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A Study on the Method to Discriminate Between the Internal and External Radioactive Contamination Using Whole Body Counter

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1. Introduction

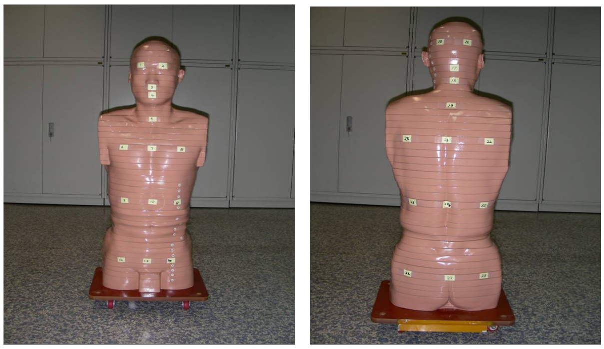
Whole Body Counter (WBC) is used to identify and measure the radioactivity in the body of human beings in a nuclear power plants (NPPs). In domestic NPPs, it is prescribed that all workers should take a whole body counting after radiation works if the possibilities of radioactive contamination exist or the radioactivity is detected by a portal monitoring. It is, however, found that the external skin contamination is occasionally estimated as the internal radioactive contamination. In this case, the worker assumed to be detected is recommended to take showers for the decontamination of skin and take a whole body counting again. Although the detected radioactivity is reduced remarkably after several decontaminations, confirmed as the external skin contamination, it is determined finally as an internal exposure if the radioactivity is still detected in the body of worker. The amount of detected radioactivity can be much higher than that of the expected for this mistaken contamination since the radioisotopes attached to skin come to be close to the detectors of WBC. Finally, this makes the misjudgment of the external skin contamination as well as the excessively conservative estimation of radioactive contamination.

In this study, several experiments were carried out to discriminate between the internal and external radioactive contamination using the humanoid phantom and WBC. Preliminary experimental results indicated that the use of front and backside counts could be applied to the discrimination of the external skin contamination and the difference of detected radioactivities between front and backside counts was less than about factor 2 for the internal contamination.

2. Method & Materials

The back and forth counting using WBC was used, in this research, to differentiate the external skin contamination from the internal contamination. It is assumed that the difference of detected radioactivities between front and backside counts is higher than those of the internal contamination if the radionuclides are attached to skin [1]. In case of the internal contamination, there is no significant change of distance between the body of workers and the detectors; thus, the difference between front and backside counts is not distinguishable.

The humanoid phantom of typical Korean male, developed by the Radiation Health Research Institute (RHRI) of Korea Hydro & Nuclear Power (KHNP) Corporation for radiation protection purpose, was used for front and backside counts. This phantom satisfies the reference Korean physical model (Height: 170.9cm, Weight: 68.1kg, etc.) and is sliced into 2cm sections to facilitate dose mapping [2]. First, the number tags of 1 to 14 for front and 15 to 28 for backside of the phantom surface were attached to position the radioactive source (Fig. 1).



(a) Front (b) Back

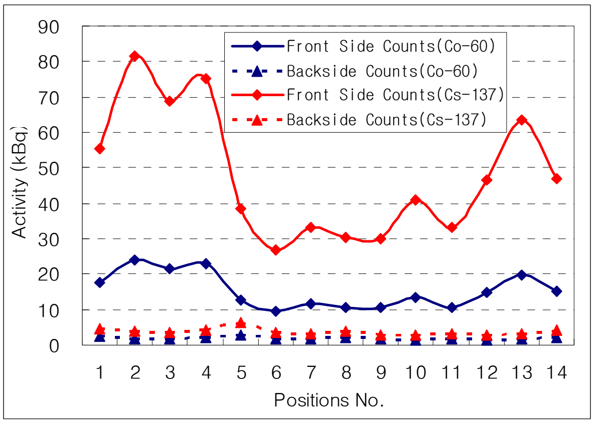
Fig. 1 The Humanoid Phantom of Typical Korean Male

The WBC utilized for the experiments is Canberra's Fastscan (Model 2250), which is used at most domestic NPPs except for Ulchin unit #5 & #6. A mixture source of Cs-137 and Co-60, manufactured by North American Scientific Inc., was used for the experiments of external skin contamination and two point sources of Cs-137 and Co-60, manufactured by Korea Research Institute of Standards and Science (KRISS), were used for the experiments of internal contamination since those radioactive sources are the most important and common internal dose contributors for PWR reactors.

