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Development of a Real-time Personal Dosimeter System and its Application to Hanul Unit-4

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1. Introduction

Korea Hydro & Nuclear Power Co. (KHNP) continues to make every effort to reduce radiation dose and to prevent unplanned radiation exposure of workers. As a part of that, KHNP developed real-time personal dose monitoring system. Real-time dosimetry system and remote radiation monitoring system had been used in a number of nuclear power plants in the United States, Britain, Japan and other developed countries. The main reasons to adopt the system are to minimize unnecessary exposure, to calculate one's dose faster, to provide a possible alternatives of personnel such as radiation safety manager.[1] The KHNP's Remote radiation Monitoring System (KRMS) is characterized as integrated, less bulky, lighter comparing to existing instrument although it have multifunction of real-time dosimetry and voice communication. After laboratory test in Central Research Institute (CRI) and field test in Hanbit unit-3&4, KRMS was applied to main radiation works in Hanul unit-4.

2. Methods and Results

2.1 The Main Configuration of Personal Dosimeter System

KRMS consists of personal dose monitoring system, video camera system and voice communication system. Personal dose monitoring system consists of transmitter which has built-in dosimeter, repeater which passes information from transmitter to receiver, base station which gathers information and sends it to the server, and control unit which controls the systems. The transmitter alarms to Health Physics room as well as worker when a worker exceeds working hours or dose limit. The dosimeter has been designed to meet the requirements of IEC 61526. Video camera system with its wireless camera was designed to rotating, tilting and zooming. Voice communication system transmits audio data to HP room via Bluetooth earset which is designed to be in off normally but to start when there is call.

2.2 Main Radiation Work of Hanul-4

The radiation works of tenth overhaul in Hanul unit-4 consisted of 24 works including steam generator replacement, disassembly and assembly of reactor, penetration test of reactor head, maintenance of steam generator tube, periodical inspection of reactor coolant pump. The steam generator replacement is one of the most important tasks, which is committed to more than 400 workers. It consisted of 14 unit processes like installation of S/G support, decontamination of RCS pipe, cutting and welding of RCS pipe…etc. Among the processes the highest radiation dose is RCS pipe cutting and welding process which is anticipated to be 60% of the total dose.

2.3 Installation of KRMS and System Optimization in Hanul Unit-4

Figure 1 shows the schematic diagram of KRMS installed in Hanul unit-4. The fiber optic system and several receivers and repeaters were used on the network. In Hanul unit-4, six repeaters were installed at the top of inner wall of RCB 100' and 122'. The prior field test in Hanbit unit-3&4 shows that the lead jacket possibly cause degradation of data communication. To solve this problem in Hanul unit-4, extra repeaters and high-sensitivity antenna were installed additionally.

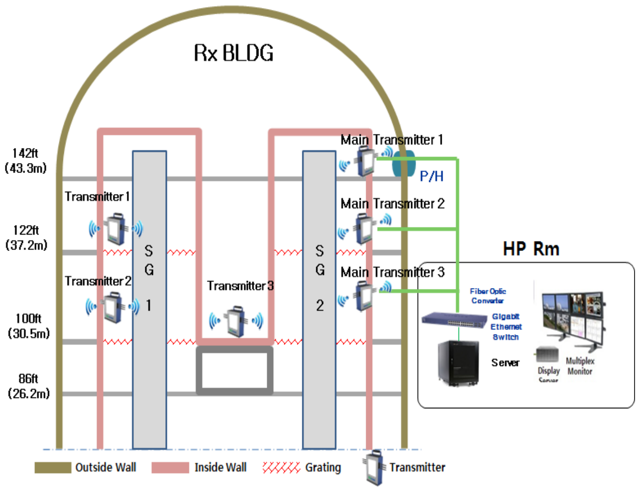

Fig. 1. The schematic diagram of KRMS in Hanul unit-4

After installation, field tests were done as ; (1) Wearing lead jacket on the protective clothing where the dosimeter is located inside (2) Checking output resolution according to distance (3) Finding the value not decrease the sensitivity. Table 1 shows recorded output of Wi-Fi analyzer at the main work area of reactor building. The values are over -70 dBm which is the criteria of no loss of data and good voice communication. Figure 2 shows the wireless network signal of the system at Steam Generator 'A' area.

