Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2012, 3 (3):1262-1265

Pelagia Research Library

ISSN: 0976-8610
CODEN (USA): AASRFC

Indoor radon levels in some dwellings surrounding the National Thermal Power Corporations (NTPCs), India

Mamta Gupta[1,2]*, A. K. Mahur [3] and K. D. Verma[1]

[1]Department of Physics, S. V. (P. G.) College, Aligarh, India
[2] Department of Physics, NIEC, New Delhi, India
[3]Vivekananda College of Technology and Management, Aligarh, India

---

ABSTRACT

Fly ash from a thermal power plant is spread and distributed in the surrounding area by air and may be deposited on the soil of the region surrounding the thermal power plant on which the dwellings are constructed. Indoor radon concentration depends on the characteristic of the soil, the type of building structure, ventilation condition and occupant's behavior. The present study represents the measurements of indoor radon and its progeny concentration in the dwellings constructed in the surroundings of National Thermal Power Corporations (NTPCs) situated at Badarpur (Delhi) and at Dadri, (U.P.) India. LR-115 type-II solid state nuclear track detectors fixed on a thick flat card were exposed in bare mode. Keeping the radiation hazards of radon for general population in mind, the annual effective dose in these dwellings has also been calculated. The results for radon levels and annual effective dose are found to be below the recommended action levels.

Key words: Radon, LR-115 Type-II SSNTDs, Effective dose.

INTRODUCTION

Direct measurement of ^{222}Rn (radon) and its progeny in indoor air is important for assessing the natural background radiation exposures received by the general population, through the inhalation route [1]. The studies have shown that more than 50% of annual exposure to humans is from radon and its daughter products [2]. Radon, ^{222}Rn is a natural radioactive noble gas directly produced by the decay of ^{226}Ra, resulting itself from the radioactive decay of ^{238}U .Being an inert gas (having life time 3.8 days) radon does not chemically react with environment but it can diffuse through the soil and enter the atmosphere. The solid alpha active decay products of radon (^{218}Po, ^{214}Po) become airborne and attach themselves to the dust particles, aerosol and water droplets in the atmosphere. In dwellings, the radon is generated from radium present in soil, constructed materials and water. Radon and its daughter products may pose a significant health hazard when concentrated in poorly ventilated and badly designed house [3].

Radon gas decays overtimes into radioactive particles that can be inhaled and trapped in the lungs as these daughter products remain air borne for a long time and can adhere to the epithelial living of the lung, there by irradiating the tissue. The exposure of population to high concentrations of radon and its daughters for a long period lead to pathological effects like the respiratory functional changes and the occurrence of lung cancer [4].

Keeping the radiation hazards of radon for general population in mind, a systematic study of the indoor radon concentration is done. For this purpose, radon measurements have been carried out in a number of dwellings around the NTPCs (National thermal power corporations) situated at Badarpur (Delhi) and at Dadri, (U.P.) India.

MATERIALS AND METHODS

For the measurement of radon levels in the dwellings LR-115 type-II solid state nuclear track detectors (SSNTDs) were employed. LR-115 type-II is mainly detects the alpha particles of range 0.17 to 4.8 MeV and is unaffected by electrons, x-rays and γ-rays. A small strip of LR-115 type-II solid state nuclear tracks detector film of size 2 × 2 cm. fixed on a thick flat card was exposed in "bare mode". Several detectors were mounted at different locations such as drawing room, kitchen and bed room, inside the dwellings for a period of 100 days, at a height of more than 2 meters above the ground level and about 1 meter below the ceilings and away from the walls. The detectors mounted in this condition viewed a hemisphere of radius at least 6.9 cm. and can record alpha particle from a hemisphere of air of this radius which corresponds to the range of alpha particles from ^{214}Po [5]. No surface was closer than this range as the decay products would acts as an indeterminate source of α-particles. Detectors were mounted vertical and locations were so selected that dust collection on the detectors to be minimum. After an exposure time of 100 days, detectors were removed and etched using 2.5N NaOH solution at 60^0 C for 90 min. in a constant temperature water bath. Then, these SSNTDs were washed, dried and scanned under a binocular microscope with a magnification of 400× track density measurements.

