Volume 10, Number 3, 2017. pp. 139-141

Jordan Journal of Physics

ARTICLE

Assessment of Indoor Radon Levels in Selected Locations within Lagos State University, Ojo, Lagos

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Received on: 9/2/2017; *Accepted on: 31/7/2017*

Abstract: An indoor radon measurement survey was carried out in eleven offices in the campus of Lagos State University, Ojo, Nigeria using Pro series 3, radon gas detector model HS71512. The main objective of this survey was to estimate radiation doses received by the dwellers of these offices due to indoor radon exposure. For this research, radon detectors were suspended, where the ventilation slits will not be blocked at least 1.2m above the floor, a height in the breathing zone of a seated person, for 48 hours. The values of indoor concentration vary from 3.70 Bq/m^3 to 218.30 Bq/m^3 with an average value of 84.04 Bq/m^3. The value of effective dose varies from 0.08 mSv to 3.76 mSv with an average value of 1.45 mSv.

Keywords: Indoor radon concentration, Effective dose, Average effective dose.

Introduction

Naturally occurring radon originates from the presence of radium in soil and rocks. It is generated within the mineral grains by alpha decay of radium, which migrates from the solid mineral and grains into the air through pores in the soil or ground water [1]. Radon is a chemical element having the symbol ^{222}Rn and the atomic number 86. It is a radioactive, colorless, odorless and tasteless noble gas occurring naturally as an indirect decay of uranium [2].

Radon has a half-life of about 3.8 days (91hrs and 10min), a density of 9.73 kg/m^3 and is one of the densest gases at room temperature (25^{o}C). Radon is soluble in water but more soluble in organic solvents. Under normal condition, Rn is a radioactive isotope, which makes it a health hazard due to radioactive reactions [1-2].

Radon is naturally occurring as radioisotope and is about 55% main source of internal radiation exposure [3]. 1mSv of the 2.4mSv estimated average annual effective dose value is due to radon exposure [4]. Radon concentration in air varies in accordance with location, height, material of the built houses, ventilation rate at homes and meteorological parameters [5-8].

A combined analysis of lung cancer mortality among 11 cohorts of underground miners confirmed that high levels of exposure to radon are associated with increased lung cancer risk.Cellular mutagenesis studies, experimental research in animals and occupational epidemiologic studies have established radon as a human lung carcinogen [9]. Several studies have been carried out on indoor radon in various parts of the world [7, 10, 11].

Potential hazard of exposure to radon gas radiation from natural background, e-waste, dumpsites, quarries, underground water, building materials and cracks in walls, among others, cannot be underestimated.

Despite the associated hazards of radon, it is used as tracer in studying indoor and outdoor air

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and investigating atmospheric conductivity and mobility spectra. Research on radon inhalation and ingestion in Africa and the developing countries is still minimal.

The present research was carried out at the campus of Lagos State University, Ojo, Nigeria (situated at 6.4677°N and 3.180°E) to provide information on radon concentration levels and risk of lung cancer in some offices at the campus. Radon concentration level was measured in 11 offices within the vicinity of the university. The choice of the offices was strategically pre-determined with respect to natural potential factors that influence concentration level, yet all occurring in the most natural conditions.

Material and Methods

In this study, an active electronic device (Pro series 3, radon gas detector) was employed for the measurement of indoor radon in 11 offices in the above-mentioned university. The detector measures radon in picocuries per litre (pCi/L). It was pre-caliberated to measure radon activity between 0.0 and 999.9pCi/L and measured values were converted to Bq/m^3 by multiplying the measured value by 37.

Pro series 3 radon gas detector was designed to take samples for 48 hours before an accurate result can be displayed. For the same location, the readings are updated every hour and new values of indoor radon concentration are consequently displayed if the concentration of radon differs from the initial stored value previously determined from the 48-hour sampling. Radon samples were classified based on WHO, 2009 handbook on indoor radon.

Sampling Procedure

Sampling was conducted in eleven offices containing the same building materials and having the same dimensions and geographical age. The dimensions of the offices were within a floor area of 21m^2, a gross volume of 63m^3 and a net volume of about 56.38m^3 (obtained by subtracting the volume of fixture). Natural ventilation conditions involving opening of windows and doors were employed during the period of measurement.

The radon gas detector was suspended where the ventilation slits will not be blocked and such that it was at least 1.2m above the floor, a height in the breathing zone of a seated person. The detector was at least 0.9m from windows, doors or any other potential openings in the exterior walls. No objects were placed within 0.1m from the detector. These positions, which were fixed throughout this work, were maintained, since it was shown that radon level depends remarkably on the sampling position. These procedures were followed according to the research work conducted by [12].

Results and Discussion

The annual average radon concentration, average effective dose, lifetime fatality risk and excess lifetime cancer risk for each study location have been calculated as shown in Table1.

TABLE 1. Radon concentration and annual effective dose.