Table I: Recorded output at the main work area

Location	RCB 142’		RCB 122’		RCB 100’	
	P/H	Path way	S/G A	S/G B	S/G A	S/G B
Avg. Output	-48	-60	-43	-45	-52	-50

(unit : dBm)

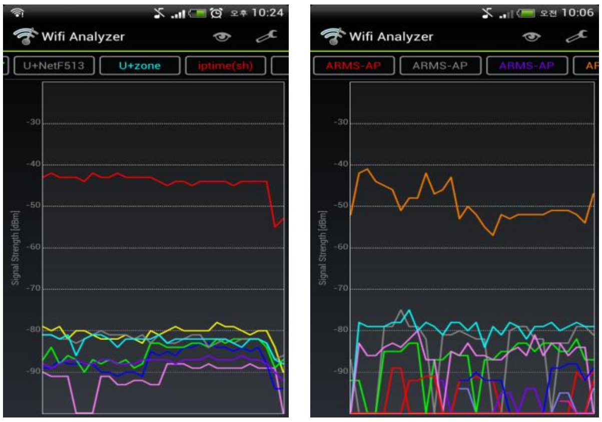

Fig. 2. Wireless network signal of KRMS at RCB 122’, 100’ of S/G A

2.4 Results and Some Considerations

The dosimeter of KRMS was provided additionally to workers with existing Automatic Dose Reading system (ADR). In Hanul unit-4, 148 workers used the system to 24 radiation works. The result showed that there was no shaded area of wireless output and no data loss of communication in spite of wearing lead jacket. Figure 3 shows the dose trends of a worker by time. Figure 4 shows the comparison of values received by KRMS and existing ADR of 12 workers whose dose are more than 50 uSv. It was found that the deviation is in the range 0 ~ 20% and the value of highest dose is 3%. The average of deviation is about 2%, which tell us it matches fairly well. And it was found that 7 out of 12 KRMS’s values are larger than existing ADRs’ while 4 out of 12 existing ADR’s values are larger than KRMSs’. It can be induced that the deviations are affected by work condition rather than dosimeter itself. The lessons learned at Hanul unit-4 are (1) It Needs simplification of operating system and battery rack (2) It requires additional functions to be able to check battery level at HP room.

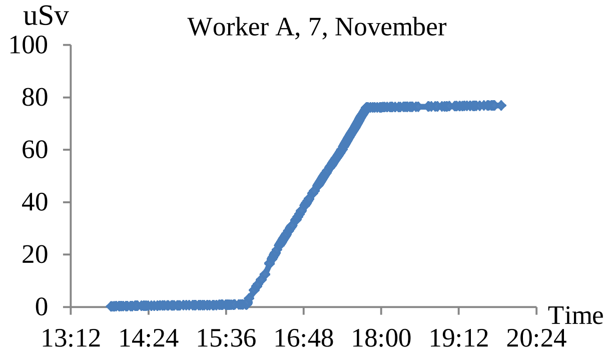

Fig. 3. Accumulated dose of a worker by time

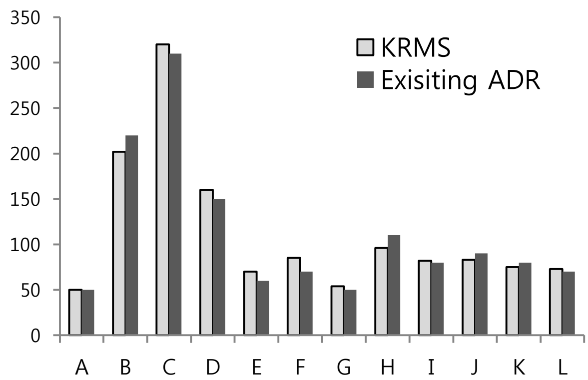

Fig. 4. Comparison of KRMS and existing ADR in Hanul-4

3. Conclusions

KHNP-CRI has developed real-time personal dose monitoring system and applied to Hanul overhaul which include steam generator replacement. It took 5 days to install the system in reactor building and the optimal location for the repeater was 3 points at 122ft and 3 points at 100ft.

Owing to the optimization of repeater and high sensitivity antenna, there was no shaded area of wireless network and no loss of dose data in spite of wearing lead jacket. The average deviation of personal dose received by KRMS and existing ADR is about 2%, which tell us it matches well.

The lessons learned in Hanul unit-4 are it needs simplification of operating system and it requires a function to be able to check battery level at remote area.

REFERENCES

[1] EPRI TR 1003687, Remote Monitoring Technology Guidelines for Radiation Protection : Implementation of Remote Monitoring (2004)