, S.H. Hong, J.H. Song, Integrated database establishment of TROI experiment, KAERI/TR-5808/2014.
[4] Soo-Yong Park, Kwang-Il Ahn, Development of the Severe Accident Analysis DB for the Severe Accident Management Expert System (II), KAERI, KAERI/TR-4980/2013, Daejeon, 2013.
[5] Won-Tea Kim, Jae-Uk Shin, Jin-Sik Kim, Chang-Kyung Sung, Kwang-Il Ahn, Development of an optimized strategy for SFP severe accident and evaluation database, KAERI, KAERI/CM-2449/2016, Daejeon, 2016.
[6] Seunghwan Kim, Yochan Kim, Sun Yeong Choi, Jinkyun Park, Wondae Jung, Design and implementation of HRA database based on simulator training data, KAERI, KAERI/TR-6527/2016, Daejeon, 2016.