Measurement of Indoor Environmental Radon Concentration Level by Using LR-115 Type II Plastic track detector (SSNTDS) in the Eastern U.P.

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***Abstract* - A study of indoor radon dwelling of Balrampur, Uttar Pradesh, India. Radon is an invisible radioactive gas that occurs naturally in the indoor atmosphere. It comes from the naturally breakdown of uranium in soils and rocks. Lung cancer risk depends upon the concentration of radon, thoron and their decay product in air. This paper presents the experimental calibration of LR-115 type II plastic track detectors for monitoring environmental radon. Radon in dwellings originates from walls, floors and ceilings and also depends on the construction material. The conditions prevailing in India eastern region in the Utter Pradesh with respect to people's life-styles, building construction type, topography and meteorological parameters are greatly different. Concentration of Radon measured in different houses, SSNTD technique is used for present work in selected indoor environments. Detector mounting for three months. Detector used in Bare on card mode and Dosimeter. Most of the houses in Balrampur district are houses with typical construction their dense population, different geological and environment conditions which provide a wide scope of radon studies in this area. A results of measurements of radon concentration in Balrampur (India) are presented.**

***Keywords:* SSNTDS, Dosimeter, Indoor Environment.**

I. INTRODUCTION

Radon is a colourlesss and odourless radioactive gas. Radon has been a natural component of the air we breathe. Natural radiation is present throughout the biosphere due to radioactive elements and their decay products in the earth. The monitoring of indoor radon levels has acquired a significant importance all over the world from the public health point of view. Radon in dwellings originates from walls, floors and ceilings and also depends on the construction material. The conditions prevailing in India eastern region in the Utter Pradesh with respect to people's life-styles, building construction type, topography and meteorological parameters are greatly different. I visited Balrampur district. I found the some specific reason of the eastern U.P. (Balrampur district) to measure the radon concentration level by using the method of LR-115 type II plastic track detector. In present investigation concentration of Radon measured in different houses, SSNTD technique is used for Sample mounted in Balrampur district dividing it into five parts east, south, north, west and central region in winter season. Five sample mounting in each region five indoor environment. I visited Maharani Lal Kuwari P.G. College Balrampur department of Physics with the proper guidance of Dr.Shrinivas Shukla and Dr. P.K. Singh for my research work. I found the some specific reason of the eastern U.P.(Balrampur district) to measure the radon concentration level by using the method of LR-115 type II nuclear track detector for research work and I mounted the nuclear track detector in the Balrampur district we are choosing some specific reason. It is very useful for measurement of radon concentration. Area name M.L.K.P.G. College in physics department, government girls hostal, police chowki hanuman mandir and some houses in the district. I used this type of LR-115 film, mounting nuclear track detectors in specific areas.

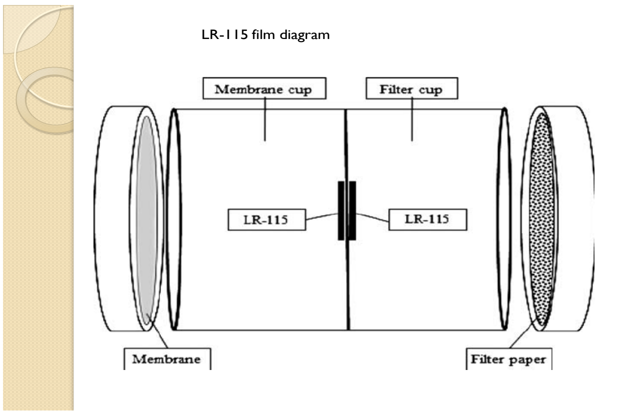

Fig.1 LR-115 Film Diagram

Detector mounting for three months. Detector used in Bare on card mode and Dosimeter. The sample exposure in this conditions: (a) ventilation rate~ 1 h-1, (b) ventilation rate>1 h-1, and(c) closed rooms. Most of the houses in Balrampur

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district are houses with typical construction their dense population, different geological and environment conditions which provide a wide scope of radon studies in this area.

II. EXPERIMENTAL DETAILS

Radon are invisible, odorless, heavy and radioactive gases which are present in dwellings and in the environment. LR-115, Type- II plastic track detectors commonly known as solid state nuclear track detectors (SSNTDs) used to measure the radon concentration. The measurements were carried out in the field of radon and the detectors were exposed for about 30 days. The passive time-integrating 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. The LR-115 type II track detector was used in bare mode. The piece of detector film (1 cm x 1 cm) fixed on a thick flat card was exposed for a period of 3 months. The tracks registered in the detector due to alpha particles .The detectors were placed in the room where the occupants of the house spent most of their time. The detectors were either hung in an interior surface or placed on a horizontal surface so that it was exposed to room air. To obtain the PAEC of radon daughters in WL, it is essential to calibrate the detectors with known radon daughter concentrations in a radon chamber under conditions almost similar to those which prevail in Indian dwellings. The calibration experiment was performed under controlled conditions and the details of the experiment are given elsewhere. The PAEC in WL of radon daughters was calculated by using the calibration factor. After the exposure, the detectors were brought back to the laboratory and chemically etched in 2.5N NaOH solution at 60±1°C for 2 hours in a constant temperature water bath. The resulting tracks due to alpha particles from radon progeny were counted by using a research microscope under magnification of 100 X.The results of these measurements are shown in tables. Present the measured radon concentration distributions and show that in all five places radon concentrations vary appreciably from dwelling to dwelling. The radon distributions in the present measurements are found to be approximately log-normal in Balrampur district (U.P.). Measurements in progress to collect enough data to separate the houses with higher concentrations from those houses with lower concentrations to find features responsible for the difference.

