

Effective Measures on Safety, Security, Hygiene and Disaster Prevention in Laboratories

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INTRODUCTION: Important aspects of the study can be found in the following keywords, such as safety, security, hygiene and disaster prevention. Nuclear research reactors are one of the representative facilities together with these keywords under their operation. It is effective to investigate the latest status on practical measures on these keywords in various facilities including nuclear research reactors, to compare each other among facilities, and to discuss more optimized ones for our positive safety management. Through this process, it is also essential to investigate the latest international and/or national regulations and the movement of revision of them. In addition, the development of human resources and public literacy on nuclear science and technology is also within the scope of the research. The total discussion contents and their fruits are directly useful for all relating laboratories.

RESEARCH APPROACH: General research approach is as follows; - Measures of safety management during operation or standstill status of the real facilities would be investigated. This information would be used for our research discussion on positive and more optimized safety management. - It would not be a single year research, but maybe two to three years of research for one theme. - Information source of facilities would not be only KUR, KUCA or the other facilities in Kyoto University, but also the Kindai university research nuclear reactor or the facility of National Institute of Fusion Science, etc. This research is active joint-research with these related facilities and positive researchers on safety management. - One of the distinctive features of this research is to involve office staff as cooperators as well as re-searchers and technical staff. In The University of Tokyo, most of the members in Division for Environment, Health and Safety are office staff who know the real situation of safety management in laboratories very well. Concrete discussion targets in FY of 2025 were determined as (1) ‘Optimized safety management of X-rays following revised the national regulation’, and (2) ‘General understandings of the national guide on the radiation protection of NORM (naturally occurring radioactive materials)’. These were the representative hottest topics in the field of radiation protection and safety.

RESULTS: <X-RAYS SAFETY MANAGEMENT > To understand and apply the Japanese regulation on X-rays safety control revised in October 2025, the contents were in detailed discussed from the viewpoint of real-site control. Future issues to be overcome listed out, and they were presented and shared with experts in an academic meeting. <NORM RP> The latest Japanese activity and movement on NORM problems was discussed based on the new national guide published in November 2025, and future issues to be discussed were listed out. This topic will be one of the thema in 2026.

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- [1]https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/koyou_roudou/roudoukijun/anzeneisei29/0000186714_00002.html
- [2]DOI: 10.5453/jhps.60.236
- [3]<https://www.da.nsr.go.jp/view/NRA100015337?contents=NRA100015337-002-005#pdf=NRA100015337-002-005>

Evaluation of Air Dose Rate Distribution Around Monitoring Post Using KURAMA-II

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INTRODUCTION: The Nuclear Regulation Authority has commissioned a nationwide survey of environmental radioactivity levels, including air dose-rate measurements from approximately 80 portable monitoring posts in Fukushima Prefecture. Among these measurements, the air dose rate at the Omaru Community Center (Namie Town) decreased from approximately 4.5 $\mu\text{Gy/h}$ to approximately 1.2 $\mu\text{Gy/h}$ due to decontamination work around the monitoring post from April to May 2025. The data from the monitoring posts represent typical values for their installation sites and do not provide a detailed picture of the air dose rate distribution in the surrounding area. Therefore, we conduct a walking survey around the monitoring posts using the carborne survey system KURAMA-II (Kyoto University Radiation Mapping System) [1] to investigate the distribution of detailed air dose rate following decontamination.

EXPERIMENTS: We conducted a walking survey near the monitoring post installed at the Omaru Community Center, carrying the KURAMA-II on our backs at a height of 1 m above the ground. Using the standard functions of Kyoto University's cloud server, each measurement point is plotted as a dot on a map, with color indicating the air dose rate.

RESULTS: The air dose-rate map shown in Fig. 1 is divided into the following three areas. Area①(blue box): The air dose rate was approximately 1.5 $\mu\text{Sv/h}$, comparable to measurements at the monitoring post. Area②(yellow box): The air dose rate ranged from approximately 1.5 $\mu\text{Sv/h}$ to 5 $\mu\text{Sv/h}$, from levels comparable to those at the monitoring post to several times higher. This is most likely due to the residual contamination resulting from the incomplete decontamination. Area③(red box): The air dose rate ranged from approximately 2.5 $\mu\text{Sv/h}$ to 5 $\mu\text{Sv/h}$, higher than at the monitoring post. Hotspots at 5 $\mu\text{Sv/h}$ or higher were confirmed in Areas② and ③, while no locations with locally high air dose rate (hotspots) were identified in Area①. Furthermore, in Area③, the air dose rate tended to increase as the distance from Area① increased, suggesting that decontamination has not been performed throughout Area③. Based on these results, it is believed that the distribution of air dose rates in areas away from the monitoring posts is due to the presence of locations where decontamination has not been fully carried out or has not been performed at all.

