# Comparative Study of Indoor Radon and its Progeny in Dwellings around Kasimpur Thermal Power Plant and its Neighboring Regions

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*Abstract*— In the present study radon dosimeters containing LR-115 type II detector films in bare mode were placed in 30 rooms in the dwellings around Kasimpur Thermal Power Plant, 20 rooms in the dwellings of Ukhalana village and 10 rooms in the dwellings of Sunamai village. LR-11 type II solid state nuclear track detectors fixed on a thick flat card were exposed in bare mode. Track etch technique has been used to estimate the radon concentration. Annual effective dose has been calculated from the radon concentration to carry out the assessment of the variability of expected radon exposure of the population due to radon and its progeny. The radon concentration in the dwellings of Kasimpur Thermal power plant varies from 56.2 Bq $m^{-3}$ to 241.4 Bq $m^{-3}$ with an average value of 150.24 Bq $m^{-3}$. Annual effective dose equivalent in the dwelling around Kasimpur Thermal Power Plant varies from 2.1 mSv $y^{-1}$ to 9.2 mSv $y^{-1}$ with an average value of 5.71 mSv $y^{-1}$ . The measured radon concentration in the dwellings of Ukhalana Village varies from 44.3 Bq $m^{-3}$ to 236.1 Bq $m^{-3}$ with an average value of 136.49 Bq $m^{-3}$. Radon activity may vary with the ventilation condition, type of construction materials and other factors. Annual effective dose equivalent varies from 1.7 mSv $y^{-1}$ to 9.0 mSv $y^{-1}$ with an average value of 5.21 mSv $y^{-1}$. The measured radon concentration in the dwellings of Sunamai village varies from 66.1 Bq $m^{-3}$ to 234.8 Bq $m^{-3;}$ with an average value of 134.25 Bq $m^{-3}$. The variation in radon activity may vary with the ventilation conditions, type of construction materials and other factors. Annual effective dose equivalent varies from 2.5 mSv $y^{-1}$ to 8.9 mSv $y^{-1}$ with an average value of 5.1 mSv $y^{-1}$. These values are below the recommended action levels.

***Key words:*** LR-115 Type II Dector, Effective Dose, Kasimpur Thermal Power Plant, Ukhalana Village, Sunamai Village

## I. Introduction

Radon pollution is an important global problem of radiation hygiene. Radon and its progeny are the major contributors in the radiation dose received by general population of the world [1].Short-lived radon and its decay products are the most important sources of radiation from natural sources which effect human beings [2]. Most of these have very short half-lives in comparison to radon-222. Radon, $Rn^{222}$ is a natural radioactive noble gas directly produced by the decay of $^{226}$Ra, resulting itself from the radioactive decay of $^{238}$U. it dose not chemically react with its environment and being an inert gas and having sufficient half life (3.8 days). It can easily disperse into the atmosphere as soon as it is released. The solid alpha active decay products of radon ($^{218}$Po, $^{214}$Po) become airborne and attach themselves to the dust particles, aerosols and water droplets in the atmosphere. On inhalation, these solid decay products along with inhaled air may get deposited in the tracheo-bronchial(T-B) and pulmonary (P) regions of lungs, and continuously irradiate the cells by α-particles which may cause lung cancer. Radon can also be transported by water seeping through soil and cracks. The radon gas decays in turn to radioactive daughters of the elements Bi, Po, Pb which can become attached to aerosol particles and which after inhalation can be deposited in respiratory tissues. Major contribution to the total radiation dose to human beings comes from the inhalation of short-lived daughter products of naturally occurring $^{222}$Rn [3-6]. I In homes the predominant source of radon in indoor air is the soil beneath structures, but building materials and water used in the homes and in a few cases natural gas may also contribute [7-9]. Several surveys have been undertaken in Europe and North America and in many of the dwellings in some countries high Rn concentrations have been reported.

