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Development of a Portable Type Personal Dosimeter for internal and external dose assessments

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Abstract
In the Fukushima-Daiichi Nuclear Power Station (FDNPS) accident that occurred in March 2011, existing monitors for radioactive materials in the atmosphere are expensive and often large, so they could not be deployed in a wide range of locations after the accident. Thus, there are few data on internal exposure doses of residents after the FDNPS accident. On the other hand, small and inexpensive radiation measuring instruments for assessing external exposure doses are available on the market, but there have been many cases where the indicated values differ depending on the manufacturer even when measured at the same location, or where it takes time to obtain the indicated values. In this study, we have developed an instrument that can evaluate not only ambient dose equivalent rate but also airborne radioactivity concentrations which are corresponding to internal exposure doses quickly, easily, and precisely with a single measuring instrument under an emergency situation. The structure of the monitor developed in this study is shown in Figure 1. For internal exposure dose assessment, radioactive materials in the atmosphere are collected on a filter, and their radiations are detected by a silicon semiconductor detector placed in front of the filter. The detection and collection sections are designed so that the alpha particles on the filter can be detected efficiently. In emergency situations, the purpose is to detect plutonium and uranium, and the exposure dose is evaluated by the gross count rate of detected alpha particles. The performance of the system was evaluated by conducting continuous measurements in the radioactive aerosol chamber installed at the Institute of Radiation Emergency Medicine (IREM), Hirosaki University. A GAGG scintillator was used as a detector to evaluate the ambient dose equivalent rate. Cs-137 gamma-ray source was used for evaluation of the energy resolution and energy calibration of the GAGG scintillation detector. The integrated measuring instrument for simultaneous assessment of ambient dose equivalent rate and atmospheric radionuclides concentration developed in this study was significantly smaller and lighter than the devices available on the market so far. On the other hand, there is still room for improvement at present. If this issue is resolved, the device is expected to be utilized for environmental radiation monitoring around nuclear facilities and for radiation control in hospitals, universities, laboratories, and other institutions that handle radioactive materials.
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