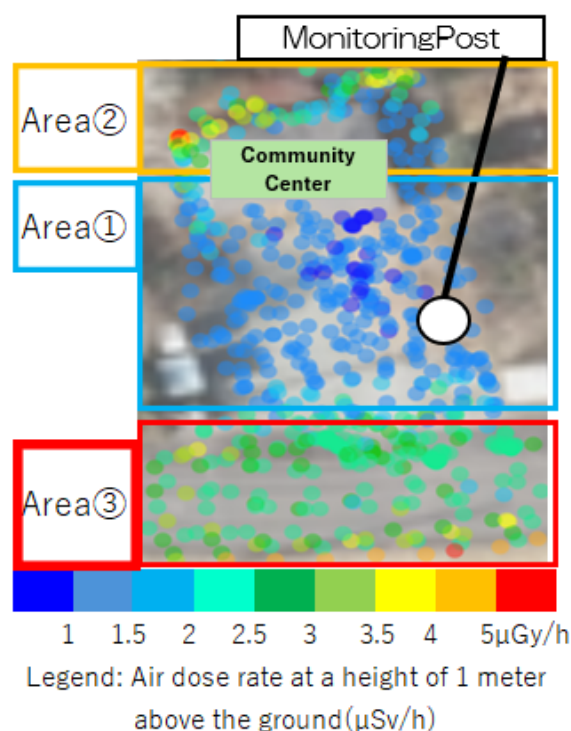


Figure 1. Map of ambient radiation dose rates after decontamination

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[1] M. Tanigaki et al., Nucl. Instrum. Meth. Phys. Res. 781 (2015) 57–64.

Determination of Chlorine and Bromine Concentration in Plastics in Construction Waste by Neutron Activation Analysis

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INTRODUCTION: In the recycling of waste plastic contained in construction waste (construction waste plastic), there are restrictions on chlorine concentration. However, the elemental composition varies from item to item, and this needs to be clarified. In this study, neutron activation analysis (NAA) was performed to analyze chlorine and bromine concentrations in 40 samples, including new plastic products and waste plastic samples provided by intermediate treatment facilities.

EXPERIMENTS: NAA was performed four times for each sample. Samples were irradiated for 3 min with a thermal neutron flux of $2.0\text{--}2.4 \times 10^{13} \text{ cm}^{-2} \cdot \text{sec}^{-1}$ at KURRI. ^{38}Cl ($t^{1/2} = 37.18 \text{ min}$, $E_\gamma = 1642, 2168 \text{ keV}$) and ^{80}Br ($t^{1/2} = 17.68 \text{ min}$, $E_\gamma = 616, 666 \text{ keV}$) were measured by using a Ge semiconductor detector for 300 sec.

RESULTS: Figure 1 shows the typical elemental composition of 40 samples of construction waste plastic obtained through NAA and various measurements. Chlorine and bromine are represented in blue and purple, respectively. Among the 22 building material items, high concentrations of chlorine were detected in 13 items, identifying them as PVC products. In contrast, among the 18 packaging and protection items, high chlorine concentrations were detected in only three items: PVC tape, flame-retardant sheets, and hoses. Since these specific items are easily distinguishable by visual inspection, these results suggest that packaging and protection waste has high recycling potential if these items are properly segregated.

