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Spectroscopic-based simultaneous monitoring for neutron-gamma H*(10) using an organic scintillation detector

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A dose monitoring system is crucial for protecting workers from overexposure to neutrons and gamma rays in the neutron utilization facilities and decommissioning of nuclear power plants. Traditional passive dosimeters have been widely used to measure both radiation types simultaneously. However, these dosimeters are incapable of real-time dose estimation and detecting hotspot locations. A combination of GM counters and He-3 proportional counters also have been employed for area monitoring. Although it is possible to monitor dose in real-time, this is relatively bulky and requires additional equipment for identifying radionuclides.
This study proposes a methodology for spectroscopic-based neutron-gamma simultaneous dose (ambient dose equivalent, H*(10)) estimation using an organic scintillation detector. Firstly, we performed time-of-flight measurements with two detectors to obtain a neutron response matrix. A detection system, our interest, comprised a stilbene scintillator and a photomultiplier tube (PMT). The other consisted of PMT and an EJ-200 scintillator to detect gamma-triggering signals. A Cf-252 source was placed between two detectors at 50 cm from each detector. The 256 channels were calibrated to a range of 60 to 1850 keV. The neutron response matrix was validated for consistency with the Watt fission spectrum.
To convert $H(10)$ from the neutron spectrum, we calculated the G (E) function using the ADAM method, and it had the smallest mean square error at Kmax = 16. The performance of the G(E) function was evaluated with the H*(10) estimation accuracy and linearity depending on the dose rate. The test dataset was obtained with a pulse shape discrimination (PSD) method. The results demonstrated linearity within an error of approximately 18% ranging from 0.1 to 5 μSv/hr. The study on the $H(10)$ estimation in environments with gamma sources only and simultaneous neutron and gamma sources is ongoing. The findings will be discussed at the conference presentation.

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