Safety Enhancement and Change of Codes and Standards of NPPs During One Cycle PSR

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1. INTRODUCTION

The KHNP has been performing Periodic Safety Reviews (PSRs) for all nuclear power plants according to regulatory requirements [1]. Sixteen units of the twenty power plants currently in operation in Korea have been operated for more than ten years as of year 2010. And the 10-year-basis Periodic Safety Reviews for these sixteen units (Kori#1,2,3,4, Yonggwang#1,2,3,4, Wolsong#1,2, 3,4, and Ulchin#1,2,3,4) have been completed.

In 2000 the first PSR has been performed for Kori Unit 1, which was a comprehensive study to assess and confirm the safety of nuclear power plants and to identify areas for improvement to enhance the safety, taking into account aspects such as operational history, age of the plant, past safety analyses, and internationally recognized codes and standards. Additionally, the safety enhancements for a nuclear power plants are identified from the PSR results. The implementation plans for these safety enhancements are established and implemented in phases depending on the plant. Therefore, the safety of nuclear power plants is enhanced through these series of processes. The key examples of safety enhancements and the changes in the codes and standards applied during one cycle PSR are reviewed in this paper.

2. SAFETY ENHANCEMENT AND CODES AND STANDARDS

Periodic Safety Reviews of the nuclear power plants have been almost conducted nearly every year since the passing of the PSR legislation in 2001. In addition, the number of safety enhancements as reflected in the results of PSRs has been optimized from year to year (Fig 1). The total number of safety enhancements for Kori unit 1 PSR was 40. These enhancements involved the development of an aging management program, conducting total equipment qualification tests, and improving the design of MCB (Main Control Board). Kori unit 1 has had the most safety enhancements compared to those done at other plants, but one reason behind this is the fact that this plant has been in operation the longest. Moreover, a PSR has been performed only once since the plant started operation. The major equipments of Kori unit 1, including its low-pressure turbine rotors, steam generators, and process and control system, were improved at that time. Safety analyses for Kori unit 1 were performed taking into account advanced codes and standards, and the major safety issues (e.g., developing an aging management program, analyzing fire hazards, and improving the MCB) in relation to Kori unit 1 were reflected. Therefore, it was determined at that time that Kori unit 1 had a safety margin that was sufficient until the time of the next PSR.

The number of safety enhancements was gradually decreased since Kori unit 1, as shown in Fig. 1. This is because that the safety enhancements of the earlier nuclear plant were applied to subsequent nuclear plants.

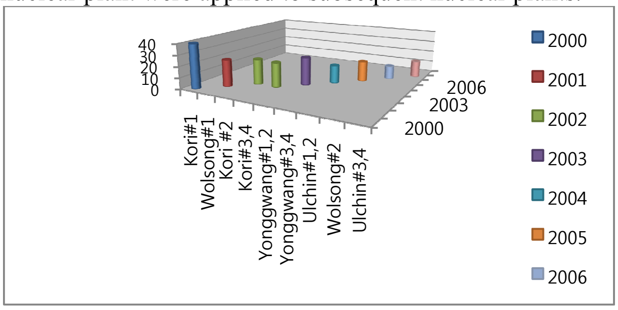

Fig. 1. The status of the safety enhancement for NPPs

The safety of nuclear power plants in Korea has been enhanced through the PSR over the past 10 years. The key safety enhancements are as follows:

Table Ⅰ. Examples of safety enhancements in NPPs

Title	Improvement
An aging management plan for safety-related structures, including the containment building	• Provide improved reliability of safety-related concrete structure and the containment building. • Provide an aging management plan for subsurface concrete and seawater adjacent structures. • Provide an aging management plan in the area of penetrations of the structure and a type of seismic gap filler.
Equipment qualification management system	• Provide an equipment list and management procedure for EQ (environment qualification)/ SQ (seismic qualification). • Provide of evaluation report and the development of an EQ management program.
Heat exchanger performance management	• Establish the performance test procedures regarding the regenerator, let down operation and spent fuel pool heat exchanger. • Modify the performance test procedures regarding the primary component cooling water and shutdown cooling water HX
Containment building SUMP performance evaluation and design improvements	• Design improvement of a containment building recirculation SUMP screen reflecting the assessment results of the debris generation and transportation in LOCA. • Maintain the long-term core cooling capability by providing sufficient NPSH margin of the ECCS pump in the recirculation phase in post-

	LOCA period.
Improvement control panel and procedure considered the ergonomics	• Improve the procedures considering the ergonomics. • Improve the alarm windows, indicators, recorders and controller in the MCB considering the ergonomics of these systems.

