Proceeding of 2nd International Science Postgraduate Conference 2014 (ISPC2014)

RADON AND THORON SURVEY IN HIGH BACKGROUND RADIATION AREA AT SEGAMAT, JOHOR

[1*] NUR AMIRA ABD WAHAB, [2]AHMAD TERMIZI RAMLI, [3]NOORDDIN IBRAHIM and [4]ISMAIL SULAIMAN

[1,2]Department of Physics, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[3]Centre for Research and Innovation Management, National Defence University of Malaysia, Sungai Besi Camp, 57000 Kuala Lumpur, Malaysia
[4]Health Physics Group, Radiation Health & Safety Division, Malaysian Nuclear Agency, Bangi, 43000 Kajang, Malaysia

[1*]iera_2709@yahoo.com.my , [2]ahmadtermizi@utm.my, [3]noorddin@upnm.edu.my, [4]ismail_sulaiman@nuclearmalaysia.gov.my

*Corresponding author

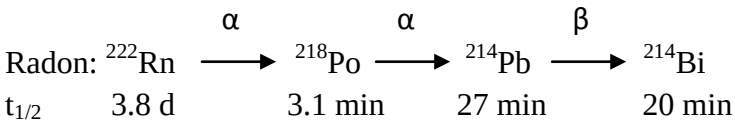
Abstract. This paper aims to present the preliminary data of radon (^{222}Rn) and thoron (^{220}Rn) in some high background radiation areas (HBRA) at Segamat, Johor. DOSEman PRO (SARAD GmbH, Germany) with grab sampling technique was used to measure the equilibrium equivalent concentration of radon (EEC_{Rn}) and thoron (EEC_{Tn}) in indoor and outdoor air during May-June 2013. Radon and thoron concentrations were monitored twelve hours every day in thirty-two locations at Segamat district. The value of EEC_{Rn} ranged from 0.37 to 69.26 Bq m^{-3}, with mean value of 13.59 Bq m^{-3} and 8.03 Bq m^{-3} for indoor and outdoor respectively. While measured values of EEC_{Tn} varied from 3.43 to 27.50 Bq m^{-3}, with mean value of 7.34 Bq m^{-3} and 7.21 Bq m^{-3} for indoor and outdoor respectively. In general, they received 3.56 mSv per year due to inhalation of radon and thoron, where indoor inhalation contribute until 2.92 mSv per year compare to only 0.64 mSv per year for outdoor.

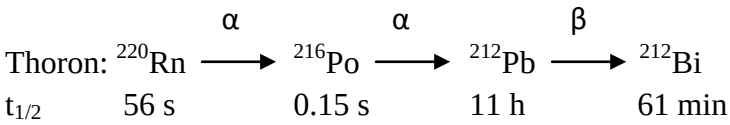
Keywords: Radon; Thoron; HBRA; Segamat; EEC; DOSEman PRO

1.0 INTRODUCTION

The exposure to natural radiation has become part of human's life. Humans are exposed to natural radiation via two routes; external and internal [1]. The external exposure due to gamma radiation comes from the terrestrial sources, mainly by ^{238}U and ^{232}Th series and ^{40}K and cosmic radiation. The internal exposure otherwise comes from the inhalation of radon and thoron and their short-lived decay products.

Radon (^{222}Rn) is produced by ^{226}Ra in the uranium (^{238}U) decay series and thoron (^{220}Rn) is produced by ^{224}Ra in the thorium (^{232}Th) decay series. These two radioactive gases decay to short-lived progenies as shown in decay series below. The inhalation of these progenies could cause internal exposure.





According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), inhalation of radon and thoron makes up until 50% of the total average worldwide exposure to natural radiation sources [2]. Moreover, from the total annual effective dose (1.25mSv) due to both radon and thoron, inhalation of radon alone is responsible for 92% of it or 1.15 mSv.

The respective dose contributed by the radon isotopes and its progeny are largely depend on the local geology or the ratio of the concentration of ^{238}U and ^{232}Th in the soils [3]. There are several areas in the world such as Brazil, China, India, Australia, France and Iran, where the background radiation levels were found to be high [1]. Palong, located in the Segamat district, northern part of Johor state, is well-known as a high background radiation area (HBRA). It is noticed that according to previous study that the ^{238}U and ^{232}Th content in soils is quite high due to the presence of monazite [4]. Therefore, from the viewpoint of radiation exposure, it is necessary and important to evaluate the contribution from radon and thoron.

2.0 MATERIALS AND METHODS

Radon and thoron measurements were performed by using DOSEman PRO, supplied by Malaysian Nuclear Agency. DOSEman PRO is an electronic radon dosimeter based on deposition of radon decay products on a semiconductor detector coupled with an alpha spectroscopy [5]. The equipment consists of an internal pump, a membrane filter on the top, an alpha spectroscope, an infrared adapter, a microprocessor, a Si-semiconductor and a battery [6].