S/N	Sampling Points	Radon Concentration (pCi/L)	Radon Concentration (Bq/m^3)	Annual Exposure WLM	Lifetime Fatality Risk X10^{-4}	Annual Effective Dose (mSv)	ELCR
1	OF1	4.60	170.20	0.76	2.28	2.95	11.36
2	OF2	5.90	218.30	0.97	2.91	3.76	14.48
3	OF3	0.10	3.70	0.02	0.06	0.08	0.31
4	OF4	0.20	7.40	0.03	0.09	0.12	0.46
5	OF5	1.50	55.50	0.25	0.75	0.97	3.73
6	OF6	0.40	14.80	0.06	0.18	0.23	0.89
7	OF7	5.20	36.40	0.16	0.48	0.62	2.39
8	OF8	1.70	62.90	0.28	0.84	1.09	4.20
9	OF9	4.80	177.60	0.79	2.37	3.07	11.82
10	OF10	4.30	159.10	0.71	2.13	2.75	10.59
11	OF11	0.30	18.50	0.08	0.24	0.31	1.19

The values of indoor concentration vary from 3.70 Bq/m^3 to 218.30 Bq/m^3 with an average value of 84.04 Bq/m^3. Radon concentration was used to calculate the annual exposure in working level months (WLM) using the following equation [15]:

$$\text{Annual Exposure (WLM)} = \frac{FC_O}{3700}\,\frac{t}{170} \qquad (1)$$

where t = 8760h/y is the number of hours per year, C_O is the radon concentration in Bq/m^3 and F is the equilibrium factor (0.4).

The conversion factors of 3 x 10^{-4} WLM and 3.88 mSvWLM [3] are used for calculating the lifetime fatality risk and the annual effective dose, respectively. The value of effective dose varies from 0.08 mSv to 3.76 mSv with an average value of 1.45 mSv, while the excess lifetime cancer risk (ELCR) is given as:

$$\text{ELCR} = \text{AEDE} * \text{DL} * \text{RF} \qquad (2)$$

where AEDE, DL and RF are the annual effective dose, duration of life of 70 years and risk factor of 0.05, respectively.

Conclusion

In this study, radon concentration levels in some offices in Lagos State University, Ojo were measured with the average radon concentration higher than the world average radon concentration of 40 Bq/m^3 [13]. This might be as a result of low air flushing, ventilation and location of these offices, since the higher the elevation in a building, the lower the radon level [14] and that higher concentration of radon are present in basement and ground floor buildings. Furthermore, radon operates through the process of diffusion, where the farther from the contact source the lower the concentration of radon.The radiological implication of these values should not be ignored and periodical studies of offices should be carried out for monitoring and proactive actions taken.

References

[1] Mehra, R. and Bala, P., Pelagia Research Library, 4(1) (2013) 212.

[2] Kant, K., Upadhyay, S.B., Sharma, G.S. and Chakervarti, S.K., Iran J. Radiat. Res., 1(4) (2004) 181.

[3] ICRP, "Protection against Radon-222 at Home and at Work". International Commission on Radiological Protection, (Oxford: Pergamon Press, ICRP Publication No.65, 1993).

[4] UNSCEAR, "Sources, Effects and Risks of Ionizing Radiation", United Nations Scientific Committee on the Effects of Atomic Radiation, Report to the General Assembly, (United Nations, New York, 2000).

[5] Salih, L.M., Journal of Al-Nahrain University, 17(3) (2014) 94.

[6] Mustapha, A.O., Alatise, O.O., Okeyode, I.C., Makinde, V., Akinyemi, O.D., Akinboror, F.G., Rabiu,A.J., Dawodu, G.A., Gbadebo, A.M., Olaoye, M.A., Okedeyi, A.S. and Al-Azmi, D., Proceedings of an International Symposium, Beijeng, China, (2013) 645-651.

[7] Obed, R.I., Lateef, H.T. and Ademola, A.K. Journal of Medical Physics, 35(4) (2010) 242.

[8] Quarto, M., Pugliese, M., La Verde, G., Loffredo, F. and Roca, V., Int. J. Environ. Res. Public Health, 12 (2015) 14948.

[9] Krewski, D., Lubin, J.H., Zielinski, J.M., Alavanja, M., Catalan, V.S., William Field, R. and Sandler, D.P., Journal of Toxicology and Environmental Health, Part A, 69(7-8) (2006) 533.

[10] Rahman, S., Faheem, M., Rehman, S. and Matiullah, Radiat. Prot. Dosimetry, 121 (2006) 333.

[11] Virk, H.S. and Sharma, N., Proceedings of Fifth International Conference on High Levels of Natural Radiation and Radon Areas: Radiation Dose and Health Effects. Germany: Munich, (2000) 193.

[12] Oni, O.M., Isola, G.A., Oladapo, O.O. and Oni, E.A., Research Journal of Environmental and Earth Sciences, 4(1) (2012) 131.

[13] World Health Organization, WHO Handbook on Indoor Radon: A Public Health Perspective (Internet). Geneva, WHO, 2009. http://whqlibdocwho.int/publications/2009/9789241547673_engpdf.

[14] Shirav, M. and Vulkan, V., Environ. Geol., 31(3–4) (1997) 167.

[15] Mansur, H.H., Radiation Measurement, 40 (2005) 544.