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Advances in Applied Science Research, 2018, 9(2):75-78

ISSN : 0976-8610
CODEN (USA): AASRFC

Indoor Radon Levels and the Associated Effective Dose Rate Determination at Al-Elaf Distinguish Secondary School for Girls in the Basrah Governorate, Iraq

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ABSTRACT

Study of indoor radon has been carried out in Al Elaf Distinguish Secondary School for Girls in Basrah Governorate, south of Iraq, using LR-115 type II solid state nuclear track detectors (SSNTDs). Indoor radon has become a great concern worldwide due to its health hazard effects on population. Lung cancer risk depends upon the concentration of radon and their decay products in air above action level. In the present study the value of concentration of radon ranges from 28 to 128 Bq.m^{-3} with an average value of 57 Bq.m^{-3}. The Potential of Alpha Energy Concentration (PAEC) in terms of mWL ranges from 3.03 to 13.84 with an average value of 6.19. The annual exposure in terms of WLM ranges from 0.04 to 0.16 with an average value of 0.07. The annual effective dose ranges from 0.14 - 0.63 mSv.y^{-1} with an average value of 0.28 mSv.y^{-1}. All these values are within the acceptable level.

Keywords: Indoor radon, Annual effective dose, LR-115 type II detector, Radon concentration, PAEC.

INTRODUCTION

Radon is a naturally occurring odourless, colourless, tasteless and chemically inert gas and radioactive in all of its isotopes, which is imperceptible to our sense. Radon-222, is produced continuously from ^{226}Ra in the decay series of ^{238}U, being the most important radon isotope in terms of radiation exposure, is measured in different environments to determine its contribution to human radiation exposure. Rn-222 contributes about 55% of the annual radiation dose to the general population [1]. The measurement of radon in human's environment is of interest because of its emitting nature of alpha particles. Radon decays with a half-life of 3.825 days into a series of short-lived daughter produced out of which ^{218}Po and ^{214}Po emit high-energy alpha particles which are highly effective in damaging tissues. Inhalation of these radionuclides represents the main source of exposure to ionizing radiation for population in most countries [2]. Nationwide measurements of radon activities in the indoor air of dwellings are continuously presented all over the world. As gases the isotopes are mobile and carry messages over significant distances within the earth and in the atmosphere, but, on the other side, inhalation can be a problem to health [3].

The fact that radon, when inhaled during breathing, can cause lung cancer in human beings is known since a long time ago. Studies on underground miners have shown an increased risk of lung cancer after exposure to high doses of radon and radon daughters [4].

At sufficiently high concentrations, radon and it's a particle-emitting decay product (polonium-214, polonium-218) have been shown to cause lung cancer among underground miners, especially those who smoke cigarettes. There is concern that residential exposures might be responsible for a considerable number of lung cancer deaths in the general population [5]. Long-term exposure to elevated indoor radon concentrations has been determined to be the second leading cause of lung cancer in adults after tobacco smoking [6].

Radon exposure variability seems to be affected by several factors: soil temperature, soil permeability, moisture state, temperature differences between the interior and exterior of buildings, air pressure variations, materials used for building constructions and the degree of ventilation of closed environments, among the most important. The concentration of indoor radon also depends on the ventilation rate of the dwellings. It is important to note that a reduced ventilation rate helps enhance the concentration of radon and its progenies in the air [7].

The sources of indoor radon are soil adjacent to house, earth-based building materials, domestic water, outdoor air and natural gas. However, the soil and building materials are considered as mainly responsible for indoor concentration as other sources generally contribute only a fraction of total indoor activity [8].

The radon gas can enter the body via respiring, drinking and eating. The alpha particles emitted by radon gas and other radiations emitted by its daughter products increase the absorbed dose in respiratory and digestion systems. Since people spend so much of their time indoors, indoor air is the predominant source for exposure to pollutants. More than half of the body's intake of airborne material during a lifetime is the air inhaled in the home. Thus, most illness related to environmental exposures stem from indoor air exposure [9].

The knowledge of radon levels in dwellings is important in assessing population exposure. Indoor radon concentrations are almost always higher than outdoor concentrations. Once inside a building, the radon cannot easily escape. The sealing of buildings to conserve energy reduces the intake of outside air and worsens the situation. Radon levels are generally highest in cellars and basements because these areas are nearest to the source and are usually poorly ventilated. Radon can seep out of the ground and build up in confined spaces, particularly underground, e.g. in basements of buildings, caves, mines, etc., and ground floor buildings. High concentrations can also be found in buildings because they are usually at slightly lower pressure than the surrounding atmosphere and so tend to suck in radon (from the soil) through cracks or gaps in the floor.

METHODS

The method involved exposure of the film to the indoor environment for a known period, during which the alpha particles from radon and its progeny, typically ^{218}Po and ^{218}Po which generally attach themselves to the aerosols, would leave tracks on the film. LR-115 type II solid state nuclear track detectors (SSNTDs) were employed for measuring the radon concentration. The detector films having a size of ~1.5 cm × 1.5 cm were fixed on slides and then these slides were mounted on the walls in different classes, laboratories and rooms in the school, at a height of about 2m from the ground with their sensitive surface facing the air, in bare mode, taking due care that there was nothing to obstruct the detectors within a hemispherical volume of radius 9.1 cm in front of them.