The outdoor measurements have been made at thirty-two different locations in HBRA at Segamat in May-June 2013. The air was sampled twelve hours per day; starting from 7 in the morning and lasted at 7 in the evening. The time of each measurement was confined to 7 a.m. – 7 p.m. during the daytime to ensure more uniform experimental conditions. The measurement was made at a height of 1 meter above the ground.

After end of every sampling, data collected in the DOSEman PRO will be transferred into PC and the results were read by using Radon Vision software. Radon and thoron progenies concentration were given in milliWorking Level (mWL). These progenies concentrations were then converted to radon and thoron equilibrium equivalent concentration (EEC) using the following conversion factors given by UNSCEAR [2].

1 Bq m^{-3} = 0.27mWL for ^{222}Rn and

1 Bq m^{-3} = 3.64mWL for ^{220}Rn

3.0 RESULTS AND DISCUSSION

3.1 Concentration of radon and thoron

The results of EEC_{Rn} and EEC_{Tn} are summarized in Table 1. The EEC_{Rn} values were found to be in the range of 0.37 to 69.26 Bq m^{-3}, with mean value of 13.59 Bq m^{-3} indoor and 8.03 Bq m^{-3} outdoor. While measured values of EEC_{Tn} varied from 3.43 to 27.50 Bq m^{-3}, with mean value of 7.34 Bq m^{-3} indoor and 7.21 Bq m^{-3} outdoor. In general, the EEC_{Rn} reach the maximum value in the morning and minimum in the afternoon and evening. The graph pattern of indoor and outdoor EEC_{Rn} can be seen in Figure 1 and 2. In principle, the results of this study showed daily variations of concentrations similar to patterns observed worldwide [7, 8, 9].

EEC_{Tn} seems to have irregular pattern. This might be the decaying thoron does not reach up the height of the detectors because of its short half-life, which results in low values of thoron activity concentrations.

The indoor and outdoor EEC_{Rn} and EEC_{Tn} were observed to be below the worldwide average level, which is 40 Bq m^{-3} for radon and 10 Bq m^{-3} for thoron. [2]

Table 1. Statistical parameter of EEC_{Rn} and EEC_{Tn}.

Statistical parameter	EEC_{Rn} (Bq m^{-3})		EEC_{Tn} (Bq m^{-3})	
	Indoor	Outdoor	Indoor	Outdoor
Max	69.26	48.15	20.60	27.50
Min	2.59	0.37	3.43	*BDL
Mean	13.59	8.03	7.34	7.21

*BDL (below detection limit)