III. AREA OF STUDY

Balrampur district is situated in Eastern Uttar Pradesh state of India. Geographic coordinates of Balrampur, Latitude: 27°25′46″ N , Longitude: 82°11′07″ E , Elevation above sea level: 112 m = 367 ft, covering an area of about 3,457 Sq. KM. Balrampur district is one of the districts of the Indian state of Uttar Pradesh and is a part of Devipatan division as well as the historic Awadh regions. Located on the banks of the Rapti River. The ground of Balrampur is almost plane, except for some elevations. The river water contains soil, silt, and sand in varying proportion. The soils of the Balrampur district consist broadly of "Matiyar" or clay, "Dumat" or loam. The hard clay soil or Matiyar is ideal for paddy and sugur cane etc. cultivation and very fertile. In the bank of the Rapti river red lentils pulses (masoor daal) is cultivated in the major area. The Dumat or loam is also fertile soil, ideal for cultivation of various types of crops. This is the reason for high crop yields in the district. The soil cover is generally shallow and moderate in the northern part while in the southern part the soil cover is thick. Ground water in the phereatic aquifer in general is colourless,odourless and slightly alkaline in nature. Specific Conductance (EC), which is a measure of total dissolved solids, indicates the ground water in the Balrampur district is fresh .The arsenic and fluoride value in the Balrampur district the ground water is suitable for drinking and domestic uses except at few places. The quality of ground water in deeper aquifer is also potable. The houses in study area are good and poorly ventilated. Buildings are constructed of concrete, cement, wood, mud, bricks, and blocks, some having glass doors and windows too. I visited Maharani Lal Kuwari P.G. College Balrampur department of Physics for research work and I mounted the nuclear track detector in the Balrampur district we are choosing some specific reason. It is very useful for measurement of radon concentration. The main source of indoor radon are the soil, construction materials and natural gas used for cooking and other sources.The conditions for reducing radon concentration in houses and environment measured for establishing safety standards for human being. For example, the higher radon level in poor ventilation as the windows & doors of the room remain closed during night. Therefore, indoor radon concentration, the ventilation will have a stronger role to play.

Table. 1 :- Indoor radon levels in Balrampur district:

BALRAMPUR DISTRICT

Area	Detector code	Track density rate (Tracks $cm^{-2}d^{-1}$)	PAEC (m WL)	Concentration of Radon (Bq / m³)
Professor´s Colony	BA1	2.95	4.72	43.66
	BA2	3.45	5.52	51.06
	BA3	3.52	5.63	52.08
	BA4	4.16	6.66	61.60
	BA5	4.80	7.68	71.04
Government Girls college	BA6	3.63	5.81	53.74
	BA7	4.89	7.82	72.33
	BA8	3.03	4.85	44.86
	BA9	3.92	6.27	57.10
	BA10	2.98	4.77	44.12

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M.L.K.P.G. college	BA11 BA12 BA13 BA14 BA15	5.51 3.90 3.25 3.66 4.21	8.82 6.24 5.20 5.82 6.74	81.58 57.72 48.10 53.83 62.34
Major Chowraha	BA16 BA17 BA18 BA19 BA20	4.96 5.09 3.22 3.07 4.01	7.94 8.14 5.15 4.91 6.42	73.44 75.29 47.64 45.42 59.38
Hanuman Mandir area	BA21 BA22 BA23 BA24 BA25	5.46 4.89 4.35 2.99 3.79	8.74 7.82 6.96 4.77 6.06	80.84 72.33 64.38 44.21 56.05

Minimum Concentration	43.66 Bq/m³
Maximum Concentration	81.58Bq/m³
Average Concentration	58.96Bq/m³

