Review of the applicability of Safety Factors to IAEA PSR NS-G-2.10

C. Park, B. Y. Yun, S. J. Lee
Central Research Institute, Korea Hydro & Nuclear Power Co. Ltd.
25-1 Jang-dong, Yuseong-gu, Daejeon 305-343, Korea

1. Introduction

Since the Ministry of Education, Science and Technology (MEST), the nuclear regulatory body in Korea established an institutional scheme in January 2001, PSR have been conducted at the sixteen NPPs in Korea to evaluate the safety of the NPPs and to determine reasonable and practical modifications that should be made in order to maintain a high level of safety. For the last ten years, regulators and operator have made great efforts for the successful settlement of the PSR. The PSR, based on such great efforts, have significantly contributed to the improvement of the country's NPPs. Under these circumstances, there is a movement to revise the existing regulatory policy of the PSR established by IAEA Nuclear Safety Guide 50-SG-012[1] after the IAEA announced new guidelines for PSR (IAEA Periodic Safety Review, NS-G-2.10)[2]. Therefore, this paper reviews the new guideline for PSR (IAEA Periodic Safety Review, NS-G-2.10) and the applicability of these new guidelines to the existing PSR system in Korea.

2. Methods and Results

2.1 Major revised contents of IAEA PSR (NS-G-2.10)

The IAEA Periodic Safety Review (NS-G-2.10) [2] defines fourteen safety factors with five subject areas. The major revised contents are safety factors when the existing PSR system is compared with IAEA PSR Safety Guide (NS-G-2.10). In other words, the safety factor of "Actual Physical Condition of the NPPs is subdivided into two safety factors ("Plant Design" and "Actual Condition of Systems, Structures and Component") and the safety factor of "Safety Analysis" is subdivided into three safety factors ("Deterministic Safety Analysis, Probabilistic Safety Assessment and Hazard Analysis). Also the existing safety factors are grouped into five subject areas and Global Assessment is added to the PSR process. Especially an analysis of the added safety factors which are "Plant Design", "Probabilistic Safety Assessment" and "Hazard Analysis" is needed from the utility perspective because the regulatory body has a plan to add these three safety factors to the regulate policy of the PSR This paper will provide an analysis of these three safety factors and review their applicability by comparing the existing safety activities in the NPPs, as follows.

2.2 PSA (Probabilistic Safety Assessment)

Probabilistic Safety Assessment for Korea NPPs has been conducted since the 1990s. The utility has voluntarily performed PSA in order to obtain the insight into the safety of NPPs. Furthermore there is no legally binding duty to perform the PSA. If PSA becomes one of the safety factors in the PSR, it will have legal force and be subject to regulatory approval. In this regards, the existing PSA is compared with IAEA Guideline (NS-G-2.10) in Table 1.

Table 1: Review of the status of the PSA

Section	The Point of view for the PSA review	Applicability (Need to development / Need to Complement / Acceptable)
Scope & Tasks	The existing PSA including the assumptions, fault schedule, representation of operator action and common cause events, the modeled plant configuration and consistency with other aspects of the safety case	
	The accident management programmes for server plant conditions are consistent with PSA	
	The status and validation of analytical methods and computer code used in the PSA	
	The scope and application of the existing PSA used to assist the PSR global Assessment	
	The requirements and recommendation for IAEA reference	
Method ology	The completeness against an appropriate set of postulated initiating events and hazards	
	The verification of omissions based on site specific justifications (do not weaken the overall risk assessment)	
	The consideration for the potential for unidentified cross-links and the effects of common cause events	
	The human reliability analysis	
	The results of the PSA should be compared with relevant probabilistic safety criteria (regulatory body)	
	The history of updates to the PSA to reflect changes in plant status	

Most of the PSA that have already been performed in NPPs have covered the IAEA Guideline (NS-G-2.10) in the scope, task and methodology sections, although some of the PSA needed to be complemented. For such situations, the utility (KHNP) of the NPPs in Korea have prepared the countermeasures such as the study of a low power and shutdown PSA and a study for Development of standard procedures for Living PSA. Especially, it is important to have an in-depth review in order to adapt the PSA of IAEA Guideline (NS-G-2.10) because this PSA could have legal force for the first time.

