Improving PSA Quality of KSNP PSA Model

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I. INTRODUCTION

In the RIR (Risk-informed Regulation), PSA (Probabilistic Safety Assessment) plays a major role because it provides overall risk insights for the regulatory body and utility. Therefore, the scope, the level of details and the technical adequacy of PSA, i.e. the quality of PSA is to be ensured for the successful RIR.

To improve the quality of Korean PSA, we evaluate the quality of the KSNP (Korean Standard Nuclear Power Plant) internal full-power PSA model [1] based on the "ASME PRA Standard [2]" and the "NEI PRA Peer Review Process Guidance [3]."

As a working group, PSA experts of the regulatory body and industry also participated in the evaluation process. It is finally judged that the overall quality of the KSNP PSA is between the ASME Standard Capability Category *I* and *II*.

We also derive some items to be improved for upgrading the quality of the PSA up to the ASME Standard Capability Category *II*.

In this paper, we show the result of quality evaluation, and the activities to improve the quality of the KSNP PSA model.

II. EVALUATION RESULTS OF THE KSNP PSA MODEL

The evaluation results are summarized in Figure 1. Figure 1 shows the portion of each category of the KSNP PSA model based on the ASME PRA Standard. The quality of the KSNP PSA has estimated in between the Capability Category *I* and *II* of the ASME PRA Standard, or between the Grade *2* and *3* of the NEI PRA Peer Review Guidance.

In some cases, different environments between Korea and U.S.A. make it difficult to evaluate some items and/or elements of the ASME PRA Standard and the NEI PRA Peer Review Guidance such as "the maintenance and update of the PSA model" in the NEI PRA Peer Review Guidance.

We find that the main problems of the KSNP PSA are the insufficiency of the documentation and the lack of plant-specific features rather than the PSA techniques used in the KSNP PSA model. Regarding the PSA model it-self, conservative and/or inconsistent approaches are used in some cases to determine the success criteria and human error probabilities. In addition, we have used the generic equipment reliability data in many cases due to the lack of plant specific reliability database.

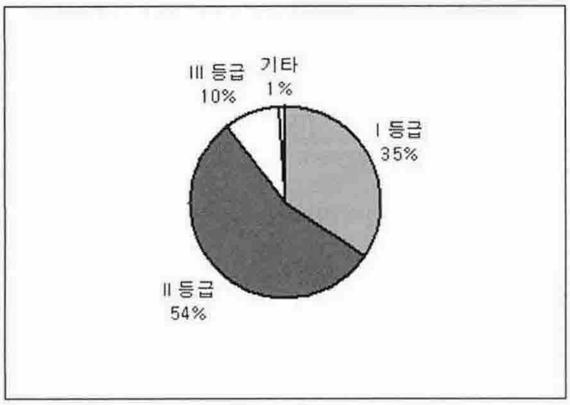

Figure 1. Evaluation Result of the KSNP PSA Model

Based on the review results and insights obtained from the evaluation process, we have performed various efforts to improve the quality of the KSNP PSA Model. Details of these activities and the results are described in the following section.

III. ACTIVITIES TO IMPROVE THE PSA QUALITY

The activities performed to improve the PSA quality can be grouped into three categories: the update of the documentations, reliability data and PSA model. These activities are explained below.

(1) Update of the Documentation
   A. Development of the detailed quality-control (Q/C) procedures for the PSA elements including a fault tree analysis, human reliability analysis and common cause failure analysis.
   B. Development of a computer program to store and manage the documents and information regarding the PSA. Special effort was given to develop the quantification engine for PSA.

(2) Update of the PSA Data
   A. Implementation of the Korean equipment reliability data, KIND.
   B. Implementation of Korean experiences in estimating the frequencies of initiating events.

(3) Update of the PSA Model
   A. A T/H analysis of the significant accident sequences using a new best-estimate T/H Code, MARS.
   B. Re-analysis of important human errors by applying a standardized Korean HRA methodology.
   C. CCF analysis by using α-factor method with new CCF data.

D. Revision of fault trees based on the updated Q/C procedures, new HRA and CCF results.

Some impacts of the above activities are summarized in Figure 2. The update of fault trees resulted in an increase of risk measure, i.e. the core damage frequency (CDF) by 19%. The change of accident sequences based on the results of the new T/H analysis for the SGTR reduced the CDF by 14%.

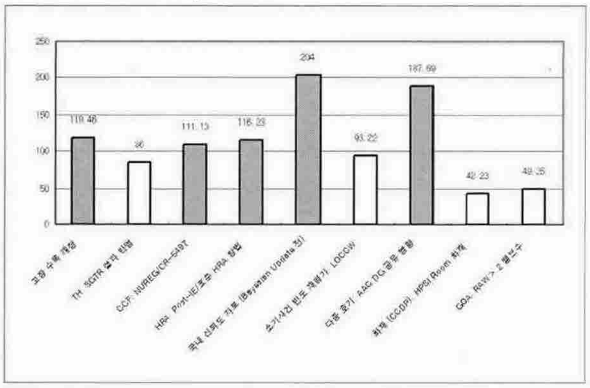

Figure 2. Results of the Quality Improving Activities for the KSNP PSA Model

The values shown in Figure 2 are interim output since our works to improve the quality of the KSNP PSA model are still at an on-going stage. For instance, we add the model of the PCS (Plant Control System) module and ESFAS-ARC part into the safety system fault trees. We re-define the LOCA grouping criteria based on the best-estimate T/H results. Most of the initiating event frequencies are updated based on the recent Korea and U.S.A. data. The details of these activities can be found in the Ref. [4-6]. The integrated effects of above activities will be assessed by the end of this year.

IV. CONCLUSIONS AND DISCUSSION

We have evaluated the PSA quality of the KSNP internal full-power PSA model based on the ASME PRA Standard and the NEI PRA Peer Review Guidance. It is finally judged that the overall quality of the KSNP PSA is between the ASME Standard Capability Category *I* and *II*. In general, it seems that the ASME PRA Standard has more rigorous requirements than the NEI PRA Peer Review Guidance.

We have tried to improve the quality of the KSNP PSA model up to Capability Category *II* of ASME PRA Standard. For this, we also have developed some new PSA techniques. For instance, the check of convergence of the quantification result was an old issue in the PSA quantification process. And ASME PRA Standard requires us to assess this issue. So, we have developed a new method to check the convergence of quantification result [7].

Through the activities for improving our PSA quality, we have enhanced accuracy and consistency of KSNP PSA model even though there are some items that cannot meet the Category II requirements due to some differences between Korea and U.S.A such as the available data for PSA. However, we believe that this model can be used as the reference model for the RIR of UCN 3&4 in the near future.

ACKNOWLEDGEMENT

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