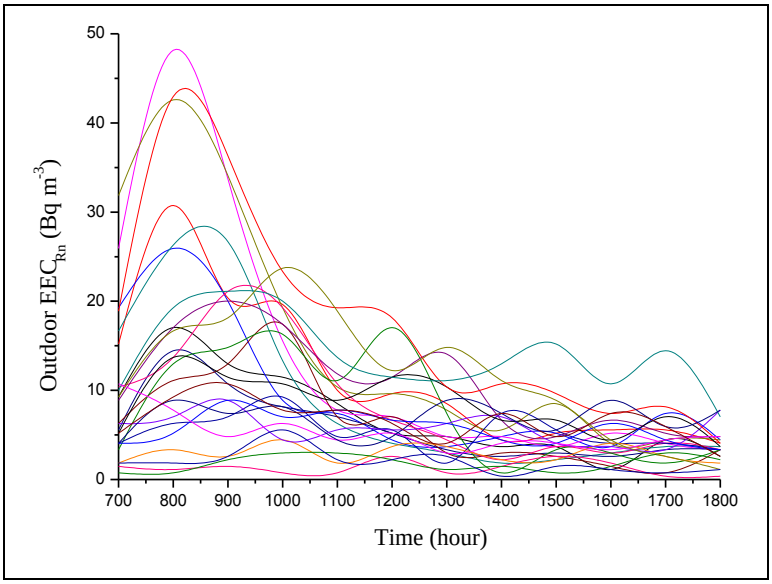


Figure 1. Twelve hours (half day) outdoor EEC_{Rn} pattern

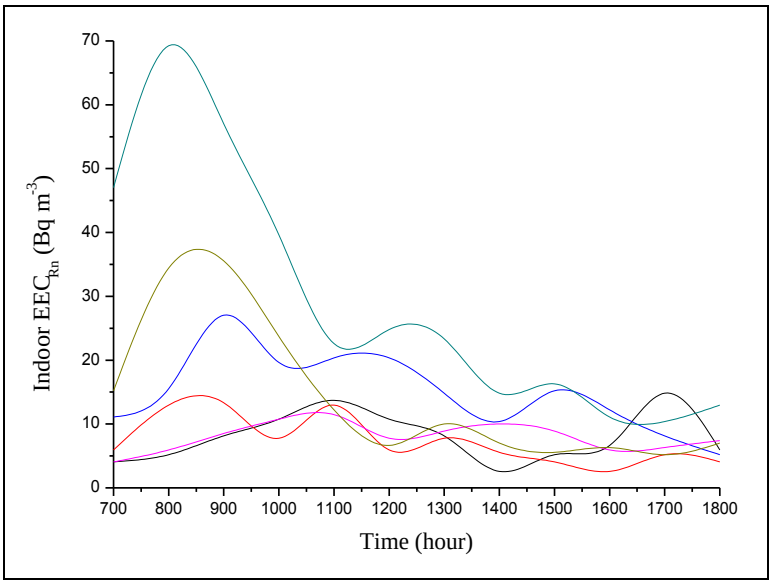


Figure 2. Twelve hours (half day) indoor EEC_{Rn} pattern

3.2 Effective dose

In order to estimate the annual effective dose received by the public, it was assumed that people exposed for 365 days a year. The UNSCEAR conversion factors i.e occupancy factor 0.2 for outdoor and 0.8 for indoor, dose conversion factor of 9 nSv $h^{-1}(Bqm^{-3})^{-1}$ (radon progenies) and 40 nSv $h^{-1}(Bqm^{-3})^{-1}$ (thoron progenies) were used [2]. The estimated effective dose due to inhalation of radon and thoron is shown in Table 2.

Table 2. Estimated annual effective dose from radon and thoron

Sources of exposure	Dose (mSv)	
	Indoor	Outdoor
Radon	0.86	0.13
Thoron	2.06	0.51
Total internal	2.92	0.64

The inhabitants of Palong received 3.56 mSv per year due to inhalation of radon and thoron. From the table above, it shows that indoor inhalation contribute 80% of the total dose and from the total indoor exposure, thoron makes up until 2.06 mSv per year. This may be due to high concentration of thorium compared to uranium in soils found in this area. Furthermore, as expected, the populations of Segamat who live in

HBRA received the dose higher than normal area [10]. Further study is suggested to verify those results, considering the meteorological factors and indoor condition.

4.0 CONCLUSION

The indoor and outdoor radon and thoron measurement in high background radiation area at Segamat has been performed in May-June 2013. The value of EEC_{Rn} ranged from 0.37 to 69.26 Bq m^{-3}, with mean value of 13.59 Bq m^{-3} and 8.03 Bq m^{-3} for indoor and outdoor respectively. While measured values of EEC_{Tn} varied from 3.43 to 27.50 Bq m^{-3}, with mean value of 7.34 Bq m^{-3} and 7.21 Bq m^{-3} for indoor and outdoor respectively. The total annual effective dose due to inhalation of radon and is 3.56 mSv y^{-1}. The populations of Segamat who live in HBRA received the dose higher than in normal area [10]. The radiological study is suggested to assess the possible health risk arising from inhalation of radon and thoron.

ACKNOWLEDGEMENT

The authors greatly appreciate the financial support from Universiti Teknologi Malaysia through vote, 00H70 and Ministry of Higher Education (MOHE) through MyBrain15 scholarship. We highly appreciate the Malaysian Nuclear Agency for the instrument and guidance. We are also grateful to the residents of Segamat for their kind help and cooperation during field survey.

REFERENCES

[1] Jayanthi, D.D., Maniyan, C.G. and Perumal, S. (2011). Assessment of indoor radiation dose received by the residents of natural high background radiation areas of coastal villages of Kanyakumari district, Tamil Nadu. India. *Radiation Physics and Chemistry.* 80. 782-785.

[2] UNSCEAR, 2000. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), Annex B: Exposure from natural radiation sources, United Nations, New York.

[3] Bhatt, C.R. (2011). *Radon exposure in a thorium rich area in Norway.* Master's thesis. Norwegian University of Life Science.

[4] Ramli, A.T., Hussein, A.W.M.A. and Wood, A.K. (2005). Environmental ^{238}U and ^{232}Th concentration measurements in an area of high level natural background radiation at Palong, Johor, Malaysia. *Journal of Environmental Radioactivity.* 80 (3), 287-304.

[5] Streil, T., Oeser, V. and Feige, S. (2002). An electronic radon dosimeter as a new multipurpose device – a bridge between dosimetry and monitoring. Geofísica Internacional. 41 (3). 285-288.

[6] SARAD GmbH. (2007). Manual DOSEman PRO Version 03. Dresden, Germany.

[7] Singh, K., Singh, S., Mehra, R., Singh, M., Sahota, H.S. and Papp, Z. (2006). Measurement of radon and thoron progeny outdoors in Malout, India, using grab aerosol sampling and beta counting. Radiation Measurements. 41 (). 108-11.

[8] Seftelis, I., Nicolaou, G., Trassanidis, S. and Tsagas, F.N. (2007). Diurnal variation of radon progeny. *Journal of Environmental Radioactivity*. 97, 116-123.

[9] Singh, K., Singh, M., Singh, S., Sahota, H.S. and Papp, Z. (2005). Variation of radon (^{222}Rn) progeny concentrations in outdoor air as a function of time, temperature and relative humidity. *Radiation measurements.* 39, 213-217.

[10] Sulaiman, I. and Omar, M. (2010). Environmental radon/thoron concentrations and radiation levels in Sarawak and Sabah. Journal of Nuclear and Related Technology. 7 (1). 1-13.