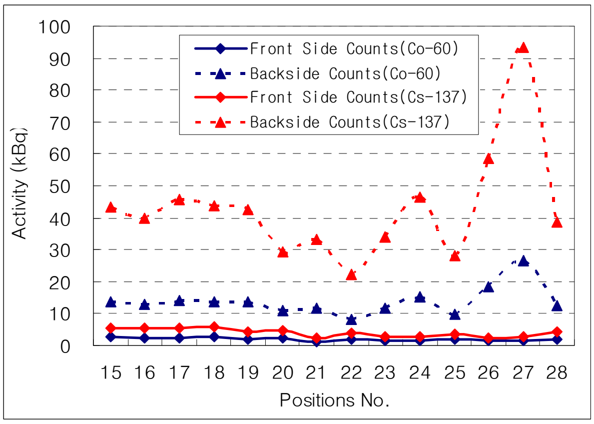
3. Experiments & Results

Two kinds of experiments were conducted. One was the front and backside count to test for the external skin contamination. In this experiment, a mixture source of Cs-137 and Co-60 was attached to front and backside of the phantom surface. The other was the back and forth counting for the internal contamination; two point sources of Cs-137 and Co-60 were located inside of the phantom. The counting time was one minute.

In the first experiment of the external contamination, the results indicated that the average ratios of front and backside counts were 8.34 for Co-60 and 13.38 for Cs-137 for the attachment of a mixture source to front side of the phantom. For the position of a source on backside of the phantom, similar results were also obtained; the average ratios of front and backside counts were 7.68 for Co-60 and 12.39 for Cs-137 (Fig. 2).



(a) Position of a Source on Front Side of the Phantom



(b) Position of a Source on Backside of the Phantom

Fig.2 The Average Ratios of Front and Backside Counts for the Experiments of External Contamination

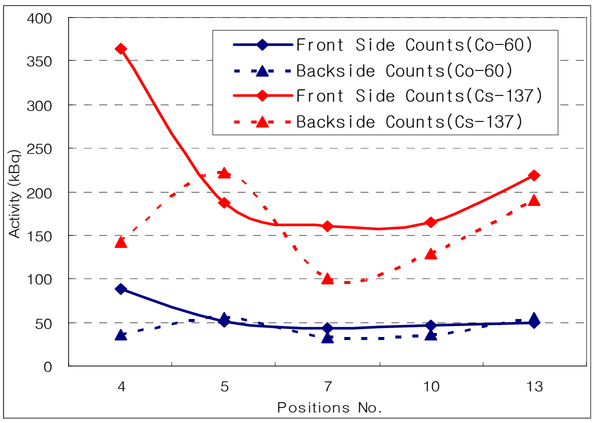


Fig.3 The Average Ratios of Front and Backside Counts for the Experiments of Internal Contamination

The experimental results of the internal radioactive contamination showed, contrary to the results of the external skin contamination, that the difference of detected radioactivities between the internal and external contamination was not significant. The average ratios of front and backside counts were 1.38 for Co-60 and 2.22 for Cs-137 (Fig. 3).

4. Preliminary Conclusion & Further Study

It is important to estimate the exact internal exposure dose for radiation workers since most workers in NPPs think that the internal contamination is more dangerous than the external contamination or external exposure. In this study, several experiments of back and forth counting using WBC were performed to distinguish the internal and external contamination. It was found, at the preliminary stage, that the use of front and backside counts could be applied to the discrimination of external skin contamination and the difference of detected radioactivities between front and backside counts was less than about factor 2 for the internal contamination.

It is, however, necessary to conduct more several experiments including the contamination of both flanks and the simultaneous contaminations of both internal and external. In addition, the application of method using the ratio of detected radioactivities from the upper and lower detectors is investigated to discriminate the external skin contamination. In case of the external skin contamination on the upper or lower part of the body, WBC probably would show the relatively remarkable difference of detected counts from the upper and lower detectors comparing to the case of internal contami-nation.

5. Acknowledgement

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REFERENCES

[1] Kong, T. Y., and Kim, H. G. The Establishment of Geometry and General Outlines of Operation for Whole Body Counter, Korea Electric Power Research Institute, TM.I05NJ14.P2006.073, pp. 28-32, 2006.

[2] Kim, J. I., Choi, H., Lee, B. I., Lim, Y. K., Kim, C. S., Lee, J. K., and Lee, C. Physical Phantom of Typical Korean Male for Radiation Protection Purpose, Radiation Protection Dosimetry Advance Access, doi:10.1093/rpd/nci338, 2006.