Among many surveys carried out for radon studies the largest and most recent of these was an international study led by the National Cancer Institute (NCI), USA which examined the data on 68,000 underground miners who were exposed to a wide range of radon levels. The study on miners shows the probability of death due to lung cancer five times more than expected for the general population. Several surveys performed in Europe and North America [10-15] revealed that some countries have high radon concentration in many of their dwellings. It has been well recognized all over the world that high radon concentration in the houses may pose a significant risk of lung cancer to the people living there. Studies form all over the world show that a well-planned and systematic measurement of indoor radon concentration is necessary to calculate the actual dose due to exposure of indoor radon concentration.

The aim of the present study is to measure the radon concentration surrounding the Kasimpur Thermal Power Plant Aligarh, India. Ukhalana village situated about 5 km from Kasimpur Thermal Power Plant and Sunamai village situated about 3 km from Kasimpur Thermal Power Plant to study the effect of fly ash spreading from the Power Plant in the neighboring regions. Kasimpur has a big coal fired thermal power plant. Large quantity of coal consumed by coal-fired power plants is likely to increase the quantity of radon in the surroundings and in neighboring regions as subsequent emission of fly ash to the environment can cause enhancement in the ambient radiation levels. This increase may be due to the fact that coal contains uranium and radon is a member of uranium decay series. In the present study radon dosimeters containing LR-115 type II detector films in bare mode were placed in 30 rooms in the dwellings around Kasimpur Thermal Power Plant, 20 rooms in the dwellings of Ukhalana village and 10 rooms in the dwellings of Sunamai village. . LR-11 type II solid state nuclear track detectors fixed on a thick flat card were exposed in bare mode. Track etch technique has been used to estimate the radon concentration. Annual effective dose has been calculated from the radon concentration to carry

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out the assessment of the variability of expected radon exposure of the population due to radon and its progeny.

## II. EXPERIMENTAL

The passive time integrated method of using a solid state nuclear track detector was employed for measuring the potential alpha energy concentration (PAEC) of radon daughters in working level (WL) units. Strips of Kodak Pathe LR-115 type II film were used as the detector in "BARE MODE".

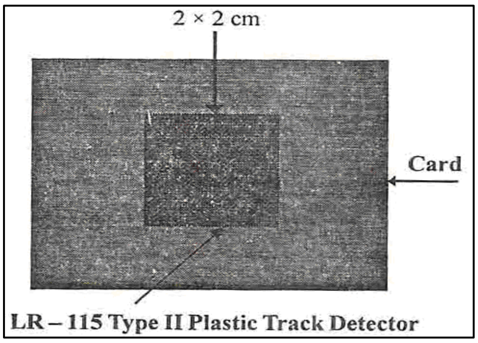


Fig. 1: Bare mode Technique

The pieces of the detector film of size 2 cm × 2 cm fixed on a thick flat card were exposed in bare mode, shown in Fig.1 by hanging the cards on the wall in the dwellings for a period of 90 days such that the detector viewed a hemisphere of radius at least 6.9 cm, the range of $^{214}Po$ α-particles in the air.

No surface should be close to this range as the decay products deposited on it would act as an additional alpha particle source including a larger error in the measurements. The track density registered in the detector will, therefore, be a function of radon progeny concentration in air. The radon concentration in Bq m$^{-3}$ was estimated by using the relation.

$$R_n\, C(Bq\, m^{-3}) = \frac{WL \times 3700}{F} \qquad (1)$$

Where F is known as the equilibrium factor. with an average value of 0.43 [16]. To know the potential Alpha energy concentration (PAEC) of radon progeny in mWL the detectors were calibrated in a radon exposure chamber at the facility available in Environmental assessment division of Bhabha Atomic Research Centre, Mumbai [17]. The mean calibration factor for LR-115 type II detector was found to be 442 tracks. cm$^{-2}$ d$^{-1}$ per WL.

## III. RESULTS AND DISCUSSION

Tables 1,2 and 3 present the measured PAEC values of radon daughters in mWL units, radon concentration in Bq m$^{-3}$ and annual effective dose equivalents in mSv y$^{-1}$ , respectively.

