Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 25-27, 2017

The introduction of the personal safety system installed in the radiation controlled area of KOMAC

Sung-Kyun Park [a*], Yi-Sub Min[a], Jeong-Min Park [a]
[a]*Korea Multipurpose Accelerator Complex, Korea Atomic Energy Research Institute,*
181, Mirae-ro, Geoncheon-eup, Gyeongju-si, Gyeongsang buk-do, 780-904, Korea
[*]*Corresponding author: skpark4309@kaeri.re.kr*

1. Introduction

Korea multi-purpose accelerator complex (KOMAC) operates a 100-MeV high-power proton accelerator, low-energy ion beam accelerator, and 1.7-MV tandem accelerator to offer an optimum proton beam and various ion beam services. These accelerators have installed at the spaces in the acceleration building and ion beam application building, called the radiation controlled area, as shown in Fig 1. And the radiation workers and experiment users worked in these radiation controlled areas can be exposed to the hazards of the ionizing radiation generated by accelerators.

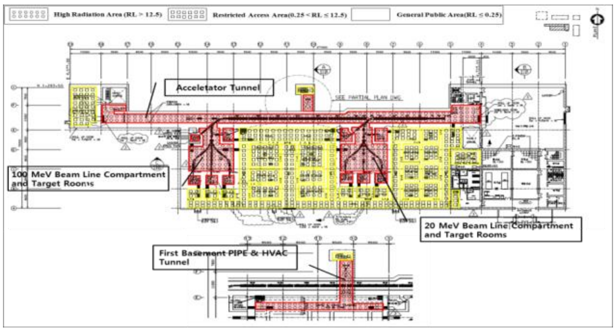

Fig. 1 Radiation controlled area defined in the first floor of the accelerator building. The red area and yellow mean the high-level radiation area with the main proton linac and the radiation worker area, respectively.

In order to protect the radiation workers from the radiation generated in the radiation controlled area, the personal dosimeters, which are classified as the passive and active personal dosimeter to measure the individual radiation exposure dose at the radiation working site, could be used [1]. The passive personal dosimeter (PPD) like the thermo-luminescence dosimeter (TLD) , required as the legal assessment dosimeter by the radiation safety act, can measure the exact individual cumulative dose quarterly. However, TLD could not provide the immediate read-out of the individual radiation dose and the warning sign at the radiation work site. To compensate for this disadvantage, the active personal dosimeter (APD) is used as the secondary dosimeter. Fig 2 shows TLD and the electric pocket dosimeter used as the secondary dosimeter necessary to access the radiation controlled area in KOMAC. The APD used in KOMAC currently is the electric pocket dosimeter. Since the personal dose measured from the electric pocket dosimeter is not updated in any data base, these personal doses could not be managed systematically and the radiation workers could not check their expose doses later. Also, this electric pocket dosimeter used in the KOMAC may be influenced by the cell phone. That is, if the cell phone is located near the pocket dosimeter, the personal exposure dose measured from the pocket dosimeter may be increased without the radiation source. In this research, the condition and installation status of the new personal safety system introduced in KOMAC would be described.

Fig. 2 The thermo-luminescence dosimeter (left) and electric pocket dosimeter (right) used as the main and secondary dosimeter in the radiation controlled of the KOMAC, respectively.

2. The personal safety system for KOMAC

The personal safety system, used in the radiation controlled area of KOMAC as the secondary dosimeter with the TLD, should be satisfied with several important conditions. First, the dose value detected can be read out immediately at the radiation work site. Second, an audible alarm should be activated when the dose rate exceeds the preset value. Third, the dose value from APD could be uploaded into the data base through a reader and the radiation worker can access their own dose values easily to effectively manage personnel safety. Fourth, these secondary dosimeters should not be disturbed by external factors, not the radiation source.

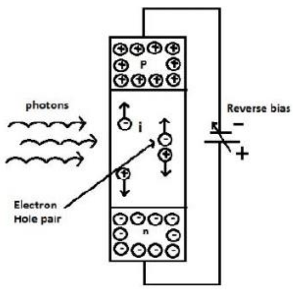

Fig. 3 The detection principle of the PIN diode detector

The electric personal dosimeter (EPD) with the PIN diode detectors would be installed newly in KOMAC as the secondary dosimetry. The PIN diode detector shown in Fig. 3 can convert the gamma energy into the electrical energy [2]. That is, under the reverse bias condition, when the gamma ray hits the intrinsic region between the p-type and n-type layer, the electron hole pairs are produced. Thus, the accelerated electron-hole pair charges produce the photo-current. The radiation worker can read out the radiation dose detected immediately by this principle.