All α-particles that reach the LR-115 type-II SSNTDs with a residual energy are registered as bright track holes. The track density on the detector is related to the potential alpha energy concentration expressed in Working Level (WL) units. WL is the concentration of any combination of radon progeny corresponds to 1.3×10^5 MeV of PAE per liter of air. The track density registered in the bare detector will, therefore, be a function of radon progeny concentration in air. The radon concentration (R_n) in (Bq m^{-3}) is calculated using the following relation [6, 7, 8].

$$R_n\,(\text{Bq m}^{-3}) = [\text{WL}\times 3700] / F \qquad (1)$$

where, F is the equilibrium factor for radon taken as 0.4 as suggested by UNSCEAR [9]. To obtain the Potential Alpha Energy Concentration (PAEC) of radon progeny in mWL, it is essential that LR-115 type-II detector films should be calibrated with a known radon concentration under the conditions almost similar to those which prevail in Indian dwellings. For this purpose, the detectors were calibrated in a radon exposure chamber at the facility available at the Environmental Assessment Division of Bhabha Atomic Research Centre, Mumbai [10, 11]. The mean calibration factor for LR-115 type II detector was found to be 442 tracks $cm^{-2}d^{-1}$ per WL. The effective dose equivalent to the occupant of the house estimated from PAEC levels. The estimation based on the conversion factor of 4mSv/WLM recommended by ICRP [12] for home exposure condition based on epidemiological approach.

Table 1 Indoor radon levels in some dwellings around the NTPC, Badarpur, (Delhi), India

S. No.	Location	PAEC (mWL)	Radon activity (Bqm^{-3})	Annual effective dose (mSv y^{-1})
1.	Drawing room	4.7	43.5	1.5
2.	Drawing room	7.4	68.4	2.3
3.	Drawing room	14.4	133.2	4.5
4.	Drawing room	21.7	200.7	6.8
5.	Kitchen	28.9	267.3	9.1
6.	Kitchen	27.1	250.7	8.5
7.	Bed room	25.3	234.0	7.9
8.	Bed room	23.5	217.4	7.4
9.	Bed room	19.9	184.1	6.2
10.	Kitchen	30.7	284.0	9.6
11.	Bed room	16.3	150.8	5.1
12.	Kitchen	25.3	234.0	7.9
13.	Kitchen	12.7	117.5	3.9
14.	Kitchen	27.1	250.7	8.5
15.	Kitchen	11.2	103.6	3.5
	Average Value	19.7	182.7	6.2

RESULTS AND DISCUSSION

Table 1 presents the results for radon levels, potential alpha activity and annual dose in the dwellings surrounding the NTPC (National thermal power corporation), Badarpur, (Delhi), India. Potential alpha activity vary from 4.7 to 30.7 mWL with an average value of 19.7 Mwl and radon levels in the dwellings vary from 43.5 to 284.0 Bq m^{-3} with an average value of 182.7 Bq m^{-3}. Annual effective dose has found to vary from 1.5 to 9.6 mSv y^{-1} with an average value of 6.2 mSv y^{-1}. Table 2 presents radon levels, potential alpha activity and annual dose in the dwellings surrounding the NTPC (National thermal power corporation) Dadri, (U.P.), India. Potential alpha activity vary from 5.4 to 30.0 mWL with an average value of 17.4 mWL and radon levels in the dwellings vary from 50.2 to 276.2 Bq

m^{-3} with an average value of 161.1 Bq m^{-3} and Annual effective dose has found to vary from 1.7 to 9.4 mSv y^{-1} with an average value 5.5 mSvy^{-1}.

Table 2 Indoor radon levels in some dwellings around the NTPC, Dadri (U.P.), India.

S. No.	Location	PAEC (mWL)	Radon activity (Bqm^{-3})	Annual effective dose (mSv y^{-1})
1.	Kitchen	27.7	256.7	8.7
2.	Kitchen	26.2	242.8	8.2
3.	Drawing room	11.2	103.2	3.5
4.	Drawing room	13.0	119.9	4.1
5.	Drawing room	7.0	64.2	2.2
6.	Kitchen	29.3	270.7	9.2
7.	Drawing room	25.3	234.4	7.9
8.	Drawing room	22.9	212.1	7.2
9.	Kitchen	19.6	181.4	6.1
10.	Drawing room	19.3	178.6	6.0
11.	Drawing room	8.7	80.9	2.7
12.	Drawing room	5.7	53.0	1.8
13.	Bed room	11.2	103.2	3.5
14.	Bed room	11.8	108.8	3.7
15.	Bed room	14.8	136.7	4.6
16.	Bed room	17.8	164.6	5.6
17.	Bed room	23.8	220.4	7.4
18.	Bed room	26.8	248.3	8.4
19.	Kitchen	30.0	276.2	9.4
20.	Bed room	5.4	50.2	1.7
21.	Kitchen	19.0	175.8	6.0
22.	Bed room	19.3	178.6	6.0
23.	Bed room	16.3	150.7	5.1
24.	Kitchen	10.6	97.7	3.3
25.	Bed room	12.7	117.2	4.0
	Average Value	17.4	161.1	5.5

Table 3 Comparison of radon levels, PAEC and annual effective dose with some Indian cities.