After the exposure of detectors these detectors were removed and etched in 2.5 NaOH for 2 h in a constant temperature bath (60± 1 C°) and after a thorough washing, they were scanned for track density measurements using optical microscope at a magnification of 400×. All α-particles that reach the LR-115 type II SSNTDs with a residual energy between (1.6-4.7) MeV are registered as bright track holes [10].

An unexposed film of the LR-115 was also etched and scanned for the determination of background track density of the film. This background track density was found to be very small and was subtracted from the observed value of the readings. The potential alpha energy concentration (PAEC) was used to estimate the lung dose for inhalation of radon and its progeny. The potential alpha energy concentration was determined using the following expression:

$$C_p(WL) = \frac{\rho}{k.t}$$

where ρ is the track density (number of tracks per cm^2) obtained after subtracting the background, K is the sensitivity factor or calibration factor, which is the quantity used for converting the observed track density rates to working level (WL) concentration of radon progeny. Calibration factors has been determined by many authors experimentally as well as theoretically for all types modes of exposures, preferably found by a calibration experiment using a standard radon chamber and t is the total time of exposure. Calibration factor was found by simulating the environmental conditions in the Environmental Assessment Division of Bhabha Atomic Research Centre. A calibration factor of 625 tracks/cm^2.d^{-1} per WL was used for evaluating the working level (WL) concentration of radon progeny [11].

The radon concentrations in Bq.m^{-3} were calculated by using the following relation [12]:

$$C_{Rn}(\mathrm{Bq.m^{-3}}) = \frac{3700 \times WL}{F}$$

Where F is the equilibrium factor, the value of F was taken to be 0.40 as recommended by UNSCEAR [13].

The annual exposure to potential alpha energy Ep (effective dose equivalent) is then related to the average radon concentration C_{Rn} by following expression [14]:

No.	Floor	Room	$T.cm^{-2}.d^{-1}$	PAEC (mWL)	$^{222}Rn\ Bq.m^{-3}$	Annual exposure of ^{222}Rn (WLM/y)	Annual effective dose (mSv/y)
1	Ground	Room Service	4.94	7.90	73	0.09	0.36
2		Teacher's room	4.24	6.78	63	0.08	0.31
3		Room 3	3.69	5.91	55	0.07	0.27
4		Room 4	3.73	5.97	55	0.07	0.27
5		Room 5	2.98	4.77	44	0.06	0.22
6		Room 6	4.54	7.26	67	0.09	0.33
7		Store 1	7.47	11.9	111	0.14	0.55
8		Store 2	8.65	13.8	128	0.16	0.63
9		Lab. of English	3.04	4.87	45	0.06	0.22
10		Lab. of physics	3.18	5.10	47	0.06	0.23
11		Class 6	5.05	8.08	75	0.10	0.37
12	First	Class 1	1.89	3.03	28	0.04	0.14
13		Class 2	2.40	3.85	36	0.05	0.18
14		Class 3	2.77	4.44	41	0.05	0.20
15		Class 4	2.32	3.72	34	0.04	0.17
16	Second	Class 1	4.65	7.43	69	0.09	0.34
17		Class 2	1.94	3.10	29	0.04	0.14
18		Class 3	2.01	3.22	30	0.04	0.15
19		Class 4	4.01	6.42	59	0.08	0.29
Av.				6.19	57	0.07	0.28
Max.				13.84	128	0.16	0.63
Min.				3.03	28	0.04	0.14
S. D.				2.88	27	0.03	0.13

Table 1: Values of indoor radon concentration in Al-Elaf distinguish school.

$$E_p(WLM.y^{-3}) = \frac{T \times n \times F \times C_{Rn}}{170 \times 3700}$$

T: is the indoor occupancy time (24 h × 365 = 8760 $h.y^{-1}$)

n: is the indoor occupancy factor equal to (0.8) for dwelling and (0.2) for workplaces.

The effective dose received by the bronchial and pulmonary regions of human lungs has been calculated using a conversion factor of 3.88 mSv/WLM [1].

RESULTS AND DISCUSSION

Table 1 represents the measurements made for PAEC values of radon daughters in WL units, radon concentration in $Bq.m^{-3}$, Annual exposure in WLM and annual effective dose in $mSv.y^{-1}$ to the occupant of at Al-Elaf distinguish secondary school for girls in Basrah Governorate. For the present study where the observation was taken from February to March, 2018. The PAEC obtained values vary from (3.03 to 13.84) mWL with an average value of 6.19 mWL. The significant value of radon activity varies from 28 to 128 Bqm^{-3} with an average value of 57 Bqm^{-3}. Annual exposure varies from 0.04 to 0.16 WLM with an average value of 0.07 WLM. Annual effective dose varies from 0.14 to 0.63 $mSv.y^{-1}$ with an average value of 0.28 $mSv.y^{-1}$. Results show higher indoor radon levels and radon effective does especially in stores as compared to other locations in the school. High values of radon activity may be due to poor ventilation rate. Radon concentration was found to be lowest in class 1 in the first floor. The change values of radon activity in other rooms may be due to ventilation conditions or the type of building materials.

