Lesson Learned from the Recent Operating Experience of Domestic Nuclear Power Plants

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1. Introduction

According to the public concerns, it seems that one of the main missions of a nuclear regulatory body is to collect operational experiences from various nuclear facilities, and to analyze their follow-up information. The extensive use of lessons learned from operating experiences to backfit safety systems, improve operator training and emergency procedures, and to focus more attention on human factors, safety culture and quality management systems are also desired [1].

Collecting operational experiences has been mainly done regarding the incidents and major failures of components (so called 'events'), which usually demands lots of regulatory resources. This paper concentrates on new information, i.e. lesson learned from recent investigation results of domestic events which contain 5 years' experience. This information can induce many insights for improving operational safety of nuclear power plants (NPPs).

2. Background

Since 2002, our company (KINS) has developed a Web-based national event database system, which called OPIS [2]. The OPIS stands for operational performance information system for NPPs, and is a comprehensive database system providing overall data on design, operation, and event as well as the INES (international nuclear event scale) and SPI (safety performance indicator) for NPPs. All the information used in this study comes from the OPIS mainly.

3. Overview of Recent Domestic Events

Up to now, there are 20 NPPs operating in the country. The most recently built one is Ulchin unit 6 which has commercially operated since June 1, 2005. The OPIS contains a lot of data on all the units from Kori unit 1 to Ulchin unit 6, and provides sufficient information on the events since 1978. Therefore, the OPIS has a total of 30 years' database for the domestic NPPs. In this data bank, if we can choose the events of last 5 years, from 1 January 2003 to 7 September 2007, the number is 97. In terms of operating experience feedback, however, we desire not to count some events such as that occurred during the startup operation. In that case, the corresponding number is 92, and it will be analyzed in this paper. Also, if we are trying to collect the reactor trip-induced events only, including all without considering whether they were induced by automatic or manual, as denoted in Table 1, 81 events may be selected.

Table 1 shows that, in 2003 and 2005, a relatively big number was displayed in view of reactor trip-induced (RT) events because:

- In 2003, there are 5 common cause trips due to transmission line failures from typhoon "Maemi" in Kori and Wolsong site.
- In 2005, there are some troubles in control rod drive mechanism (CRDM) system of KSNP plants and some human errors due to unskillful operations.

Table 1. The number of NPP events occurred during the last 5 years

Event Summary			Kori (4)	WS (4)	YGN (6)	UCN (6)
Total		**92**	**21**	**15**	**25**	**31**
2007 (Up to 7th Sep.)	RT	14	4	3	3	4
	Others	2	0	0	1	1
	Sub total	**16**	**4**	**3**	**4**	**5**
2006	RT	14	1	2	5	6
	Others	5	1	0	1	3
	Sub total	**19**	**2**	**2**	**6**	**9**
2005	RT	19	6	2	2	9
	Others	1	0	1	0	0
	Sub total	**20**	**6**	**3**	**2**	**9**
2004	RT	13	3	3	4	3
	Others	1	0	1	0	0
	Sub total	**14**	**3**	**4**	**4**	**3**
2003	RT	21	6	3	9	3
	Others	2	0	0	0	2
	Sub total	**23**	**6**	**3**	**9**	**5**

(Note: RT means reactor trip-induced event.)

4. Evidence and Insights on the Events

4.1 Comparison of Events with Other Countries

We have compared the ratio of reactor trip-induced events per operating units with those of USA and Japan. As shown in Table 2, in case of automatic trip (AT), we can see that the ratio of Korea is comparable to that of USA. However, when compared the ratio of Korea with that of Japan, there is a big difference. The reason why the Japanese plants have good performance in terms of reactor trip is not analyzed sufficiently, but it seems that there are some differences between countries in the

areas of human factors, safety culture and quality management systems, and so on.

