

Evaluation of the Effects of Cd Shell Gaps on D₂O-Moderated ²⁵²Cf Neutron Spectra

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The neutron reference radiation fields are required for the calibration of dosimeters and dose rate meters for neutron radiation. At the KHNP Central Research Institute (CRI), a neutron reference radiation field based on a ²⁵²Cf source has been established since 2012 and has been periodically calibrated by Korea Research Institute of Standards and Science (KRISS) as a secondary standard. To extend the energy range available for the calibration and testing of neutron detectors, a D₂O moderator was designed and fabricated in accordance with ISO standards. The newly developed neutron radiation field from a D₂O-moderated ²⁵²Cf source is intended to be measured and characterized using Bonner sphere spectrometry, which consists of high-density polyethylene (HDPE) spheres of multiple diameters and a ⁶LiI(Eu) scintillation detector, for the establishment of a secondary standard.

Because of manufacturing limitations, the Cd shell was fabricated by assembling multiple Cd segments into a spherical form. To ensure that thermal neutrons produced in the D₂O moderator pass through the Cd shell toward the detector and are effectively absorbed, the Cd shell was designed with minimized interfaces by considering the neutron emission angle, the source-to-detector distance, and the diameter of the neutron detector. Nevertheless, a fraction of thermal neutrons may pass through the gaps at the segment interfaces in other directions without being absorbed and are subsequently scattered within the irradiation room, potentially leading to variations in the neutron radiation field. As a preliminary assessment for the future establishment of a neutron reference radiation field, this study aims to investigate the effects of Cd shell gaps on the neutron energy spectrum of a D₂O-moderated ²⁵²Cf source and the corresponding response of a ⁶LiI(Eu) scintillation detector using Monte Carlo simulations.

1. International Organization for Standardization, "ISO 8529-1 - Neutron reference radiations fields - part 1: Characteristics and methods of production," *International Standard* (2021).