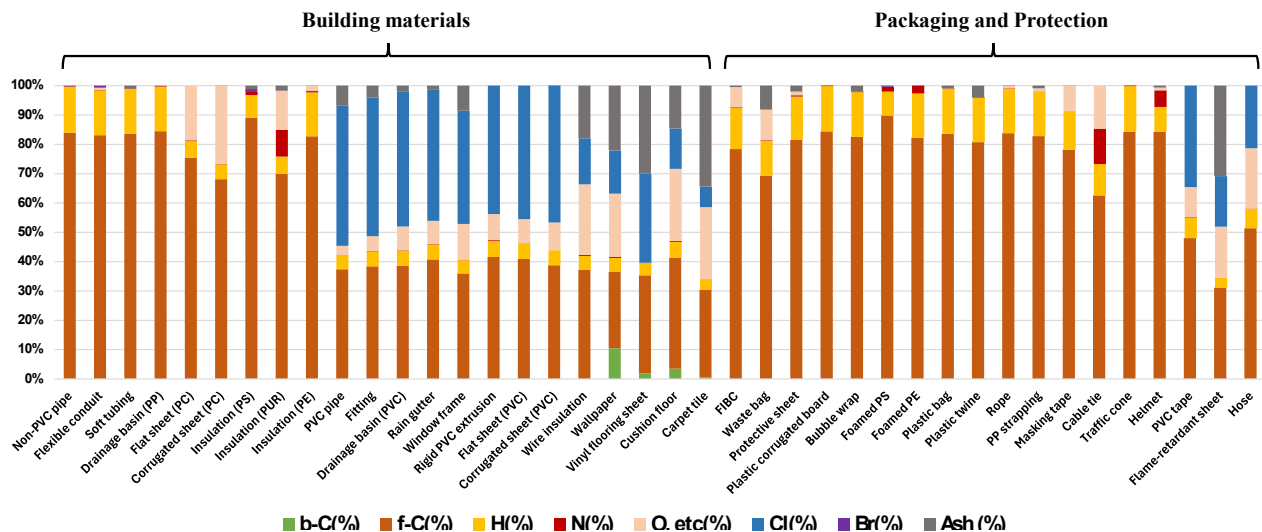


Fig.1. Histograms of chlorine concentrations

Among the building materials, soft PVC products (such as wire insulation, wallpaper, and cushion floor) showed lower chlorine concentrations compared to other PVC products. This is attributed to the high content of additives, such as plasticizers, in addition to the PVC resin itself.

Regarding bromine, concentrations of 0.3–1.0% were detected in only three items: flexible conduits, insulation (PS), and foamed PS. This is considered to be derived from additives used to impart flame retardancy.

Survey of air dose rate distribution around monitoring posts using KURAMA-II

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INTRODUCTION: In Fukushima Prefecture, monitoring posts (MPs) have been installed to monitor the nuclear power plant, and continuous measurements of air dose rates and other parameters are being conducted. Because radioactive nuclides released by the accident at the Fukushima Daiichi Nuclear Power Plant are present in the environment, the air dose rate measured at the MPs may fluctuate not only due to new releases from the plant but also due to environmental changes caused by construction work and other activities around the MPs. Therefore, if there is a significant fluctuation in the air dose rate measured by a particular MP, measuring the air dose rate distribution around the MP is also

considered useful for identifying the cause of the fluctuation. Since comparing the distribution of air dose rates with that prior to the fluctuation is an effective method for identifying the cause, we conducted a walking survey using a backpack-style KURAMA (Kyoto University Radiation Mapping system) -II [1] (Fig. 1) device to determine the distribution of air dose rates around MPs.

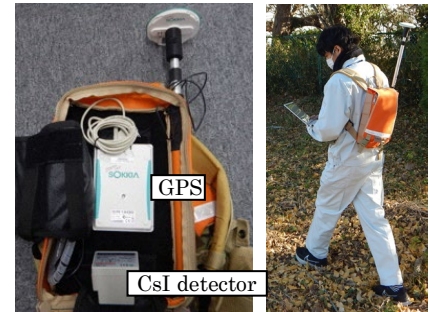


Fig. 1. KURAMA-II in a backpack.

EXPERIMENTS: A walking survey of the air dose rate was conducted by using KURAMA-II with a CsI (TI) scintillation detector (C12137-01, Hamamatsu Photonics) around the MP (an NaI(Tl) detector at 3 m height) at the Kiyohashi Disaster Prevention Community Center and its vicinity in Namie Town on December 11, 2025. The air dose rate along with the GPS data was recorded every second. The measurement route was basically the same as was in the measurement conducted on December 8, 2022. The measurement data were averaged in a 10-meter mesh and visualized to the colored air dose rate maps using GIS software (QGIS 3.44.8).

RESULTS: The air dose rate map is shown in Fig. 2 (a). The air dose rate ranged from 0.05 to 0.19 $\mu\text{Sv/h}$ (the MP air dose rate during the corresponding measurement period was 73 nGy/h). Fig. 2 (b) shows the air dose rate map generated from data collected in 2022 (the MP air dose rate during the corresponding measurement period was 77 nGy/h). Fig. 3 is the

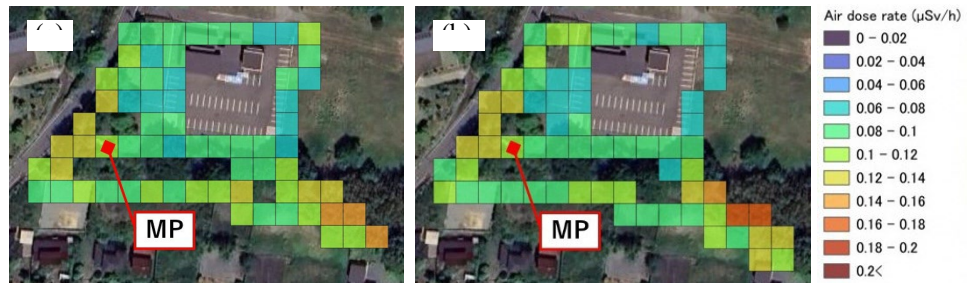


Fig. 2. The air dose rate maps obtained from measurements in (a) 2025 and (b) 2022.