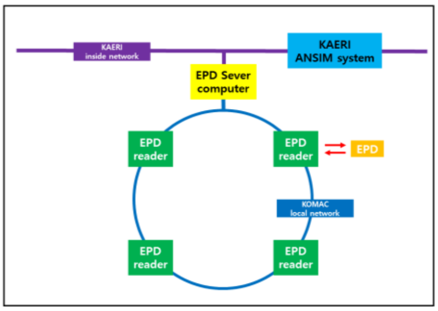

Fig. 4 the schematic diagram of the personal safety system installed newly in KOMAC.

The new personal safety system installed in KOMAC is comprised of the EPD, the EPD reader, and the EPD server as shown in Fig. 4. There are 10 EPDs arranged in each EPD reader. All EPD readers are connected by the KOMAC local network and all personal exposure dose data are updated into the database in the EPD sever via the EPD reader. After the radiation worker draft the radiation work plan to the KAERI advanced nuclear safety information management (ANSIM) system and this plan is settled, the access information of the radiation worker into the radiation controlled area are transferred into the EPD server. The radiation worker, who wants to enter into the radiation controlled area, would search his radiation work plan from the EPD reader and take one EPD with the access permission. After finishing their radiation work, the EPD is returned to the EPD reader and his exposure dose is updated into the server. Since then, the radiation worker can search his dose recorder in the KAERI ANSIM system.

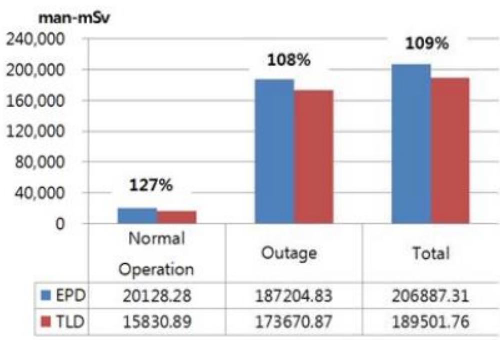

Fig. 5 Result of comparing the ratio between the total dose of EPD and total dose of TLD during the 5 years (2007-2011) in Korean whole nuclear power plants. [3]

Fig. 5 shows the result to compare the total exposure dose sums detected by EPD and TLD in the whole Korean nuclear power plants (NPP) during the 5 years. In the normal condition of NPP, the exposure dose of the EPD detected is 27% higher than the TLD. During the maintenance period of NPP, the EPD has estimated 8% higher than the TLD. This means in the high radiation controlled area, the detection accuracy of EPD would be increased and the exposure dose values detected by the EPD have been evaluated conservatively more than the TLD. If the radiation dose measured by the EPD is less than the permissible dose, his dose value would be less than the TLD. Thus, the new EPD system installed in KOMAC should be satisfied with all conditions of the personal safety system. Fig. 6 shows the EPD readers installed in front of the entrance of the radiation controlled area.

Fig. 6 the EPD readers which would have being installed at the entrance of the radiation controlled area respectively in the acceleration building and ion beam application building.

3. Conclusions

KOMAC would have been installing the new EPD system used in the radiation controlled area as the secondary dosimeter with the TLD. This new EPD system can read out immediately and give the warning alarm in the radiation work site. The radiation dose measured by the new EPD system can be updated into the data base and the radiation works can check their exposure doses on the KAERI ANSIM system. Since the new EPD system measures the radiation using the PIN diode detector, the external factors except the radiation source could not disturb the new EPD system. Therefore, the new EPD system would contribute to upgrade the personal safety in radiation controlled area of KOMAC.

REFERENCES

[1] Practical Radiation Technical Manual – individual Monitoring, IAEA, Vienna (2004)

[2] B. J. Lee, B. H. Kim, S. Y. Chang, J. S. Kim and S. R. Rho, Development of Electronic Personal Dosimeter with Hybrid Preamplifier using Semiconductor Detector, J. Korea Asso. Radiat. Prot. Vol. 27, No.1 p57 (2002)

[3] Byoung-Il Lee, Taejin Kim, and Young-Khi Lim, Performance Analysis of Electronic Personal Dosimeter (EPD) for External Radiation Dosimetry, JRPR-40-261, (2015)