Transactions of the Korean Nuclear Society Spring Meeting
Gwangju, Korea, May 30-31, 2013

Lessons-Learned from an Event during Overhaul

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1. Introduction

The event frequency, also including portion of human errors, has been decreasing compared to last ten years. However, events due to human errors during overhaul occur every year [1] (see Table I).

Table 1: Human-related events during overhaul (2008~) *

	No. of Events	No. of HE Events	No. of HE events during O/H
2008	14	4	1
2009	11	2**	1**
2010	8	1	1
2011	10	2	1
2012	12	3	2

* The events occurring in commissioning stage are excluded.
** One HE event in 2009 is classified by the electrical cause but this event includes human error, also.

From analyzed results for human-related events during overhaul, similar problems were identified. And organizational and safety cultural factors were also identified. [2] On the other hand, another event during overhaul is analyzed and Lessons-Learned is drawn in an aspect of the operators' situation awareness.

2. Event Sequences

After finishing overhaul, there was an event in a domestic Nuclear Power Plant (NPP). The reactor coolant was leaked from a seal injection filter of the reactor coolant pump (RCP) while the NPP was starting for the criticality in the operating mode 3. The event sequences are as follows.

08:00 "RCP Seal Injection Filter 03F Pressure Difference High" Alarm
10:16 Switch over RCP Seal Injection Filter 03F → 04F
14:39 "RCP Seal Injection Flow Low" Alarm Perform Abnormal procedure
14:40 Control letdown flow (290 → 165 LPM)
14:43 Check charging pump 02P (manual)
14:50 Close letdown flow
14:51 Stop charging pump 02P (manual)
14:53 Start charging pump 01P (manual)
15:02 Stop charging pump 01P, 03P (manual)
15:18 Decrease pressurizer level (<27%)
15:22 Start charging pump 02P and close isolation valve of charging flow (Identified there is no leakage from the charging flow line)
15:29 Stop charging pump 02P and close isolation valve of RCP seal injection line (Identified the leakage point from the seal injection filter)
15:30 Recover pressurizer level (>27%)
(Note: This event doesn't satisfy Reporting Criteria of NSSC Notice 2012-85.)

During the event, the MCR operators, on the basis of alarms and plant parameters, thought that the leakage had been being from the charging pump or the charging line. Because there was a failure of the indicator, that was monitoring the charging flow, it indicated wrong value. At that time, it indicated only one charging pump flow even though two charging pumps had been operating. Thus, operators recognized that the leakage was from any charging pumps or after the charging line. Finally, a field operator found out that the reactor coolant had been being leaked from the RCP seal injection filter. After that, the MCR operator isolated the isolation valve of the RCP seal injection line and the leakage was blocked. The diagram of event sequences is shown in Figure 1.

3. Analysis of the Event

This event is about the reactor coolant leakage from the RCP seal injection filter and the cause of the reactor coolant leakage is deformation of the filter due to some abnormal impact after the replacement with new one during the overhaul. Because of this problem, an O-ring of the rubber material attached inside the filter also deformed and the reactor coolant was leaked through this O-ring. After the event, the licensee replaced this filter with new one. Total amount of the reactor coolant leakage was 7.7 tons.

However, there were several problems while the operators were identifying causes of the event. First, a measuring instrument, that is an indicator in the MCR board, had been being indicated wrong value since dawn on that day. One of operators' duties was logging that parameter about the charging flow every 4 hours. However, any operators did not pay attention about the parameters of the charging flow even though the indicator did not indicate the normal charging flow as the number of the operating charging pumps. Second, even though there was an alarm related the low charging flow at that time in the MCR, both night and day shift did not pay attention this alarm.