rate of change for each mesh. The rate of change for each mesh generally fell between -25% to +25%. The present result shows that the distribution pattern doesn't change significantly over about 3 years. Given that artificial radionuclides with longer lifetimes persist in the environment in our prefecture and that air dose rates are expected to change over the long term, conducting such surveys regularly remains important.



Fig. 3. The rate of change for each mesh.

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[1] M. Tanigaki et al., Nucl. Instrum. Meth. Phys. Res. 781 (2015) 57-64.

Quantification of Trace Elements in Facility Components for Activation Assessment of the Large Helical Device (LHD)

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INTRODUCTION: Although the activation of particle accelerators has been widely recognized and extensively studied, little attention has been paid to the activation of other radiation-generating facilities. The Large Helical Device (LHD), a fusion experimental device, has previously been operated using deuterium plasma. Neutrons generated during the operation may have induced radioactive nuclides in stainless steel components of the vacuum vessel and in the concrete materials of the experimental hall. To evaluate the activation of the LHD facility, samples were collected from the device and the building materials, and trace elements were quantified by neutron activation analysis (NAA).

EXPERIMENTS: Approximately 100 mg of stainless steel was collected from the outer wall of the device using a drill. The collected material was finely cut and used as an irradiation sample. Similarly, approximately 100 mg of concrete was sampled, crushed into powder, and prepared for irradiation. JSS certified reference materials provided by the Iron and Steel Institute of Japan and GSJ reference materials provided by the Geological Survey of Japan were used as comparative standards. Neutron irradiation was carried out at the Kyoto University Research Reactor (KUR) under the conditions of 1 MW for 10 s and 5 MW for 30 min. Gamma-ray spectroscopy was performed for the irradiated samples using a germanium semiconductor detector.

RESULTS: Figure 1 shows the gamma-ray spectra of the stainless steel and concrete samples irradiated at 1 MW. For the stainless steel sample, ⁵⁶Mn was clearly detected, and several peaks originating from Ni were also observed. Based on these results, the material was estimated to be SUS316 stainless steel. For the concrete sample, peaks corresponding to ²⁴Na and ⁵⁶Mn were identified. The samples irradiated at 5 MW are currently under decay cooling, and quantitative analysis of activation products such as Co and Eu will be conducted in the near future.

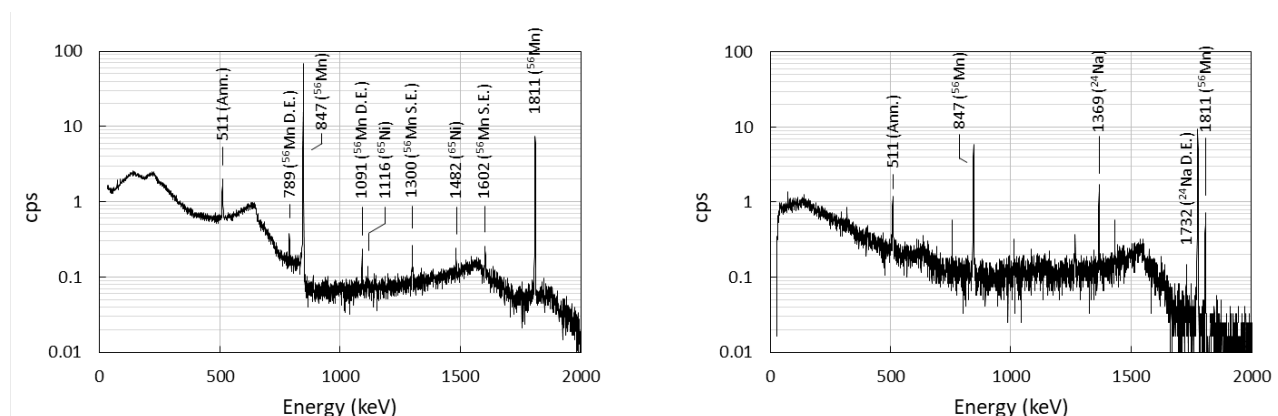


Fig. 1. γ -ray spectra of stainless-steel sample (left) and concrete sample (right) with irradiation of 1 MW - 10 s