The comparison of OFS simulation and measurement results to verify the Wolsong spent fuels in pond area

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1. Introduction

An Optical Fiber Scintillator(OFS) system is being developed to verify the CANDU spent fuels in the pond area of Wolsong Nuclear Power Plants. The OFS has been known to be able to use for neutron, alpha, beta and gamma detection in extreme environments. The OFS consists of optic detectors with light guides and light guide, Photo Multiplier Tube(PMT) modules, electronic equipment, a scanning device and computer software. This system detects a gross gamma ray emitting from the spent fuels by measuring the current from OFS. The dominant signal is from a front and a back side bundles of the OFS detector[1]. Due to the tiny and flexible structure, the detector can easily access to the spent fuels, which are located in the difficult to access area. Therefore, it is expected that the spent fuels in the pond can be verified without the tray movement using the OFS system. In this study, OFS system response using MCNP code and the result were compared with the measurement result from field test.

2. Methods and Results

2.1 Source term calculation

The gamma ray emission rates of individual spent fuel bundles were calculated by ORIGEN-ARP. ORIGEN-ARP program developed by Oak Ridge National Laboratory(ORNL) calculates spent fuel isotopes and radiation source term. This program interpolates cross section as a function of fuel enrichment, burnup, and moderator density and provides an easy-to-use Windows graphical interface[2]. Using radiation is gamma ray and the energy range of source term is 15 bins from 50 keV to 10MeV.

2.2 Monte Carlo simulation

For simulation, the radius of the depicted spent fuels is 5.125cm and the length of the spent fuels is 49.53cm. The material of the spent fuels was assumed a UO_2. These bundles were placed in two lines and sixteen layers. The radius and length of the real OFS are respectively 0.05cm and 0.5cm. But the radius of the depicted OFS was 0.5cm for reducing the simulation. The length of the OFS was 232cm, however, it was divided into 464 equal parts. Therefore, the length of the depicted OFS was the same as the real size. Doses at respective parts were calculated using the Monte Carlo code system MCNPX^{TM}, version 2.4. The results were calculated with the energy deposition tally F6 devised in the MCNP code[3].

2.3 Results

The current signal was measured by scanning the OFS system from bottom to upper layer between bundles. The result is shown in Figure 1. The OFS measured 16 peaks corresponding to individual spent fuel layers. The signal is dominated by adjacent bundles to OFS. The current is a summation of the signals from a front and a back side bundles. In order to identify a reliability of measurement result, a calculation of OFS system response using real bundles data, such as burn-up, cooling time and irradiation time, was performed. The simulation result is shown in figure 2.

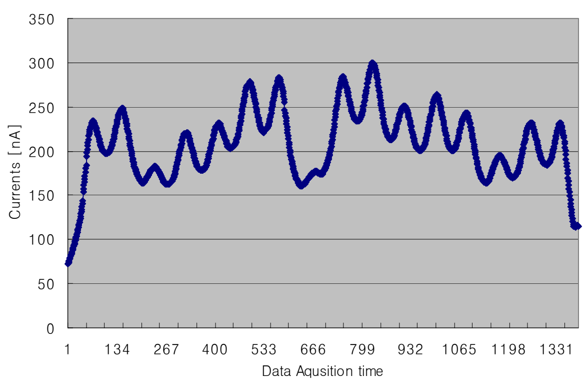

Figure 1. The OFS measurement result in the spent fuel pond

area in of Wolsong Nuclear Power Plants

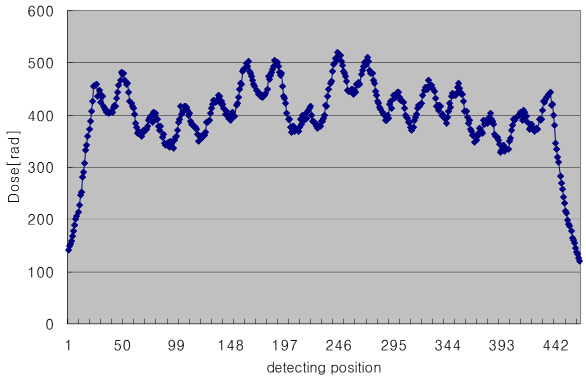

Figure 2. The OFS simulation result using MCNP and ORIGEN-ARP code

3. Conclusion

The OFS system has being developed to verify the spent fuel bundles stored in difficult to access area in Wolsong pond storage. In order to identify OFS system reliability, the measurement result was compared to the simulation result using MCNP and ORIGEN-ARP codes. The real bundles data such as burn-up, cooling time and irradiation time were used for the source term calculation. Although there is a little difference, the simulation result showed good agreement to the measurement result. However, the further measurement and simulation need to be performed for the accurate analysis. The system demonstration will be performed with IAEA in the near future. If the OFS system is certified by IAEA, it will contribute to reduce a burden and a potential danger to facility and time consuming to the IAEA inspection.

REFERENCES

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[3] LANL, MCNPX™ User's Manual, Los Alamos National Laboratory, MCNP™ 2.4.0 LA-CP-02-408, 2002