It is apparent from Table-1 that the measured radon concentration in the dwellings of Kasimpur Thermal power plant varies from 56.2 Bq m$^{-3}$ to 241.4 Bq m$^{-3}$ with an average value of 150.24 Bq m$^{-3}$. The radon activity may vary with the ventilation conditions, type of construction materials and other factors. Annual effective dose equivalent in the dwelling around Kasimpur Thermal Power Plant varies from 2.1 mSv y$^{-1}$ to 9.2 mSv y$^{-1}$ with an average value of 5.71 mSv y$^{-1}$ .The measured radon concentration in the dwellings of Ukhalana Village varies from 44.3 Bq m$^{-3}$ to 236.1 Bq m$^{-3}$ with an average value of 136.49 Bq m$^{-3}$. Annual effective dose equivalent varies from 1.7 mSv y$^{-1}$ to 9.0 mSv y$^{-1}$ with an average value of 5.21 mSv y$^{-1}$ , (Table-2). Similarly, from Table-3 it is apparent that the measured radon concentration in the dwellings of Sunamai village varies from 66.1Bq m$^{-3}$ to 234.8 Bq m$^{-3;}$ with an average value of 134.25 Bq m$^{-3}$. Annual effective dose equivalent varies from 2.5 mSv y$^{-1}$ to 8.9 mSv y$^{-1}$ with an average value of 5.1 mSv y$^{-1}$. From these Tables it is further confirmed that Kitchen shows the maximum radon concentration . This may be due to the contribution of radon from fuels (gas, kerosene etc.) and water, whereas Courtyard is fairly ventilated and thus gives minimum value of radon.

The international Commission on Radiation Protection ICRP-65 [18] has recommended that remedial action against radon and its progeny is justified above a continued dose of 10 mSv, while an action level within the range of 3-10 mSvy$^{-1}$ has been proposed. The action level for radon concentration should be in the range between 200 and 600 Bq m$^{-3}$. The measured values are below the recommended action levels.

| S. No. | Location | Track Density (Tr/Sq cm/day) | Potential Alpha Activity (mWL) | Radon Activity (Bqm$^{-3}$) | Annual Effective dose equivalent (mSv y$^{-1}$) |
|---|---|---|---|---|---|
| 1 | Bedroom | 8.4 | 18.9 | 155.4 | 5.9 |
| 2 | Store room | 5.5 | 12.5 | 102.5 | 3.9 |
| 3 | Varandah | 4.4 | 10.1 | 82.6 | 3.1 |
| 4 | Kitchen | 11.6 | 26.1 | 214.9 | 8.2 |
| 5 | Drawing room | 6.6 | 14.9 | 122.4 | 4.7 |
| 6 | Bed room | 5.7 | 12.9 | 105.8 | 4.0 |
| 7 | Bath room | 11.7 | 26.5 | 218.3 | 8.3 |
| 8 | Courtyard | 3.0 | 6.8 | 56.2 | 2.1 |
| 9 | Store room | 10.7 | 24.1 | 198.4 | 7.5 |
| 10 | Study room | 5.9 | 13.3 | 109.1 | 4.2 |
| 11 | Drawing room | 10.3 | 23.3 | 191.8 | 7.3 |
| 12 | Worship room | 11.4 | 25.7 | 211.7 | 8.0 |
| 13 | Bed room | 6.4 | 14.5 | 119.1 | 4.5 |
| 14 | Store room | 11.2 | 25.3 | 208.3 | 7.9 |
| 15 | Kitchen | 12.9 | 29.4 | 241.4 | 9.2 |
| 16 | Dining hall | 6.0 | 13.7 | 112.4 | 4.3 |
| 17 | Bed room | 6.8 | 15.3 | 125.7 | 4.8 |