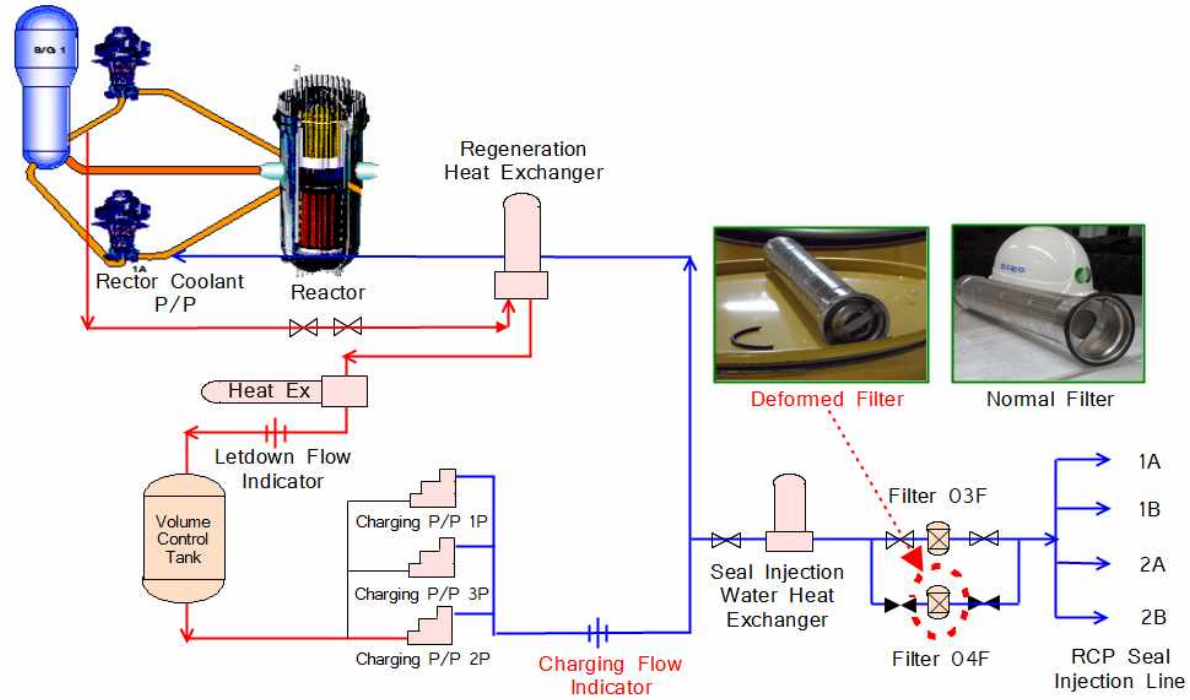

Figure 1: Diagram of the event sequences

4. Lessons Learned from the Event

If the operators had paid attention and performed appropriate actions for two problems mentioned above, the operators could have identified and blocked the leakage point rapidly when the reactor coolant leakage due to the RCP seal injection filter occurred. However, if the situation occurred in the normal power operation situation, there was possibility that the operators did not miss abnormalities about the logging data and the alarm. During overhaul, various maintenance works and tests are performed so operators cannot pay attention or miss when alarms are displayed or plant parameters are changed. In other words, operators can be insensible against abnormal alarms and plant parameters during overhaul in the aspect of the situation awareness.

In conclusion, several alarms and variation of plant parameters in NPPs can occur due to various maintenance works and tests during overhaul. Among these, some can be normal situation according to maintenance works and tests but the others can be unexpected abnormal situation. In the aspect of the situation awareness, operators can miss, neglect, or not recognize the abnormal situation due to other maintenance works and tests. Therefore, the countermeasures against these problems are 1) operator education or training, 2) development of operator support systems and further researches should be necessary in the aspect of the situation awareness.

5. Conclusion

There was an event during overhaul and the analyzed results drawn Lessons-Learned in the aspect of the operators' situation awareness. From the analysis, several alarms and variation of plant parameters during overhaul can occur due to various maintenance works and tests. And in the aspect of the situation awareness, operators can miss, neglect, or not recognize the abnormal situation due to other maintenance activities occurring simultaneously. Therefore, countermeasures such as operator education or training, development of operator support systems, and further researches should be necessary to cope with these problems.

REFERENCES

[1] KINS, Operational Plant Information System for Nuclear Power Plant (http://opis.kins.re.kr)
[2] Ji-Tae Kim, Transactions of the Korean Nuclear Society Autumn Meeting, 2001