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Note

Absorbed Dose Rate in Air at the Bunkyo-cho Campus of Hirosaki University

Masahiro Hosoda[1], Yoshinori Fukui[2,3], Chanis Pornnumpa[1], Atsuyuki Sorimachi[4], Tetsuo Ishikawa[5], Masanori Yachi[6], Ayano Nara[6], Hiromi Yokota[1,7], Shinji Tokonami[4*]

[1]Department of Radiological Life Sciences, Hirosaki University Graduate School of Health Sciences; 66-1 Hon-cho, Hirosaki City, Aomori 036-8564, Japan
[2]Student in the Education Program for Professionals in Radiation Emergency Medicine, Hirosaki University
[3]Department of Radiological Safety Management, Division of Reprocessing Business, Japan Nuclear Fuel Ltd.; 4-108, Aza Okitsuke, Ohaza Obuchi, Rokkasho-mura, Aomori 039-3212, Japan
[4]Department of Radiation Physics, Institute of Radiation Emergency Medicine, Hirosaki University; 66-1 Hon-cho, Hirosaki City, Aomori 036-8564, Japan
[5]Department of Radiation Physics and Chemistry, School of Medicine, Fukushima Medical University; 1 Hikarigaoka, Fukushima City, Fukushima 960-1295, Japan
[6]Department of Radiological Technology, School of Health Sciences, Hirosaki University; 66-1 Hon-cho, Hirosaki City, Aomori 036-8564, Japan
[7]Department of Disability and Health, Hirosaki University Graduate School of Health Sciences; 66-1 Hon-cho, Hirosaki City, Aomori 036-8564, Japan

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Measurement of absorbed dose rate in air was carried out at the main campus (Bunkyo-cho Campus) of Hirosaki University about two years after the March 2011 accident at TEPCO's Fukushima Daiichi Nuclear Power Plant. Three pocket survey meters and one 3-inch × 3-inch NaI(Tl) scintillation spectrometer were used for the measurement of absorbed dose rate and gamma-ray pulse height distribution, respectively. The arithmetic mean ± standard deviation based on 95 measurement locations at the main campus was 24 ± 3 nGy/h. Neither ^{134}Cs nor ^{137}Cs was observed throughout the whole survey time. This result suggested that their amounts were comparable to the natural background radiation level found at Hirosaki University.

Key words: absorbed dose rate in air; Hirosaki University Bunkyo-cho Campus; pocket survey meter; NaI(Tl) scintillation spectrometer

1. Introduction

Large amounts of artificial radionuclides were released to the environment from the damaged nuclear reactor buildings in the accident at TEPCO's Fukushima Daiichi Nuclear Power Plant (FDNPP) in March 2011[1)]. Ambient dose rates after the FDNPP accident have been measured not only by local government authorities but also by persons from universities and other research institutes[2,3)]. However, most local government workers are not well trained to carry out radiation monitoring, which has led to delays in response and confusion in risk communication with the general public. This situation suggested that a practical training exercise on radiation measurement which assumed a radiation emergency accident is important. Since there are several nuclear facilities in

*Shinji Tokonami: Department of Radiation Physics, Institute of Radiation Emergency Medicine, Hirosaki University; 66-1 Hon-cho, Hirosaki City, Aomori 036-8564, Japan
E-mail: tokonami@cc.hirosaki-u.ac.jp

