# Measurement Of Radon And Its Progeny Concentration In Dwellings

**A. Rawat***

## Abstract

Radon (Rn-222) is a noble gas and is present in trace amounts almost everywhere on the earth. It escapes from rock, soil or groundwater containing Radiun-226 in different concentrations. Radon can also originate from a deeply buried deposit and can migrate to the surface of earth by diffusion and transport process. It can accumulate in enclosures like rooms, caves, cellars and basements since it has a fairly long half life. The increased interest in indoor Radon concentration is due to its health hazard and environmental pollution. In the present study measurements of indoor Radon levels in Bharatpur (Rajasthan) have been made. For this LR-115 plastic track detectors were used. The average potential alpha energy level measured is found to vary from 12.60 mWL to 28.39 mWL. The average internal exposure dose to the tracheobronchial and pulmonary regions of lungs shows a variation from 3.97 m $SvYr^{-1}$ to 8.94 m $SvYr^{-1}$.

**Keywords:** Radon, Progeny, Dwellings, SSNTDs, Radon activity, Etching, Alpha tracks.

74

**DOI Number: 10.48047/nq.2020.18.3.NQ20153** **NeuroQuantology 2020; 18(3):74-77**

## INTRODUCTION: -

Radiation is a part of natural environment. Mankind is always unaware of the natural background radioactivity since it can't be detected by the senses. Natural exposure to ionizing radiations is wide spread and of varied nature. Many radio nuclides occur naturally in terrestrial soils, rocks and in building materials derived from them. Upon decay, these radio nuclides produce an external radiation field to which all human beings are exposed. The main factors that determine the exposure rate to a particular individual are the concentrations of radio nuclides in the soil, the time spent outdoors and the shielding by buildings. It is a misconception that it is safer to be within the dwellings as far as radiation exposure is concern. The building materials are also found to contain radio nuclides thus resulting in increase of indoor radiation levels. A major portion of the radiation exposure from natural environment is contributed by radon and its progeny. Awareness of health hazard from indoor radon and its progeny is increasingly growing throughout the world, following the reports of very high concentrations of radon in various countries. Inhalation of short-lived radioactive descendants of radon is associated with increasing risk of developing lung cancer[1].

Studies have shown that about 5-20% of all lung cancer deaths are attributable to breathing of air containing radon and its daughters[2-6]. Radon emanation from the soil depends upon its radium (Ra-226) content, mineralogy, porosity, grain size, moisture content and permeability through host rock and soil[7]. In dwellings rooms kept closed for long duration and in air conditioned rooms high radiation levels are possible by the accumulation of radon. Being the inert and only radioactive gas in the uranium (U-238) decay series, radon is dispersed in the atmosphere, as soon as it is released from the parent element radium (Ra-226).When radon decays, it forms its progeny $^{218}Po$ and $^{214}Po$, which are positively charged atoms at birth and can get attached themselves to tiny dust particles, water vapours, oxygen, trace gases in indoor air and other solid surfaces. These daughter products (aerosols) remain air-borne for a long

***Corresponding Author:** A. Rawat
**Address:***Department of Physics, M. S. J. Govt. PG College, Bharatpur- 321001, Rajasthan, India
Email: anandmsj@gmail.com

**Relevant conflicts of interest/financial disclosures:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

time and can easily be inhaled in to the lung and can adhere to the epithelial lining of the lung, there by irradiating the tissue. Bronchial stem cells and secretion cells in airways are considered to be the main target cells for the induction of lung cancer resulting from radon exposure.

Building materials also contribute significantly to indoor radon levels. Since the nature of building materials and their uranium content vary from place to place, their contribution to the indoor radon will also vary regionally. The exposure of population to high concentrations of radon and its daughters for a long period leads to pathological effects like the respiratory functional changes and the occurrence of lung cancer[8]. Keeping this in mind the environmental monitoring of radon and their progeny in some dwellings of Bharatpur, the eastern district of Rajasthan has been carried out. The houses selected are such that the ventilation conditions are almost similar and are having cemented walls and floorings.