It is clear that one effect of performing the PSR is that it enhances the safety of NPPs. However, disagreements about codes and standards applied to NPPs between the utility and regulatory body remain.

The regulatory body is demanding that the codes and standards of NPPs in operation have to be met to the level which applies to NPPs recently licensed. However, the position of the KHNP is that the codes and standards which have to be applied to NPPs in operation are the valid codes and standards.

The major controversial safety issues related to codes and standards are shown below.

Table Ⅱ. Changes in the codes and standards during one cycle PSR

Title	**Codes and standards for operating permit**	**The position of the regulatory body about the latest codes and standards**	**Method of Safety Enhancements or the position of KHNP**
Aging, Fire Hazards Analysis	CANDU: CSA-N293-M87 [2]	• Demand of fire hazard analysis(FHA) that reflects the current equipment condition according to the latest codes and standards (CSA-N293-M07). (Facilities improvements in large-scale may be required)	• CSA 2007 edition has been applied to some nuclear power plants in Canada due to licensing requirements. However, it is too early to apply it to the domestic power plant, since it is still under development. • This FHA is performed according to MEST Notice 2009-37 rather than the PSR's safety factor. • A valid codes and standards for FHA is CSA-N293-95.
Evaluation of the containment fan cooler performance in LOOP	GL 96-06 [3] (not applied domestically)	• Demand evaluation containment fan cooler performance considering the possibility of a water hammer in two-phase flow conditions in the event of a design basis accident with Loss Of Offsite Power. • Demand assessments as to whether the result affects safety-related systems.	• It was confirmed in an analysis through GHOTHIC that the containment cooling capacity was sufficient even if the latest standards were to be applied. • The domestic containment fan cooling system consists of a closed-loop system, unlike that of the United States. Therefore, it was determined that there was no possibility of a water hammer in LOOP.
Estimation of influence of the radiation dose using atmospheric dispersion factors from new meteorological data	- (not applied domestically)	• Revaluation of the radiation dose influence according to a new atmospheric dispersion factor [4]. • Revision of FSAR according to the results.	• It was confirmed that regulatory requirements were still satisfied, even when enhanced regulatory standards were applied.
Evaluation of Control Room Habitability	GL 2003-01 [5] (not applied domestically)	• Demand a non-filtered air in-leakage test of MCR according to ASTM E741[6]. • Demand the revision of FSAR after establishing the MCR management program.	• Measure the non-filtered air that leaks into MCR by method outlined in ASTM E741. • Establish a MCR management program including assessments of radiation effects, toxic gases and the smoke impact.

3. CONCLUSIONS

The importance of performing one cycle PSR is that systematic procedures for a comprehensive safety enhancement of NPPs rather than a partial examination and evaluation are established. Additionally, the former safety enhancements can be applied to all NPPs to maximize their levels of safety. However, the valid codes and standards remain issues between KHNP and regulatory body. Performing a PSR based on the latest codes and standards according to the regulatory requirements is always a difficult assignment for KHNP.

We cannot emphasize the importance of the safety of NPPs enough. However, the economy of NPPs and national interests are as important as the safety of NPPs. The rapid changes in the codes and standards are a large economic burden. This fact affects the interests of all people. Therefore, reasonable codes and standards acceptable to both utility and regulatory body are required in the second cycle PSR. A consensus with utility is needed before the regulatory body requires application of the advanced codes and standards to NPPs. Korea's regulatory position as an exporter of NPPs will be high when these regulation issues are settled.

REFERENCES

[1] IAEA, *Periodic Safety Review of Nuclear Power Plants – Safety Guide*, Safety Standard Series, DS307, Draft 12, IAEA Series, VIENNA, 2002.
[2] CSA, "CAN/CSA N293-M87: Fire Protection for CANDU Nuclear Power Plants," 1987.
[3] USNRC, "Generic Letter 96-06: Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," Sep. 1996.
[4] USNRC, "Regulatory Guide 1.23: Meteorological Monitoring Programs for Nuclear Power Plants," Rev.1, March 2007.
[5] USNRC, "Generic Letter 2003-01: Control Room Habitability,'' June 2003.
[6] ASTM International, "E741-00 (Reapproved 2006), Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution," 2006.