Environmental Radiation Survey Using Airborne Gamma-Ray Spectrometry Based on Manned and Unmanned Aerial Vehicles

Young-Yong Ji1*, Taehyung Lim2, Jang Hee Lee3, Eun Young Song3, Kun Ho Chung1, and Mun Ja Kang1

1 Korea Atomic Energy Research Institute, 111, Daejeon-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea
2 SI Detection Co. Ltd., 21, Yuseong-daero 1628beon-gil, Yuseong-gu, Daejeon, Republic of Korea
3 Nuclear Safety Division, Busan Metropolitan City, 1001, Jungang-daero, Yeonje-gu, Busan, Republic of Korea

*yyji@kaeri.re.kr

1. Introduction

After the nuclear accident of the Fukushima Daiichi nuclear power plants (FDNPP), the importance of environmental radiation survey has increased to quickly assess radioactive deposits in the ground. In general, the airborne gamma-ray spectrometry is widely used to rapidly estimate the distribution of environmental radiations over wide area for the purpose of the mineral exploration as well as emergency response by surveying natural and anthropogenic radiations [1-3]. Especially, the dose rate map established from the airborne monitoring was used to be the fundamental data for selecting the decontamination areas and evacuation zones in Japan.

Large-volume NaI(Tl) detectors are loaded in the manned aerial vehicle with a large payload. On the other hand, because unmanned aerial vehicles, such as a drone, has a small payload, the weight of detecting system should be limited to be generally about 10 kg. For the purpose of airborne gamma-ray spectrometry, two kinds of aerial measuring system were developed based on a 4”x4”x16” NaI(Tl) detector and two 2”x2” LaBr3(Ce) detectors, respectively. The total weight including detecting system was below about 20 and 6 kg dedicated manned and unmanned aerial vehicles.

In this study, the performance test was conducted to quickly assess the averaged ambient dose rate at 1 m above the ground over the wide area. First, the airborne survey using a drone was performed at three flight heights in relatively flat land of Jeju Island. Second, the airborne survey using a manned helicopter was conducted at about 300 m height to assess the dose rate by comparing with the results of carborne survey in the same site of Busan, with the help of Busan metropolitan city hall.

2. Method and Results

2.1 Airborne Survey System

Fig. 1 shows the airborne survey system based on a large-volume of NaI(Tl) detector and two 2 inch LaBr3(Ce) detectors. These system can be also applied to the ground-mobile gamma-ray spectrometry, such as the carborne survey. Especially, the airborne system with LaBr3(Ce) detectors is the multipurpose system for environmental radiation survey, which can be used to the ground-based gamma-ray spectrometry using a tripod and ground-mobile system using a backpack and carborne survey. Therefore, the results of airborne survey at diverse heights can be simply corrected to those at 1 m above the ground. In addition, the quality of survey results can be enhanced by comparing two results of airborne and carborne survey in the same site.
2.2 Unmanned Aerial Vehicle

Fig. 2 show the result of the airborne survey using a drone in Jeju Island. The survey was then conducted in wide area of above 100x200 m² at several flight heights and line spaces. The survey speed was fixed to be about 10 km/h. All results depending on the flight heights were corrected to those at 1 m above the ground by applying the attenuation correction factor, which was obtained from the hovering states at five heights of 3, 9, 20, 30, and 50 m. The airborne survey results were then compared with those of backpack survey and ground-based gamma-ray spectrometry using a tripod at the same site.

2.3 Manned Aerial Vehicle

The airborne survey using manned helicopter was conducted by loading a large-volume NaI(Tl) detector in a vehicle. The survey height and speed were about 300 m and 100 km/h. The survey site was designated to cover the residence area, beach, and sea of Busan with different dose rate levels. The carborne survey with the same survey system was also conducted around the site of airborne survey. The performance of airborne survey was then evaluated by comparing two survey results.

3. Conclusion

The diverse aerial measuring system based on a NaI(Tl) and LaBr₃(Ce) gamma-ray spectrometer were developed to calculate the ambient dose rate. Two types of airborne survey system was developed for the purpose of using in manned helicopter and drone, respectively. Finally, the performance of airborne survey was evaluated by comparing with ground mobile gamma-ray spectrometry using a backpack and carborne survey.

ACKNOWLEDGMENTS

This work was performed under the auspices of the Ministry of Science and ICT of Korea, NRF contract No. NRF-2017M2A8A4015256.

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