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| | | | | | |
|---|---|---|---|---|---|
| 18 | Varandah | 3.9 | 8.8 | 72.8 | 2.8 |
| 19 | Bath room | 10.5 | 23.7 | 195.1 | 7.4 |
| 20 | Courtyard | 3.2 | 7.2 | 59.5 | 2.3 |
| 21 | Bed room | 10.1 | 22.9 | 188.5 | 7.2 |
| 22 | Varandah | 3.7 | 8.4 | 69.4 | 2.6 |
| 23 | Kitchen | 12.1 | 27.4 | 224.9 | 8.6 |
| 24 | Drawing room | 10.8 | 24.5 | 201.7 | 7.7 |
| 25 | Bath room | 9.9 | 22.5 | 185.2 | 7.0 |
| 26 | Courtyard | 3.4 | 7.6 | 62.8 | 2.4 |
| 27 | Bed room | 9.1 | 20.5 | 168.7 | 6.4 |
| 28 | Varandah | 4.1 | 9.3 | 76.1 | 2.9 |
| 29 | Drawing room | 11.0 | 24.9 | 205.0 | 7.8 |
| 30 | Bed room | 11.9 | 26.9 | 221.6 | 8.4 |
| | Average value | 8.07 | 18.26 | 150.24 | 5.71 |
| | S.D. | 3.26 | 7.37 | 60.67 | 2.31 |
| | Rel. Std% | 40.39 | 40.36 | 40.38 | 40.46 |

Table 1: Indoor radon levels in dwellings of Kasimpur thermal power Plant

| S. No. | Location | Track Density (Tr/Sq.cm/day) | Potential Alpha Activity (mWL) | Radon Activity ($Bqm^{-3}$) | Annual Effective dose equivalent ($mSv\ y^{-1}$) |
|---|---|---|---|---|---|
| 1 | Living room | 7.1 | 16.0 | 131.7 | 5.1 |
| 2 | Living room | 7.8 | 17.7 | 145.5 | 5.5 |
| 3 | Varandah | 4.4 | 10.1 | 82.7 | 3.2 |
| 4 | Living room | 8.9 | 20.1 | 165.4 | 6.3 |
| 5 | Courtyard | 2.4 | 5.8 | 44.3 | 1.7 |
| 6 | Kitchen | 12.7 | 28.7 | 236.1 | 9.0 |
| 7 | Staircase | 9.8 | 22.1 | 181.9 | 6.9 |
| 8 | Bathroom | 7.6 | 17.3 | 162.2 | 5.4 |
| 9 | Staircase | 8.7 | 19.7 | 162.0 | 6.2 |
| 10 | Varandah | 4.8 | 10.9 | 89.3 | 3.4 |
| 11 | Living room | 8.4 | 18.9 | 155.4 | 5.9 |
| 12 | Store room | 9.6 | 21.7 | 178.6 | 6.8 |
| 13 | Living room | 5.5 | 12.4 | 102.1 | 3.9 |
| 14 | Kitchen | 10.7 | 24.1 | 198.4 | 7.5 |
| 15 | Living room | 8.2 | 18.5 | 152.1 | 5.8 |
| 16 | Varandah | 4.3 | 9.7 | 79.4 | 3.0 |
| 17 | Courtyard | 3.2 | 7.2 | 59.5 | 2.3 |
| 18 | Bathroom | 7.3 | 16.5 | 135.6 | 5.2 |
| 19 | Living room | 8 | 18.1 | 148.8 | 5.7 |
| 20 | Staircase | 7.5 | 16.9 | 138.9 | 5.3 |
| | Average value | 7.35 | 16.59 | 136.49 | 5.21 |
| | S.D. | 2.59 | 5.85 | 48.10 | 1.82 |
| | Rel. Std.% | 35.24 | 35.26 | 35.24 | 34.93 |