The main object of this measurement was to see indoor radon level and its daughters. The International Commission on Radiation Protection has recommended that remedial action against radon and its progeny is justified above a continued effective dose of 3-10 $mSv.y^{-1}$ has been proposed [1]. The action level for radon activity should be in the range 200-300 $Bq.m^{-3}$ [15]. The measured values are below the recommended ICRP action levels (Table 1).

CONCLUSION

In the above study we have calculated the values of indoor radon and annual effective dose due to their progenies in the indoor environment of the school. Effective dose has also been calculated for the occupants of these school. The conclusions of the present study are as follows:

- The overall average value of radon in the present study (28-128 Bq.m^{-3}) is found higher than the average value of 40 Bq.m^{-3}, for the dwellings worldwide [13].
- This may be due to the difference in the concentration of radioactive elements, viz. uranium, thorium and radium in the soil and building materials of the study area, ventilation rate, and the method of air-conditioning.
- However, most of these rooms have radon concentration below the level of concern, i.e., 150 Bq.m^{-3} [16] while none of them have a value higher than the action level 200–300 Bq.m^{-3}, recommended by Jyoti Sharma et al. 14].

So, it does not require taking any action to reduce the radon concentration in these places in school under study. The values of annual effective dose in the school, for Occupants (0.43-0.90 mSv/y) found less than the worldwide average radiation dose of 2.4 mSv/y [16], and less than the lower limit of action level (3-10) mSv/y recommended by ICRP [14]. Radon is accumulating in indoor, so it must be well ventilated.

REFERENCES

[1] ICRP, International Commission on Radiological Protection. Protection against radon-222 at home and at work, ICRP publication 65, *Ann ICRP,* **1993,** 23.

[2] Jonsson G. Indoor 222Rn measurements in Sweden with the solid-state nuclear track detector technique. *Health Phys*, **1988,** 54, 271-281.

[3] Banjanac RA. Dragic B, Grabez D, Jokovic, D, Markushev B, et al. Indoor radon measurements by nuclear track detectors: Applications in secondary schools UDC 53+504.055. *Physics Chem & Tech*, **2006,** 4: 93-100.

[4] Wichmann HE, Schaffrath Rosario A, Heid IM, Kreuzer M, Heinrich J, et al. Increased lung cancer risk due to residential radon in a pooled and extended analysis of studies in Germany. *Int Cong Ser,* **2005,** 1276, 54-57.

[5] Jay H, Lubin P, Zhonghua L, Zdenek H, Goran P, et al. Radon exposure in residences and lung cancer among woman: combined analysis of three studies. *Can Causes Conl.* **1994,** 5: 114-128.

[6] WHO. Handbook on Indoor Radon, whqlibdoc.who.int/publications /2009/9789241547673-eng.pdf, **2009.**

[7] Mehra R, Bala P. Estimation of Annual Effective Dose of 222 Rn and 220 Rn in indoor Air of Rohilkhand region, Uttar Pradesh state, India. *Adv in App Sci Res,* **2013,** 4: 212-215.

[8] Sharma N, Virk HS, Sharma N, Virk HS. Exhalation rate study of radon/thoron in some building materials, *Rad Mes*, **2001,** 34L 467-469.

[9] Komal B, Rohit M, Sonkawade RG. Estimation of indoor radon, thoron and their decay products' concentrations along with annual inhalation dose in dwellings of Punjab, India. *Indoor Built Environ,* **2012,** 21: 601-606.

[10] Misdaq MA, Mortassim A. Radiation protection dosimetry, **2008,** 130: 115-118.

[11] Shakir Khan M, Naqvi AH, Azam A. Measurement of effective radium content of sand samples collected from Chhatrapur beach, Orissa, India using track etch technique. *Rad Mes.* **2008**, 43: 385-388.

[12] Mahur AK, Kumar R, Jojo PJ, Prasad R. Radiation protection and environment. **2005,** 28: 203-205.

[13] UNSCEAR. United Nations Scientific Committee on the Effects of Atomic Radiation: Sources and effects of ionizing radiation United Nations, New York, USA. **2000,** 1.

[14] Jyoti Sharma AK, Mahur RK, Rati Varshney RG. Sonkawade R. Swarup K, et al. The study of electrical conductivity and magneto potential records on gold containing (G-3 and G-4) minerals of Bundelkhand under MRF-excitations, *Adv in App Sci Res,* **2012**, 3: 1085-1091.

[15] ICRP. International Commission on Radiological Protection, statement on radon. Ref00/902/09, *ICRP,* **2009,** 23(2): 1.

[16] UNSCEAR Report. Summary of low-dose radiation effects on health. United Nations. United Nations Publication, New York, USA, **2010.**