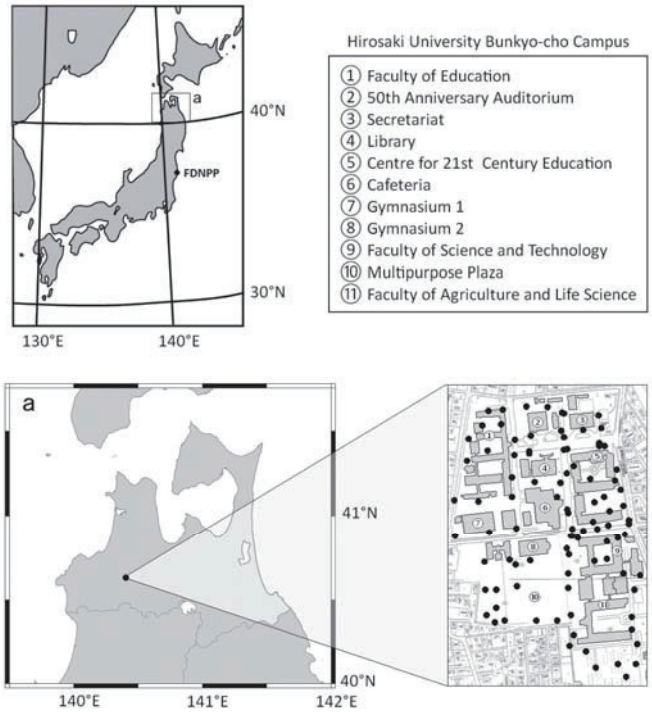

Fig. 1. Measurement locations at the Bunkyo-cho Campus of Hirosaki University. This figure was made using the Generic Mapping Tools (GMT) created by Wessel and Smith[5].

Aomori Prefecture, Hirosaki University has launched an education program on radiation emergency medicine for medical specialists in nuclear power-related facilities and hospitals in the Prefecture and for personnel working in administrative agencies[4]. This training course includes a practical exercise on the radiation measurement and making a dose-rate distribution map. Hirosaki University has two campuses, the Bunkyo-cho Campus and the Hon-cho Campus. Absorbed dose rate in air at the Hon-cho Campus was continuously measured immediately after the FNDP accident[3]. However, this measurement was not carried out at the Bunkyo-cho Campus which accommodates administrative offices of the university. In this study, the measurement of absorbed dose rate in air at the Bunkyo-cho Campus was made so as to draw a dose rate distribution map. Moreover, radioactive contamination by the FDNPP accident in this campus was also discussed using the results of gamma-ray pulse height analysis. The present study was carried out as a part of the Education Program for Professionals in Radiation Emergency Medicine.

2. Materials and Methods

2.1. Measurement of absorbed dose rate in air at the Bunkyo-cho Campus

Locations for the measurement of absorbed dose rate in air at the Bunkyo-cho Campus are shown in Figure 1.

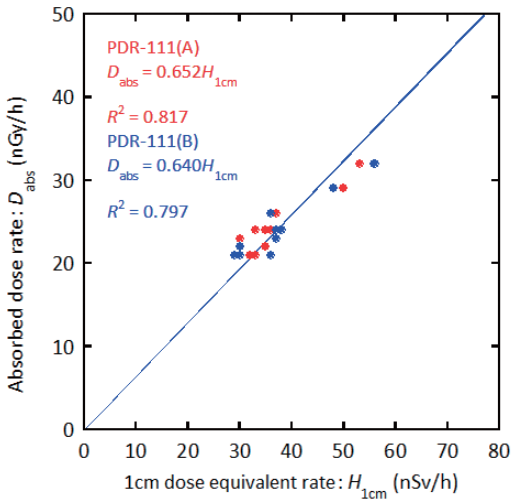

Fig. 2. Relationship between absorbed dose rate in air calibrated using a 3-inch × 3-inch NaI(Tl) scintillation spectrometer and 1cm dose equivalent rate obtained by two pocket survey meters.

Among them, 87% were paved surfaces. Three pocket survey meters (PDR-111, Hitachi-Aloka Co., Japan) were used for the measurement on June 7, 2013. One of those meters had already been calibrated by comparison to a 3-inch × 3-inch NaI(Tl) scintillation spectrometer (JSM-112, Hitachi-Aloka Co., Japan)[6]. Therefore, the other two meters were calibrated based on this meter. The measurement was conducted at a 1 m height above the ground (pavement) surface. Longitude and latitude were also recorded at each measurement location using a GPS recorder (WPL-2000LX, Wintec Co. Ltd, Taiwan). The weather condition was sunny throughout the entire measurement period.

2.2. Measurement of gamma-ray spectrum

Gamma-ray pulse height distributions were obtained using a 3-inch × 3-inch NaI(Tl) scintillation spectrometer (EMF-211, EMF-Japan, Japan) at two points in the campus. Both these measurements were carried out 1 m above a paved surface and a grass surface in front of gymnasium-1 (location 8 in Figure 1). Measurement time was set as 900 s. The obtained gamma-ray pulse height distributions were unfolded by a 22 × 22 response matrix for the evaluation of absorbed dose rates in air[7]. This calculation software assumed that the fallout formed an infinite plane source on the ground.

