

## <sup>222</sup>Rn Concentration of Soils at Selected Locations in Universiti Sains Malaysia Health Campus

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**ABSTRACT.** This study was determined the influence of radiation and non-radiation work activities over <sup>222</sup>Rn concentration levels in soil at selected areas in Universiti Sains Malaysia Health Campus. Radon Sentinel 1030 monitor was used to determine <sup>222</sup>Rn concentrations emanated from soil collected at Radiology Department and Nuclear Medicine Department (red areas), hospital lobby, hostel and Registry Department (public areas) and isolated area. Each reading was recorded within 30 min time intervals in a close perspex room for 5 consecutive days to obtain average <sup>222</sup>Rn concentrations reading. The results show the Radiology Department and hostel have obtained least amount of <sup>222</sup>Rn concentrations, which were 0.287 pCi/L and 0.246 pCi/L. Concentration of <sup>222</sup>Rn at Nuclear Medicine Department was 0.304 pCi/L, whereas 0.289 pCi/L in isolated area. Insignificant reading at Radiology and Nuclear Departments prove the proper application of radiation protection principle has been applied such as half value layer rule for wall thickness. Meanwhile, Registry Department and hospital building (public area) showed the highest concentration of <sup>222</sup>Rn which were 0.561 pCi/L and 0.462 pCi/L due to the natural environmental radiations that are mainly depending on geographical conditions, as the random properties of <sup>222</sup>Rn emanations cannot be controlled.

**Keywords:**  $\alpha$ -Particles, Radiation protection, Environmental radiations, Health implications;

*Received:* 15.10.2017, *Revised:* 15.12.2017, *Accepted:* 30.02.2018, and *Online:* 20.03.2018;

**DOI:** 10.30967/ijcrset.1.S1.2018.269-273

*Selection and/or Peer-review under responsibility of Advanced Materials Characterization Techniques  
(AMCT 2017), Malaysia.*

### 1. INTRODUCTION

Radon (<sup>222</sup>Rn) is one of the radioactive gases that contributes towards background radiations [1-2]. It is occurred naturally in the environment from the Uranium-238 decay series in the soil that originate from the Earth's crust. As the <sup>222</sup>Rn exists in soil, it will leave the soil grain by  $\alpha$ -recoil process and moves towards atmosphere [3]. Emanation of radon towards surrounding poses high risk for health due to the successively decay of their daughters of alpha ( $\alpha$ ) particles [1]. The inhalation of the gas and its decay products into the respiratory system will be absorbed by the lung tissues and unfortunately increases the risk of lung cancer and other health problems [2, 4-7]. Theoretically, the <sup>222</sup>Rn concentrations might be influenced by its location,

based on the activity that has been conducted such as mining industry and radiations work. Human-made of radioactive chemicals have enter the environment from activities such as mining and the use of radioactive materials in nuclear medicine, military, industrial applications, consumer products and nuclear power generation. The radiations most commonly emitted by radionuclides are alpha particles, beta particles and gamma rays. The radiation exposure is harmful to human health.

Through this research, we were revealed the  $^{222}\text{Rn}$  concentrations level of soils originated from six different locations and generally classified; a: red areas (radiation working areas; x-rays, ultrasound, unsealed radioactive sources), b: isolated area (no development and human activities area) and c: public areas (human activities area, building area, residential area). The data presented should be the base line in considering any radiation protection and initial awareness among the related group of people at related locations in Universiti Sains Malaysia Health Campus.

## 2. MATERIALS AND METHODS

This research work was conducted to determine the  $^{222}\text{Rn}$  concentrations among different locations of soil samples in Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia. In this study, soil samples were collected from six different locations and categorized into three general areas which are red, isolated and public areas. The samples were dried to reduce and remove the moisture into the soil as shown in Fig 1. Radon Sentinel 1030 monitor manufactured by Sun Nuclear Corporation, United State of America (USA) was used to measure the  $^{222}\text{Rn}$  concentrations emanated from the selected soils in a close perspex box as shown in Fig. 2.



**Fig. 1** Soil samples after drying process for  $^{222}\text{Rn}$  measurements collected from six different locations

Radon Sentinel 1030 monitor was setup to record  $^{222}\text{Rn}$  concentrations within 30 min time interval. Each soil sample was measured within 24 hours for 5 consecutive days. Hence, there were 240  $^{222}\text{Rn}$  data has been recorded for each sample. Average of  $^{222}\text{Rn}$  concentrations has been obtained using Eq. 1:

$$\text{Average } ^{222}\text{Rn} = \text{Cumulative } ^{222}\text{Rn} \text{ readings} / 240 \quad (1)$$

The average of  $^{222}\text{Rn}$  concentrations for each sample collected in red areas, public areas and isolated area have been presented in Table 1.



**Fig. 2** Radon Sentinel 1030 monitor was used to determine  $^{222}\text{Rn}$  concentrations level emanated from collected soil samples

### 3. RESULTS AND DISCUSSION

Registry Department and hospital building (public area) showed the highest concentration of  $^{222}\text{Rn}$  which was 0.561 pCi/L and 0.462 pCi/L as shown in Table 1 and plotted in Fig. 3. This is due to the natural environmental radiations that are mainly depending on geographical conditions, as the random properties of  $^{222}\text{Rn}$  emanations cannot be controlled [8].