## MATERIALS AND METHOD: -

The measurement of the indoor radon and its progeny concentration using LR-115 type-II Solid State Nuclear Track Detectors (SSNTDs) has been carried out by many workers in recent years[9-15]. LR-115 detectors consist of thin films of cellulose nitrate manufactured by DOSIRAD, France. Type-II non-strippable LR-115 films, with a 12μm thick sensitive (or active) cellulose nitrate layer coated on a 100μm thick polyester base, were employed in the present studies. The pieces of the detector film of size 2X2 cm, fixed on a thick flat card were exposed in 'Bare' mode by hanging the cards on the wall in the room for a period of 90 days such that the detector viewed a hemisphere of radius at least 6.9 cm i.e. the range of $^{214}$Po α-particles in the air. No surface was closer than this range as the decay products would act as an intermediate α-particle sources. Detectors were mounted vertical and the locations were so selected that the dust collection on the detectors be minimum. After exposure, the detectors were collected and brought back to the laboratory for analyses. The detector films were etched in 2.5N NaOH solution at 60±1°C for 90 min in a constant temperature water bath in order to make the tracks of α-particles visible under binocular optical research microscope with a magnification of 450X. The track density registered in the bare detector is a function of radon progeny concentration in air. The radon concentration in Bq $m^{-3}$ was estimated from working level by using the following equation[12, 15-17].

$$\text{Rn C (Bqm}^{-3}) = (\text{WL X } 3700) / F$$

The equilibrium factor[18] for radon has been taken as 0.45 as suggested by UNSCEAR, 2000. 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 in Environmental Assessment Division (EAD) of Bhabha Atomic Research Centre (BARC) Mumbai[19-21].

## RESULTS AND DISCUSSION: -

Table 1 presents the measured PAEC value of radon daughters in m WL units, radon concentration in Bq$m^{-3}$, annual effective dose equivalents in mSv and Table 2 presents their average values in different type of rooms. Effective dose equivalent was calculated by using the conversion factor[22] of 9mSv/WLM suggested by ICRP-65. The measured radon concentration in the dwellings of Bharatpur town varies from 103.61 Bq$m^{-3}$ to 233.46 Bq$m^{-3}$ with an average value of 170.08 Bq$m^{-3}$. The radon activity may vary with the ventilation conditions in different types of rooms and other factors. Store rooms and kitchens show the maximum radon concentration, the reason may be the poor ventilation in store rooms, in the kitchens it may be due to some extra radon release from the burning of LPG as fuel and use of water, as the average radon concentration in LPG has been estimated to be about 700 Bq$m^{-3}$,[23] and radon is mildly soluble in water. If the radon concentration in air is about 3 Bq$m^{-3}$, the concentration in water will be 1.5 Bq$m^{-3}$ at 0°C[24]. The bed rooms show more activities than drawing rooms. This variation may be due to different ventilation conditions of the rooms. Annual effective dose equivalent in Bharatpur town varies from 3.97 mSv to 8.94 mSv with an average value of 6.51 mSv. The International Commission on Radiation Protection[22] ICRP-65



eISSN: 1303-5150

has recommended that remedial action against radon is justified above a continued effective dose of 10 $mSvYr^{-1}$, while the action level for radon concentrations should be in the range 200-600 $Bqm^{-3}$.

## CONCLUSIONS: -

The radon concentrations were measured in five dwellings of Bharatpur (Raj.). Significant variations of radon concentrations were found in the different type of rooms such as drawing room, bed room, kitchen and store room. The measured values are below the recommended action levels. The computed data indicates that the region is safe without posing significant radiological threat to population.

**Table 1:-** Indoor radon levels in dwellings of Bharatpur (Rajasthan)

| Dwellings | Type of Room | m WL | $Bqm^{-3}$ | $mSvYr^{-1}$ |
|---|---|---|---|---|
| D-1 | Drawing room | 17.99 | 147.89 | 5.66 |
| | Bed room | 22.01 | 181.00 | 6.93 |
| | Kitchen | 23.91 | 196.63 | 7.53 |
| | Store room | 27.40 | 225.27 | 8.62 |
| D-2 | Drawing room | 14.30 | 117.57 | 4.50 |
| | Bed room | 20.32 | 167.05 | 6.39 |
| | Kitchen | 25.63 | 210.76 | 8.07 |
| | Store room | 23.64 | 194.39 | 7.44 |
| D-3 | Drawing room | 15.11 | 124.26 | 4.76 |
| | Bed room | 14.77 | 121.47 | 4.65 |
| | Kitchen | 20.72 | 170.40 | 6.52 |
| | Store room | 24.95 | 205.18 | 7.85 |
| D-4 | Drawing room | 18.51 | 152.17 | 5.82 |
| | Bed room | 17.49 | 143.80 | 5.50 |
| | Kitchen | 23.71 | 194.95 | 7.46 |
| | Store room | 25.07 | 206.11 | 7.89 |
| D-5 | Drawing room | 12.60 | 103.61 | 3.97 |
| | Bed room | 14.00 | 115.15 | 4.41 |
| | Kitchen | 23.17 | 190.49 | 7.29 |
| | Store room | 28.39 | 233.46 | 8.94 |