3. Results and discussion

The relationship between absorbed dose rate in air obtained by the calibrated meter and 1cm dose equivalent rate (PDR-111 (A) and (B)) is shown in Figure 2. Both conversion factors from 1cm dose equivalent rate (Sv/h) to absorbed dose rate in air (Gy/h) of PDR-111(A) and (B)

Fig. 3. Distribution map of absorbed dose rate in air at the Bunkyo-cho Campus of Hirosaki University.

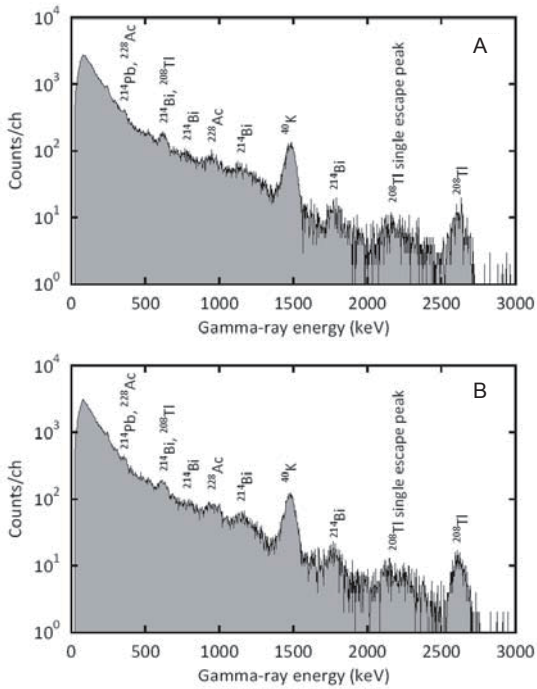

Fig. 4. Gamma-ray pulse height distributions measured for the pavement surface (A) and the grass surface (B) in front of gymnasium-1 on the Bunkyo-cho Campus.

were evaluated as 0.652 and 0.640, respectively. Thus, the readings of the survey meters (Sv/h) were converted to absorbed dose in air by using these conversion factors.

A distribution map of absorbed dose rate in air at the Bunkyo-cho Campus is shown in Figure 3. Absorbed dose rates in air around buildings were relatively higher than those values on the ground around the multipurpose plaza (location 10 in Figure 1). The arithmetic mean ± standard deviation based on 95 measuring locations on the campus was estimated to be 24 ± 3 nGy/h. This value was similar to the authors' previously reported value of 23 ± 3 nGy/h (n = 68) which was measured at Hirosaki Park in Hirosaki City).[6] The maximum and minimum values were both observed near the 50th Anniversary Auditorium (location 2) and were 32 nGy/h and 17 nGy/h, respectively. The distance between the location, where the maximum value was observed, and the auditorium outer walls were close. On the other hand, the location where the minimum value was observed was close to a wooden house. Thus, these results suggested that the difference in building materials and distance from the buildings (their outer walls) affected the absorbed dose rate in air.

Several artificial radionuclides were observed in the gamma-ray pulse height distribution at the Hon-cho Campus on March 20, 2011[8]. Gamma-ray pulse height distributions for the pavement surface and the grass surface in front of gymnasium-1 are shown in Figure 4. Photon peaks generated from radiocesium were not observed in these gamma-ray pulse height distributions. Although the number of obtained gamma-ray spectra was small, these results showed that the radioactive contamination at the Bunkyo-cho Campus due to the FDNPP accident was negligible. Absorbed dose rates in air for pavement and grass surfaces were calculated using the response matrix method and these values were evaluated as 27 nGy/h and 26 nGy/h, respectively. These values were not significantly different.

4. Conclusion

Absorbed dose rate in air and gamma-ray pulse height distribution on the Bunkyo Campus of Hirosaki University were measured by pocket survey meters and a NaI(Tl) scintillation spectrometer. The arithmetic mean of absorbed dose rate in air was 24 nGy/h and this was similar to the value the authors previously obtained for a park study in Hirosaki City. Artificial radionuclides such as ^{134}Cs and ^{137}Cs were not observed in the present measurement. Therefore, this result suggested that effects of artificial radionuclides were not seen and the level measured was comparable to the natural background radiation level for Bunkyo-cho Campus.

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