

GAMMA RADIATION STREAMING THROUGH TRIPLE BENT LABYRINTH

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INTRODUCTION

Radiation streaming is one of the difficult problem in the radiation shielding. For photons, several works on the attenuation of photon dose through the streaming pass exists and the discussions were done by mainly considering geometrical effects. As a recent movement, connecting to the radioactive waste handling facilities and the reprocessing plants, the precise handling of gamma streaming has been required(1-3). In this paper, as a purpose of providing a benchmark data, the experiment and calculation for photon streaming of three bent labyrinth was performed.

EXPERIMENT

The experiment was done in the Cobalt-60 Irradiation Facility Room of the University of Tokyo(4). The irradiation room and labyrinth structure are shown in Fig.1. Gamma dose were measured by ionization chambers, which were used as a monitor and an absolute detector. Thermoluminescent dose meters (TLD) were also used as a dosimeters for mapping of spatial gamma dose distribution. For several typical positions, a photon spectrometer of NaI(Tl) scintillator was used to get gamma spectra by doing spectral unfolding.

CALCULATION

The calculational method was a Monte Carlo method and MCNP4a code was applied. The photon cross section was Hubbell's one(5). The variation reduction techniques were used based on the discussion of scattering importance and the determinations of scattering region and angular selection. The used calculational geometry is shown in Fig.2. The detailed structure of concrete and iron lining of room wall etc. were included in the calculation.

RESULTS AND DISCUSSIONS

Some of the measured and calculated results are shown in Fig.3 and 4. The comparison between experiment and calculation was done. On the spatial dose attenuation along the axis of labyrinth, a completely good result of C/E was obtained in Fig.3, in spite of seven decades decrease of gamma dose. From the detailed discussions of dose distribution in the labyrinth, the followings were found. The first scattering wall has an important roll of streaming estimation, which is, for instance, a kind of shining source to the labyrinth.

For photon spectra, typical results are shown in Fig.4. In this figure, Co-60 high gamma was suddenly degraded in energy, and Compton and multiple scattered gamma made a soft spectrum. This procedure was excellently reproduced by the calculation. The uniform spectral field was fabricated after second bent. This means the conversion factors of the measured TLD to radiation dose should be differently used, depending on the position, for the reasons of sudden spectral change.

CONCLUSIONS

Co-60 photon streaming experiment through triple bent labyrinth was done and dose attenuation along the central axis and gamma spectral change were obtained. The analysis of the Monte Carlo calculation was followed and the important scattering region and angular section was clarified. This good estimation of C/E contributed to the establishment of the photon streaming analysis.

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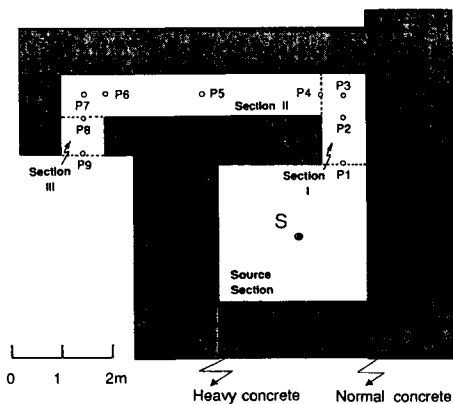


Fig.1. Structure of labyrinth in cobalt-60 irradiation facility.
(S: Cobalt-60 Source; P1,...,P9: Measuring point identification number).

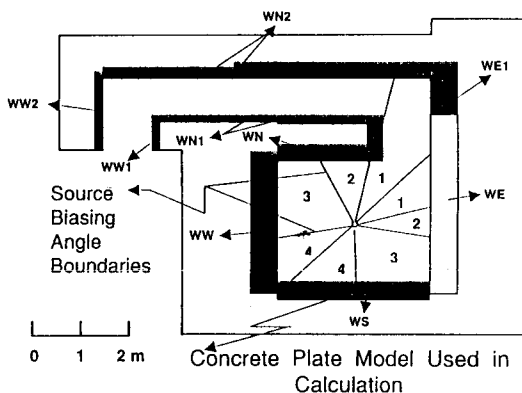


Fig.2. Calculational models for gamma radiation streaming through the labyrinth.

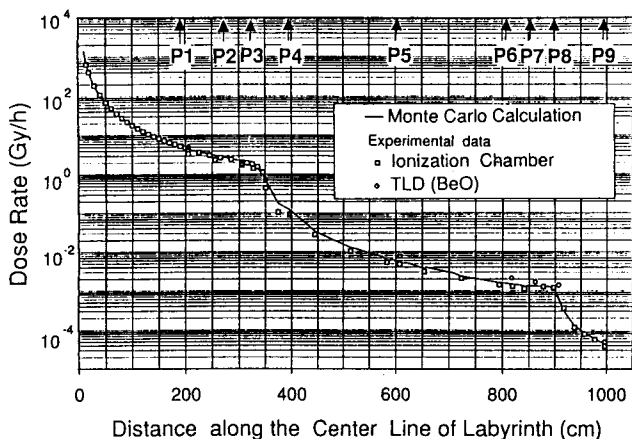


Fig.3. Dose rate spatial attenuation from cobalt-60 source center in the irradiation room.

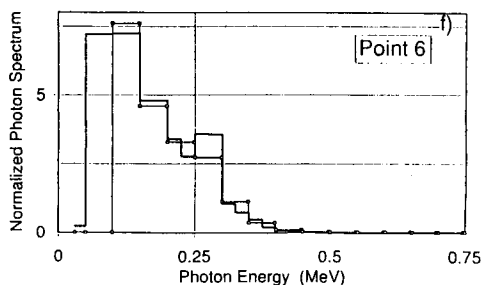
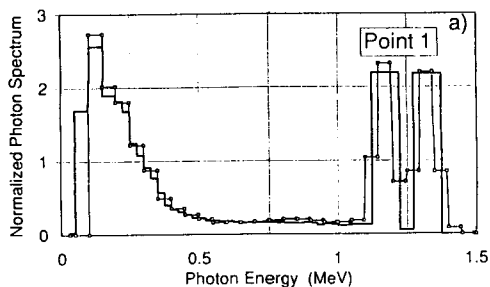


Fig.4. Comparison of measured and calculated photon spectra along the labyrinth.