2.3 Hazard Analysis

Actually, hazard analysis of internal and external events has been considered in current practice since the utility designed the NPPs. Detailed information for the

hazard analysis recommended by IAEA Guideline (NS-G-2.10) is summarized in Table 2.

Table 2: The detail information of the hazard analysis

Internal Hazard (Based on NS-G-2.10)							
FIRE	Flooding	Pipe Whip	Missiles	Steam release	spray	Toxic and/or corrosive gases	explosion

External Hazard (Based on NS-G-2.10)							
Changes in site characteristics	External flooding	High winds	Temp. Extremes	Seismic hazard	Aircraft crash	Toxic gas	explosion

Although the IAEA suggests a detailed hazard analysis, most hazard analyses such as those considering a fire, flooding, and pipe whip etc. have already been checked and confirmed by the utility of the NPPs through the plant design, the operation of the NPP and the existing PSR. Therefore the hazard analysis suggested in IAEA Guideline (NS-G-2.10) could be covered with the existing hazard analysis. Also it is important to carry out a selection of hazard analyses in order to find out whether these hazard analyses could reflect the status of the NPP' sites in Korea. After the Fukushima Nuclear Power plant accident, the importance of hazard analysis has been suggested and countermeasures to follow up after the Fukushima NPP' accident have been carried out as a separate incidents. For such situations, an in-depth review for the hazard analysis will proceed if the hazard analysis becomes one of the safety factors in the PSR.

2.4 Plant Design

The plant design is added with specific review factors and methodology in IAEA PSR Safety Guide (NS-G-2.10), compared with IAEA Nuclear Safety Guide 50-SG-012 based on the existing PSR system. The detailed items recommended by the IAEA PSR Safety Guide (NS-G-2.10), which are used to evaluate the plant design, are as follows,

- ☐ A detailed description of the plant design, supported by drawings of the layout, system and equipment
- ☐ A list of SSCs important to safety and their classification
- ☐ Documented design basis
- ☐ Significant differences between the present plant design and the current standards (used for comparison)
- ☐ The safety significance of the identified shortcomings relating to the application of defense in depth

The aspect of the plant design safety factor is the same as the hazard analysis because the basic requirements for the plant design recommended by IAEA PSR Safety Guide (NS-G-2.10) are already conducted by the utility of the NPPs. For example, the utility has managed the drawings, design specifications (included FSAR) and maintenance reports etc. in order to evaluate plant design. Also the utility has tried to obtain the design basis documents for the performance of the existing PSR system and long term operation.

3. Conclusions

The PSR system has contributed much to the improvement of the safety of NPPs because the utility and the regulatory body have always made great efforts to conduct the PSR. In this paper, the applicability of the added safety factors has been reviewed according to priority because these three factors (PSA, Hazard Analysis and Plant Design) are newly introduced in IAEA PSR Guideline (The IAEA Periodic Safety Review, NS-G-2.10). With the above review of the three safety factors, the safety activities related to the added three safety factors have already been conducted and managed by the operating NPP without acknowledgement because these activities are not classified as part of the IAEA PSR Safety Guide (NS-G-2.10). However, complementary and reasonable alternatives could be needed when these safety factors are introduced and the current technical basis is applied to the existing PSR system. This means that a detailed analysis of the IAEA PSR Safety Guide (NS-G-2.10) should be conducted. In the face of these facts, workers in the nuclear industry should consider and develop practical and reasonable PSR guideline that can ensure the rational improvement of the safety of NPPs and the public trust.

REFERENCES

[1] IAEA safety standard series, Periodic Safety Review of Operational Nuclear Power Plants, Safety Guide, No. 50-SG-012, 1994, IAEA
[2] IAEA safety standard series, Periodic Safety Review of Nuclear Power Plants, Safety Guide, No. NS-G-2.10, 2003, IAEA
[3] Tae Eun Jin, Current Status and Prospect for Periodic Safety Review of Aging Nuclear Power Plants in Korea, Vol, 41 No.4 May 2009, Nuclear Engineering and Technology.