Cities	PAEC (mWL)	Radon activity (Bqm^{-3})	Annual effective dose (mSv y^{-1})
Eravipuram (Kerela)	14.2	131.7	4.5
Panmana (Kerela)	24.0	222.1	7.5
Thankassery (Kerela)	17.5	144.7	5.5
Deharadun (U.A.)	7.9	64.8	2.5
Mathura (U.P.)	12.6	103.8	3.9
Agra (U.P.)	9.7	80.3	3.1
Banswara (Rajasthan)	11.8	95.5	3.6
Palampur (H.P.)	15.1	123.8	4.7
Baijnath (H.P.)	17.8	146.8	5.6
Bhatinda (Punjab)	14.9	125.6	4.8
Around the NHPC (Arunachal Pradesh)	16.6	158	2.3
Around NTPC, Badarpur (Delhi) (Present study)	19.7	182.7	6.2
Around NTPC, Dadri. (U.P.) (Present study)	17.4	161.1	5.5

There is large variation in the values obtained. The radon activity depends upon the many factors like soil beneath the house, building materials, ventilation conditions etc. Indoor radon levels and radon effective does are higher especially in kitchen as compared to other locations. High values of radon activity may be due to the use of water and cooking gas in kitchen, as cooking gas contains so many radioactive elements. Radon concentration was found to be lowest in bed room. The International Commission on Radiation Protection (ICRP) [13] has recommended that remedial action against radon and its progeny is justified above a continued effective dose of 3-10 m Sv y^{-1} has been proposed. The action level for radon activity should be in the range 200-600 Bqm^{-3}. The measured values are below the recommended action levels and hence will pose none serious health risk.

A comparison of PAEC values, radon levels and annual effective dose in the dwellings of different cities in India [3, 7] is present in Table 3. Our results show the higher values of radon activity as compared to others, except only one .The maximum value of radon activity was found to be highest in the dwellings of Panmana city in Kerela [3]. This city is situated in the vicinity of High Background Area. The higher results for radon levels, PAEC values and annual effective dose in this study are may be due to the presence of thermal power plants.

CONCLUSION

Radon concentrations were measured in bed rooms, kitchens and drawing rooms of 40 dwellings surrounding the NTPCs situated at Badarpur, (Dehli) and at Dadri, (U.P.), India. Maximum value of radon concentration was found in kitchen may be due to the use of fuels like gas, kerosene etc. and water. Radon concentrations and annual effective dose are well below the recommended safe limit values. It is found that radon activity and radon effective dose rate depend upon many factors inside the dwellings. Ventilation plays an important role as far as the problem is concerned. Computed data indicates that region is safe without posing significant radiological threat to population.

Acknowledgements

The authors would like to express our thanks to the residents of the study areas for their cooperation during the research work. Sincere thanks are also due to Dr. Amit Roy, Director, Inter-University Accelerator for providing constant temperature water bath and microscope for the analysis of radon concentrations.

REFERENCES

[1] R. Mishra, R. Prajith, B. K. Sapra and Y. S. Mayya, *Radiat. Protect. Dosimetry*, 141, 363, **2010**.
[2] R. P. Chauhan, *Indian. Jour. of Pure & Applied Phys.* 48, 470, **2010**.
[3] A. K. Mahur, R. Kumar, P. J. Jojo, Ashwani Kumar, A. K. Singh, A. K. Varshney and Rajendra Prasad, *Asian Jour. of Chem*. 18, 3371, **2006**.
[4] BEIR VI, *Report of the Committee on the Biological effect of Ionizing Radiation, National, Research* (Natl Acad Press, Washington, DC), **1999**.
[5] S. A. Durrani and R. K. Bull, *International Series in Natural Philosophy* 111 Pergamon Press Oxford **1998.**
[6] A. K. Mahur, R. Kumar, P. J. Jojo, and R Prasad *Radiat. Prot. and Environ.* 28**, 2005.**
[7] A. K. Mahur, Rajesh Kumar, Meena Mishra, Ameer Azam and R Prasad, *Indian J. Phys.* 83, 8, **2009**.
[8] Mamta Gupta, A.K.Mahur, R.G.Sonkawade and K.D.Verma, *Pelagia Research Library* 2(5) **2011**, 421-426.
[9] UNSCEAR *United Nations Scientific Committee on the Effect of Atomic Radiation. Annex A: Exposure from Natural Sources*, United Nations, New, **2000**.
[10] A. K. Singh, A. J. Khan and Rajendra Prasad, *Radiat. Prot. Dosim.* 74, 189, **1997.**
[11] P. J. Jojo, A. J. Khan, R. K. Tyagi, T. V. Ramchandran, M. C. SubbaRamu and R. Prasad ,*Radiat. Meas.* 23, 715**, 1994**.
[12] ICRP, *International Commission for Radiological Protection: Protection against radon at home and at work*. Annals of ICRP, 65, **1994**.
[13] ICRP, *International Commission for Radiological Protection: Protection against radon at home and at work*. Annals of ICRP 23, 65**, 1993**.