Table 2: Indoor radon levels in dwellings of Ukhalana village

| S. No. | Location | Track Density (Tr/Sq cm/day | Potential Alpha Activity (mWL) | Radon Activity ($Bq\ m^{-3}$) | Annual Effective dose equivalent ($mSv\ y^{-1}$) |
|---|---|---|---|---|---|
| 1 | Varandah | 5.2 | 11.7 | 95.9 | 3.7 |
| 2 | Bath room | 8.5 | 19.3 | 158.7 | 6.0 |
| 3 | Varandah | 5.3 | 12.1 | 99.2 | 3.8 |
| 4 | Bed room | 6.2 | 14.1 | 115.7 | 4.4 |
| 5 | Varandah | 4.8 | 11.3 | 92.6 | 3.5 |
| 6 | Living room | 9.4 | 21.3 | 175.3 | 6.7 |
| 7 | Staircase | 7.1 | 16.1 | 132.3 | 5.0 |
| 8 | Courtyard | 3.6 | 8.0 | 66.1 | 2.5 |
| 9 | Kitchen | 12.6 | 28.6 | 234.8 | 8.9 |
| 10 | Drawing room | 9.2 | 20.9 | 171.9 | 6.5 |
| | Average value | 7.19 | 16.34 | 134.25 | 5.1 |
| | S.D. | 2.72 | 6.18 | 50.81 | 1.92 |
| | Rel. Std.% | 37.97 | 37.82 | 37.85 | 37.65 |

Table 3: Indoor radon levels in dwellings of Sunamai village

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The variation of PAEC and radon concentration with type of room are shown in Figs. 2-4.

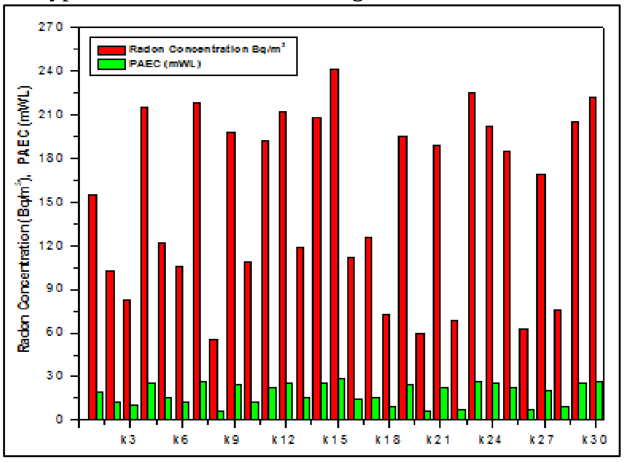


Fig. 2: Variation of PAEC(mWL)and radon concentration(Bqm-3) with type of rooms in the dwellings of Kasimpur Thermal Power Plant

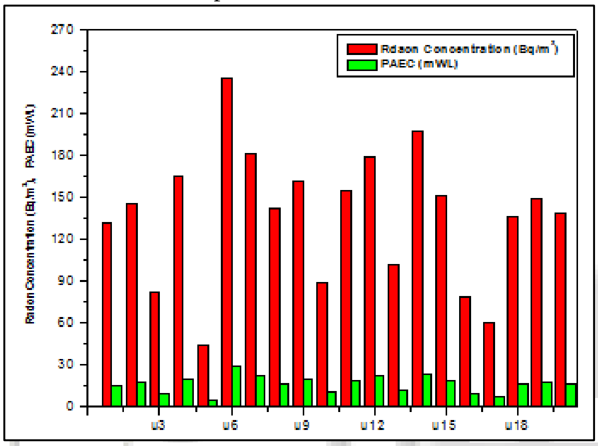


Fig. 3: Variation of PAEC(mWL) and radon concentration(Bq m-3) with type of rooms in the dwellings of Ukhalana village

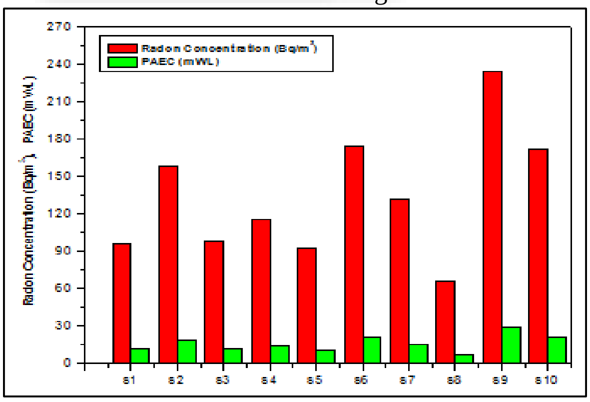


Fig. 4: Variation of PAEC(mWL)and radon concentration(Bq m-3) with type of rooms in the dwellings of Sunamai village

