Proposal for Korean RIPBA Implementation Plan

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1. Introduction

Korea is facing difficulties in the operation of nuclear power plants due to various social and technical factors, and the operation rate is much lower than before. Therefore, to solve these problems and improve the safety and performance of domestic nuclear power plants, it is necessary to improve the domestic regulatory system and the effectiveness and efficiency of nuclear power plant operations. To this end, the Institute of Advanced Policy Studies, belonging to the Korean Nuclear Society (KNS), has conducted its own policy project [1]. This project examined the Risk-informed-Performance-based Approach (RIPBA), a regulatory framework and operation method for U.S. nuclear power plants that currently demonstrates world-class safety and performance. In addition, we proposed a plan to introduce the RIPBA in Korea. This paper briefly introduces the contents of this research project.

2. Current Status of RIPBA in U.S. and Other Countries

The United States uses the RIPBA to regulate and operate its nuclear power plants (NPPs). The effectiveness of the RIPBA is demonstrated by the improvements in safety and performance of U.S. NPPs over the past 25 years since its introduction in 1995 [2]. The current risk level of U.S. NPPs is one-tenth of what it was in the early 1990s. Other benefits of the RIPBA include fewer unplanned outages, improved utilization, and lower worker exposures [3].

The safety and performance of the U.S. nuclear fleet are remarkable, considering that most U.S. NPPs in operation today began operation in the 1960s and 1970s, and the average age of most reactors is over 40 years. The project of the KNS examines how the U.S. nuclear fleet has achieved its current level of safety and performance through the RIPBA. The most important reason for this achievement is that the U.S. nuclear industry has utilized various risk information to improve the safety of its NPPs and focus its resources on critical safety or operations issues [3].

Since the introduction of the RIPBA in the U.S., many countries with NPPs, including Korea, have been working to introduce a framework similar to the RIPBA of the U.S. However, no country has yet established a RIPBA framework at the U.S. level. In Korea, the nuclear regulator and industry have promoted the introduction of RIPBA several times in the early and mid-2000s [4, 5]. However, it is still difficult to say that the RIPBA has been settled successfully in Korea. However, Japan began operating a new inspection system similar to the Reactor Oversight Process (ROP) of the U.S. in April 2020 [6]. China is currently implementing the U.S. RIPBA across board areas [7]. Therefore, it is necessary to consider the introduction of the RIPBA in Korea again. Therefore, the following section summarizes and introduces the domestic introduction of RIPBA.

3. RIPBA Implementation Plan for Korea

In order to verify the necessity of introducing the RIPBA in Korea and to derive an efficient domestic implementation plan for RIPBA, this paper examined the current status of the RIPBA in the U.S. from five aspects: (1) risk assessment method, (2) policies related to risk information utilization, (3) framework for utilizing risk assessment results, (4) linking risk assessment and performance, and (5) establishing a foundation for the RIPBA. In addition, the current status of the RIPBA in Korea was examined from the same five aspects, and differences with the U.S. were analyzed. Based on these five aspects, the project suggests five sectoral responses to revitalize and establish the RIPBA in Korea: (1) RIPBA technologies, (2) the RIPBA-related policy legislation, (3) human resource development, (4) increasing the acceptance of the RIPBA by relevant organizations, and (5) creating an environment for the RIPBA acceptance.

This paper synthesizes the above findings and suggestions to propose a way forward for the RIPBA in Korea. The RIPBA is not just a technical issue but also includes organizational and cultural issues such as acceptance of the RIPBA. Therefore, considering these aspects and the current level of technology related to the RIPBA in Korea, it is proposed to introduce the RIPBA in Korea in the order of (1) Maintenance Rule, (2) Probabilistic Safety Assessment (PSA) standard and quality improvement, and (3) Reactor Oversight Process (ROP).

We propose the maintenance rule as the first step to introduce the RIPBA in Korea for three reasons. First, since maintenance rule can be applied with a focus on securing and improving the safety of NPPs, it will reduce the burden on regulatory authorities to introduce maintenance rule. Second, since Korean industries are

already implementing their own maintenance rule program, it is possible to implement them in the field quickly once the decision to introduce them in Korea is made. Third, as shown in the U.S. case, maintenance rule can lay the foundation for the introduction of other risk-informed/performance-based applications in the future by providing an opportunity for regulators who are unfamiliar with risk concepts and the use of related computer programs and industrial personnel to acquire knowledge in the risk field. In addition, as in the case of the U.S., improving the acceptance of RIPBA through maintenance regulations is possible.

PSA standards can play an essential role in addressing the mistrust and concerns of regulators and industry personnel unfamiliar with the probabilistic approach and risk assessment. In other words, PSA standards can improve the quality of domestic PSAs and reduce anxiety about the use of PSA results by improving the reliability of PSA results.

The difficulty of introducing the ROP system in one fell swoop is that it requires an overall change in the current domestic regulatory and operational framework. Therefore, the gradual introduction and operation of core parts of ROP, such as Accident Sequence Precursor (ASP) and Significance Determination Procedures (SDP) may be a realistic way to introduce ROP. Once the RIPBA implementation plan is established, it is judged that individual studies on the domestic implementation of each detailed system, such as ASP and SDP, will be required to determine how to apply them in practice. Once the above three areas are started, it is expected that risk-informed applications such as risk-informed technical specifications will also be possible.

4. Conclusions

Establishing domestic RIPBA is not a matter of adopting the above three areas alone but requires a more comprehensive approach. To this end, we have developed a roadmap for the introduction of the RIPBA in Korea, as shown in Figure 1, taking into account the various technical, policy, and environmental factors described above. The establishment of the RIPBA in Korea can only be achieved through the continuation of several short-, medium-, and long-term tasks, including (1) maintenance rule, (2) PSA standards and quality improvement, and (3) ROP adoption, as outlined in the roadmap.

Finally, a consensus on the purpose of the RIPBA between domestic regulators and industry is essential for its implementation. The basic philosophy of the RIPBA is to improve the effectiveness and efficiency of both regulatory and operational aspects by focusing resources on what matters for nuclear safety and performance based on insights from risk and performance assessments in addition to existing regulatory requirements. A vital part of this process is the agreement between regulators and operators on what is critical to nuclear safety, and this can only be achieved through ongoing communication between both parties. In the U.S., the approach to increasing acceptance of the RIPBA has been to focus on the safety benefits of the RIPBA. This fact has implications for activating RIPBA in Korea as well.

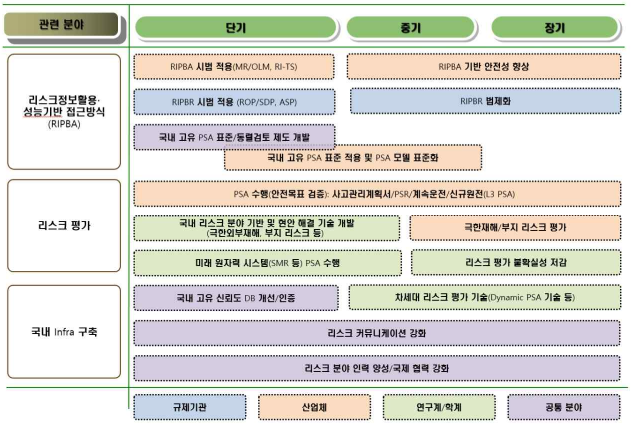

Fig.1 Roadmap for Korean RIPBA

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