**Table 1** Average of  $^{222}\text{Rn}$  concentrations obtained from soil sample at six selected locations.

Location of soil collected	Average of $^{222}\text{Rn}$ concentrations level (pCi/L)
Nuclear	0.304
Radiology	0.287
Hospital	0.462
Hostel	0.246
Registry	0.561
Isolated	0.289

In addition, the soil characteristics such as porosity at Registry Department is one of the major factor in emanating the higher  $^{222}\text{Rn}$  concentration. Thus,  $^{222}\text{Rn}$  was easily emanated from the sand and released to the surrounding through common ways [9]. Average concentration of  $^{222}\text{Rn}$  at Nuclear Medicine Department was 0.304 pCi/L since the soil sample was collected around the delay tank of radioactive waste. In this issue,  $\text{I}^{131}$  and  $\text{Tc}^{99\text{m}}$  were used as unsealed radioactive sources for patient treatment and the waste product were drained in the delay tank. The exposure rate decreased due to the attenuation by the wall of delay tank itself

[10]. In other way, good material selection to develop the tank wall might be one of the main factor in preventing the radiations to pass through.

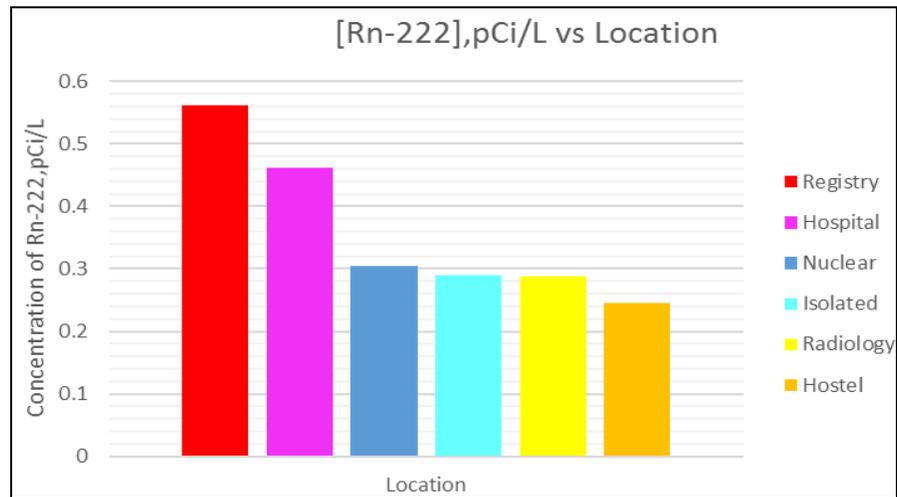


Fig. 3 <sup>222</sup>Rn concentrations level of soils based on selected locations

Meanwhile, average <sup>222</sup>Rn concentration in isolated area was 0.289 pCi/L, which is a little bit higher than red area. This is due to the presence of naturally occurred radioactive nuclides in soil such as Ra<sup>226</sup> and U<sup>238</sup>. Decay chain of these radioactive nuclide occurs with varying degrees of concentration (random) in earth crust [11-12]. However, concentration of <sup>222</sup>Rn in hostel was the least compared to the other places. This is due to the trapped air in one place. Slow movement of wind will carry the contaminated air and distribute towards environments.

Moreover, average of <sup>222</sup>Rn concentration at Radiology Department seems unexpected reading with lower record than unusual radiations area (isolated area) with 0.287 pCi/L. With heavily usage of x-ray modalities for medical diagnostic, the productions of  $\alpha$ -particle as secondary radiation due to material interactions with x-rays should be higher and expected to interfere the <sup>222</sup>Rn data has been obtained. Conversely, there are no significant results recorded which means the secondary particles has almost been prevented, but secondary x-rays and Compton scattering might be dominant.

#### 4. SUMMARY

Radiology Department and hostel showed the least amount of average <sup>222</sup>Rn concentrations, which were 0.287 pCi/L and 0.246 pCi/L. Theoretically, aggressive used of ionizing and non-ionizing modalities in the department should contribute to the higher <sup>222</sup>Rn measurements. However, the graph in Fig. 3 has shown insignificant findings at Radiology Department. This is due to the proper application of radiation protection principal such as half value layer of wall thickness in preventing the unwanted of wave and mostly particle radiations. Concentration of <sup>222</sup>Rn in hostel was the least compared to the other places. This is due to the trapped air in one place. Slow movement of wind will carry the contaminated air and distribute towards environments. Meanwhile, average <sup>222</sup>Rn concentration in isolated area was 0.289 pCi/L, which is a little bit higher than red area. This might be due to the presence of naturally occurred radioactive nuclides in soil such as Ra<sup>226</sup> and U<sup>238</sup>.

#### ACKNOWLEDGEMENT

This research has been conducted under Research Acculturation Grant Scheme (RAGS) awarded by Ministry of Higher Educations (MOHE) via Universiti Malaysia Kelantan with Grant Number:

R/RAGS/A08.00/01030A/001/2015/000217 and Short Term Research Grant Scheme (STRG) with Grant Number: R/SGJP/A08.00/00451A/001/2015/000241 awarded by Universiti Malaysia Kelantan.

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