Table 2. Reactor trip ratio comparison among 3 countries

Trip/Units	2003		2004		2005		2006	
	AT	AT& MT	AT	AT& MT	AT	AT& MT	AT	AT& MT
Korea	0.83	1.17	0.47	0.68	0.7	0.95	0.35	0.70
USA	0.75	-	0.56	-	0.47	-	0.32	-
Japan	0.1	0.3	0.1	0.5	0.2	0.6	-	-

4.2 Specific Analysis of the Events

Figure 1 shows a reactor type-dependent ratios of RT events which is prepared utilizing 91 events, except the last event (Wolsong unit 4 at Sep. 6, 1997). From the figure, we can get the comparison result for the events depending on the reactor type. It is noted that, compared with Westinghouse-type and Framatome-type NPPs, CANDU-type and KSNP-type NPPs have a relatively low value of the ratios.

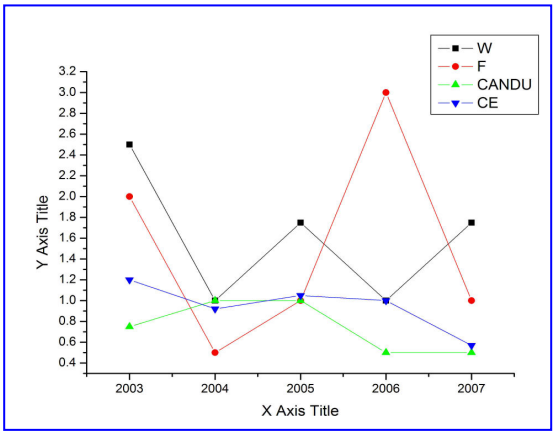

Figure 1. Comparison of the reactor type-dependent occurrence of events

Figure 2 shows another comparison result for the events depending on the site. It also denotes that, compared with Wolsong and Yonggwang NPPs, Kori and Ulchin NPPs have a relatively-big number of ratios during last 5 years.

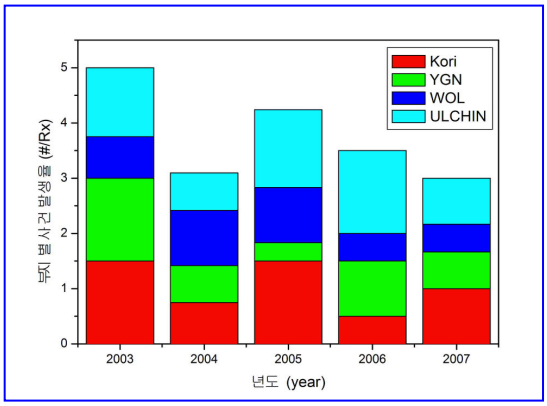

Figure 2. Comparison on the occurrence in each site

The most interesting result from the operational experience may be the statistics on the causes of events occurred. Up to now, the OPIS has 4 categories of the causes of events – human-related, mechanical, electrical, and I&C. Figure 3 provides the results on these causes for each fiscal year, and gives interesting insights in case of the human-related category. It seems that the occurrence of human-related events has dramatically decreased since late 2005.

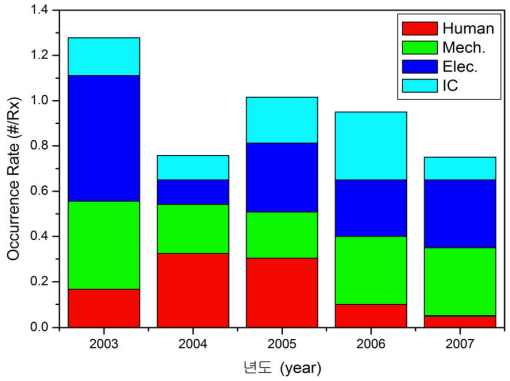

Figure 3. Comparison on the causes of events

5. Conclusions

As announced by the senior level expert group of OECD/NEA [3], there can be no doubt that the systematic evaluation of operating experience by the regulator is essential for continued safe operation of NPPs. Recent deep concerns by the public on the reactor shutdown and any event related to radioactive material releases will also urge the regulators to have more attention to those kinds of events. This paper discusses lesson learned from the recent 5 years' operational events, and concludes there may be some interesting points in terms of reactor types, site-specific features, and (root) causes of the events.

REFERENCES

[1] Enhancing the Use of International Operating Experience Feedback for Improving Nuclear Safety, OECD/NEA, May 2007.
[2] http://opis.kins.re.kr/
[3] Regulatory Challenges in Using Nuclear Operating Experience, OECD/NEA, 2006.