Development of A Korean Specific PSA Framework for All Mode/All Hazard Site Risk Profile

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1. Introduction

There were many arguments regarding the usefulness of the PSA (Probabilistic Safety Assessment) after the Fukushima accidents. After the Fukushima accidents, it seems that the European Union (EU) countries and the U.S.A. took different approaches in strengthening the safety of the Nuclear Power Plants (NPPs). The EU countries focused on the deterministic approach such as the stress test in ensuring the safety of the NPPs. On the other hand, the U.S.A. emphasized the balance between the deterministic and risk-informed approaches. NRC Commissioner George Apostolakis commented that defense in depth and PSA should be treated at the same level [1]. It seems that each country has a different view on the role of the PSA. Such differences may be a result of the different regulatory infrastructure and the PSA capability of each country. In this paper, we try to identify the problems of the current PSA practice and show the ways of overcoming such problems.

2. Current PSA Practice

The use of PSA in the nuclear industry started with the well known WASH-1400, published in 1975 [2]. The risk profiles of 100 NPPs were compared to the risks from various man-made disasters. After that, the effort in the U.S.A. was focused on the limited scope of the PSA, that is, the limited level 2 PSA for the internal events, internal fire, internal flooding and seismic PSA at full power only. This became a kind of standard scope in the PSA area after the IPE and IPEEE [3, 4]. Many countries adopted such practice into their own countries. The PSAs outside of the limited scope were not performed in many cases: that is, the low power shut down (LPSD) PSA, the level 3 PSA, and the other external PSA. For instance, in many countries, the level 3 PSA is regarded as a kind of sensitivity analysis.

Even though the PSA with a limited scope has been working well for a long time and resulted in successful risk-informed regulation (RIR) in the U.S.A. [5], it seems that such practice resulted in problems on the use of the PSA in other countries. It seems many countries have focused on the values of CDF and LERF (Large Early Release Frequency) rather than the insights obtained from the PSA. What we have focused on in using the PSA is the derivation of measures for the design/operational improvements mainly based on the internal level 1 PSA results. Many risk insights from level 2/3 PSA and external PSA were not implemented in the real operation/preparedness of the NPP: for example, Severe Accident Management Guideline (SAMG), Emergency Preparedness (EP), etc.

Current PSA practice also resulted in problems in the technical basis of the PSA outside of the limited scope. Most countries lack of a technical basis for the level 3 PSA such as the effects of country specific food chain, dose factor, etc. In some cases, a country needs a technical basis for some external initiating events that are unique for that country. For instance, Japan developed a good technical basis for the seismic PSA since Japanese NPPs face a high probability of a strong earthquake [6]. However, the Fukushima accident showed that such technical basis is not enough in some cases. Even though we can give many reasons why the PSA cannot prevent accidents like those at the Fukushima, the fact is that a PSA cannot prevent a nuclear accident. However, in my opinion, the PSA is the only way that we can predict Fukushima type accidents at the present state of technology.

3. PSA after the Fukushima Accidents

To prevent Fukushima type accidents effectively, we may need to revise the current PSA practice. Basically, we have to extend the scope of the PSA to all mode/all hazard level 3 PSA. We know that in some areas we do not have the necessary technical basis. However, in such cases, we can adopt a conservative approach. Even with such conservative approach, we can get key insights useful in enhancing the safety of an NPP.

Before the Fukushima accident, many countries focused on the PSA quality. The U.S.A. published PRA standards, and the IAEA also published similar ones [7. 8]. However, at present, we have to re-think the quality and the scope issues. The PSA quality is an important issue in reducing the uncertainty and enhancing the confidence in the PSA results. However, the Fukushima accident showed the importance of expanding the PSA scope as well.

The Fukushima accidents also revealed many other issues related to the PSA. Some of these were already discussed before the Fukushima accident. For instance, there were researches on the risk assessments of the multi-unit, spent fuel pool (SFP), etc., which are not included in the current PSA practice. After the Fukushima accident, many countries are doing a lot of things to strengthen the safety of the NPP against extreme external events. Even though strengthening the deterministic approach is an essential part in ensuring the safety of the NPPs, we also have to strengthen the PSA as well, since we cannot operate the existing NPPs and/or building new NPPs without accepting the residual risk concept. At present the PSA is the only way to estimate the residual risk of the NPPs, in my mind.

4. Building Korean Specific PSA Framework

After the Fukushima accident, KAERI started new research projects to build a Korea-specific PSA framework covering the issues discussed above [10]. Our basic approach is to produce the basic risk information regarding all facilities in a site needed to make an effective and efficient decision making on the safety of the NPPs. The final goal of the research is to derive a risk profile for a Korean site including multi- units and SFP risk, i.e. Korean WASH-1400 or NUREG-1150 [9] These projects also include the research on the derivation of Korea-specific external events and the related technical basis. The Korea-specific issues regarding the level 3 PSA will be also covered in these research projects. However, there are still some issues to be resolved, such as the assessment of combined hazards and the establishment of safety goals for a site. These will be the research items for another project.

4. Conclusions

We know that even if we extend the scope of the PSA and develop better PSA technologies as much as we can, there can be still some important risk contributors that we don’t know and/or cannot anticipate. Such contributors should be covered by the accident mitigation strategy in principal. However, the insights from the PSA will be helpful to establish the effective mitigation strategy, so such insights should be incorporated into the SAMG or EP as well. This is another topic of our research projects. We hope to build a complete PSA framework for a Korean site through these research projects.

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