**Table 2:-** Average values of radon and its daughter's concentrations in different rooms:-

| Type of room | m WL | $Bqm^{-3}$ | $mSvYr^{-1}$ |
|---|---|---|---|
| Drawing room | 15.70 | 129.10 | 4.94 |
| Bed room | 17.72 | 145.69 | 5.58 |
| Kitchen | 23.43 | 192.65 | 7.37 |
| Store room | 25.89 | 212.88 | 8.15 |

**Table 3:-** Range and averages of measured data:-

| Measurements | Minimum | Maximum | Average |
|---|---|---|---|
| Rn-concentration ($Bqm^{-3}$) | 103.61 | 233.46 | 170.08 |
| Progeny concentration (m WL) | 12.61 | 28.39 | 20.69 |
| Effective dose equivalent (mSv $Yr^{-1}$) | 3.97 | 8.94 | 6.51 |

## REFERENCES

1. ICRP (1986) Lung cancer risk from indoor exposure of radon daughters, International Commission on Radiological Protection, Pergmon Press, Oxford, 50.
2. Subba Ramu M. C., Muraleedharan T. S., Ramachandran T. V. and Shaikh G. N. (1987) BARC Report, 1390.
3. ICRP (1990) International Commission on Radiological Protection, Pergmon Press, Oxford, 60.
4. Pershangen Liang Z., Hrubec Z., Svenson C. and Boice J. D. (1992) Health Physics, 23, 641.
5. Field R. W., Steck D. J., Smith B. J., Brus C. P., Fisher E. L., Neuberger J. S., Platz C. E., Robinson R. A., Woolson R. F. and Lynch C. F. (2000) American Journal of Epidemiology, 151, 1091.
6. Field R. W. and Becker K. (2001) Radiation Protection Dosimetry, 95, 75.
7. Grastly R. L. (1994) Health Phys., 65, 185.
8. BEIR (1999) The Health Effects of Exposure to Indoor Radon (Report of the Committee on the Biological Effects of Ionizing Radiation) Natl. Res. Council (Washington, DC: Natl. Acad. Press).

9. Singh S., Sharma D. K. and Kumar A. (2004) Journal of Environmental Radioactivity, 76, 3, 369.
10. Ramola R. C. (2005) International Congress Series, 1276, 215.
11. Yu K. N., Nikezic D., Ng F. M. F. and Leung J. K. C. (2005) Radiation Measurements, 40, 2-6, 560.
12. Kumar R., Mahur A. K., Jojo P. J. and Prasad R. (2007) Indian Journal of Pure and Applied Physics, 45, 877.
13. Danalakshmi B., Balasundar S. and Sreedevi K. R. (2008) Radiation Measurements, 43, 1, S456.
14. Khan M. S., Naqvi A. H. and Azam A. (2008) Radiation Measurements, 43, 1, S385.
15. Kumar R., Mahur A. K., Singh H., Sonkawade R. G. and Swarup R. (2010) Indian Journal of Pure and Applied Physics, 48, 802.
16. Kumar R., Sengupta D. and Prasad R. (2003) Radiation Measurements, 36, 521.
17. Mahur A. K., Kumar R., Jojo P. J. and Prasad R. (2005) Radiation Protection and Environment, 28, 203.
18. UNSCEAR (2000) United Nations Scientific Committee on the Effect of Atomic Radiation Annex. A: Exposure from Natural Sources, United Nations, New York.
19. Singh A. K., Jojo P. J., Khan A. J., Prasad R. and Ramchandran T. V. (1997) Radiation Protection and Environment, 20, 129.
20. Singh A. K., Prasad R. and Khan A. J. (1997) Radiation Protection Dosimetry, 74, 189.
21. Jojo P. J., Khan A. J., Tyagi R. K., Ramchandran T. V., Subba Ramu M. C. and Prasad R. (1994) Radiation Measurements, 23, 715.
22. ICRP (1993) International Commission on Radiological Protection, Pergmon Press, Oxford, Publication 65.
23. Gesell T. F. (1975) Health Phys., 29, 681.
24. Musa I. S. M. (2003) Radon in natural water, Doctoral Thesis, Faculty of Health Sciences, Linkoping University, Sweden.