## IV. Conclusions

Radon levels in the rooms of some dwellings in the surroundings of Kasimpur Thermal Power Plant and its neighbouring villages (Ukhalana and Sunamai) varies with the ventilation conditions, type of construction materials and other factors.

Comparison with the measured Radon data in Kasimpur Thermal Power Plant (Table 1) there seems to be no appreciable change in the Radon activity in dwellings and places of the dwellings in Ukhalana and Sunamai villages ~ 5 km and ~3 km from Kasimpur power plant. Thus the spread of fly ash does not affect the ambient Radon levels.

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## References

[1] Saini, R.S., Nain, Mahabir., Chauhan, R.P., Kishore, Nawal., and Chakaravarti, S. K., 2009. Indian J. Phys. 83 (8) 1197-1200.
[2] Sivakumar, R., 2010. Iran. J. Radiat. Res., 8 (3) : 149-154.
[3] Sathish, L.A., Ramanna, H.C., Nagesh, V., Nagaraja, K., Shobha, S., Sundareshan, S., Ramachandran, T.V., 2010. The Arabian Journal for Science and Engineering, volume 35. Number 2A.
[4] Zubair, Mohd., Shakir Khan, M., Verma, Deepak., 2011. Scholars Research Library, Archives of Applied Science Research, 3(1) : 77-82.
[5] Narayanan, K.K., Krishnan, D.N., and Subba Ramu,M.C., 1992. Report, ISR (K)-BR-3, Indian Association of Radiat. Prot. (ISRP) (BARC, Trombay).
[6] UNSCEAR, United Nations Scientific Committee on the Effects of Atomic Radiation, Sources 1988. Effects and Risks of Ionizing Radiation (New York).
[7] UNSCEAR, United Nations Scientific Committee on the Effects of Atomic Radiation, Sources 1993. Effects and Risks of Ionizing Radiation (United Nations,New York).
[8] Nero, A.V., Nazaroof, W.W., 1984. Radiation Prot. Dosim. 7 23.
[9] Mahur, A.K., Kumar, Rajesh., Mishra, Meena., Azam, Ameer., and Prasad, Rajendra., 2009. Indian J. Phys. 83 (8) 1177-1181.
[10] Khayrat, A.H., Al-Jarallah, M.I., Fazal-ur-Rehman, X., Abu-Jarad, F., 2003. Radiation Measurements 36, 449-451.
[11] Kumar, Rajesh., Mahur, A.K., Varshney, A.K., Prasad, R., 2003. Indian J. environmental protection, Vol. 23, No. 10.
[12] Kumar, Rajesh., Mahur. A.K., Varshney, A.K., Prasad, R., 2004. Indian J. Environmental Protection, Vol. 24, No. 8.
[13] Kumar, R., Mahur, A.K., Kumar , Ashvani ., Prasad., R., 2005. NUCAR.
[14] Ramoal, Rakesh Chand., Kandari, Manbrendra Singh., Negi, Manbeer Singh., and Choubey, Vinay Mohan., 2000. Journal of health Physics, 35 (2), 211-216.
[15] Reddy, K., Reddy B., Reddy, M., Reddy, Ch., P., Reddy, K., 2003. Radiation Measurement 36, 419-423.
[16] Khan, A.J.,1995. 3rd International colloquium on Rare gas geochemistry . Amritsar. Proceedings, PP 299-300.
[17] Jojo, P. J., 1994. Radiat. Meas., 23. 715-724.
[18] ICRP, International Commission on Radiological Protection, 1993. Annals of ICRP 23 (ICRP publication 65).

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