The value of radon progeny (PAEC) in mWL for radon progeny was estimated by using the following equation

$$Cp\ (m\ WL) = \rho / K.\ t$$

The SSNTD Method is used for the measurement of Radon concentration α—sensitive plastic track detectors provide a very useful and less expensive, method for integrated radon measurements (Frank and Benton., 1977; Fleischer et al., 1980) Generally, two plastic track detectors have been used for this.The radon concentration, C, measured by α-sensitive plastic detector is related to the track density ρ and the time of exposure t by the formula (Abu-Jarad et al., 1980)

$$\rho = K.\ C.\ t$$

K is the sensitivity factor with a value which depend on the configuration of the detector, viza-viz its surroundings, and also on the etching conditions used, Although the value of K can be calculated for different geometries (Fleischer et a., 1980). The calculation is not very straight forward except in the case of "BARE" detector mode (Abu— Jurad et al., 1980). It is always perferable to use the calibrated value of K obtained from laboratory calibration experiments using a standard radon chamber.Where ρ is corrected track density in tracks/cm², t is the exposure time and *K* is the calibration or sensitivity factor. The average calibration factor for LR-115 type II plastic in the BARE on card mode reaches 625 T $cm^{-2}d^{-1}$ WL. Calibration factor for LR-115 radon detectors in BARE on card mode. (D. S. SRIVASTAVA, P. SINGH, N. P. S. RANA, A. H. NAQVI, A. AZAM, T. V. RAMACHANDRAN and M. C. SUBBA RAMU *Nucl. Geo phys.* Vol. 9, No. 5, pp. 487-495, 1995, Copyright f 1995 Elsevier Science Ltd.) For the measurement of radon concentration (in Bq/m³).

$$C_{Rn}\ (Bq/m^3) = WLconc. \times 3700/\ F_R$$

$$C_{Rn}\ (Bq/m^3) = PAEC\ (mWL) \times 3.7 / F_R$$

F_R = equilibrium factor (0.4)

C_{Rn} = radon concentration in Bq m 3.

PAEC(mWL) = potential a-particle energy concentration

ρ =corrected track density in tracks/cm²

K =sensitivity factor

t = time of exposure

Where F_R is the equilibrium factor for radon having the value 0.4 given by UNSCEAR [UNSCEAR, 2000]. The radon levels or PAEC values (in mWL) calculated by using the equations

$$PAEC\ (mWL) = C_{Rn} \times F_R / 3.7$$

Most of the houses in Balrampur district are houses with typical construction their dense population, different geological and environment conditions which provide a wide scope of radon studies in this area.

IV. RESULTS AND DISCUSSION

Table 1 gives the PAEC levels of radon daughters in WL and track production rate (tracks $cm^{-2}d^{-1}$per WL) along with the calibration factor (tracks T $cm^{-2}d^{-1}$/WL) for BARE on card mode. It is seen that the average calibration factor for LR-115 type II plastic in the BARE on card mode reaches 625 T $cm^{-2}d^{-1}$ per WL. It is seen that the values of calibration factor for a LR-115 detector are slightly more than those reported by Ramachandran *et. al.* (1988). This difference may be due to use of a different manufacturing batch and also due to differences in etching conditions. Hence, it is desirable to have detectors from each batch calibrated before using them for environmental radon measurements. The values of radon concentrations in typical ground floor rooms of Balrampur city are much less than those levels causing concern (150 Bq m^{-3}).

V. CONCLUSION

The radon concentrations were measured in 25 dwellings of Balrampur district of eastern U.P.in the winter season. Significant variations of radon concentrations were found in the different types of houses. The different types of houses show the maximum or minimum radon concentration. These high values may be due to high emanation from the ground surface and from the building materials of the house. This difference may be due to use of a different manufacturing batch and also due to differences in etching conditions. Hence, it is desirable to have detectors from each batch calibrated before using them for Environmental radon measurements. The primary source of radon and its progeny in the dwellings are the soil adjacent to the building material. The indoor concentration however

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depends on various factors viz. ventilation condition, type of construction seasonal variation and geology of the area. We were choosing the some-specific reason of the eastern U.P. to calculate the radon concentration level by using the method of LR 115 type-II plastic track detector. Balrampur is the dense forest region we would like to check the radon level in environment of certain areas. Balrampur was selected for our study because of their dense population different geological conditions and environment. We were planning to study radon concentration in different houses, environment, mud houses in these districts. The present paper measurements of radon concentrations in 25 dwellings using solid state nuclear track detectors (Table 1) shows that the region is in safe limit from the radiation protection point of view. The residential buildings, selected for installing dosimeters, are both new and old (Kumar et al., 2014). They are mainly made of bricks along with cement and concrete. The selection of these houses for dosimeters installation took the degree of ventilation, floor types, and number of windows and doors into account as they are all responsible for variations in indoor radon concentration. All the measurements took place at noon/night in winter seasons. However, the recorded values of radon the resulting gases fall well below the internationally-recommended levels, which clearly indicates that the houses in Balrampur Eastern Uttar Pradesh are quite safe in terms of protection from any radiation (Rawat et al., 2011). The present study showed a minimum indoor radon concentration of 43.66 Bq/m³ in Professor´s Colony and a maximum concentration of 81.58 Bq/m³ in M.L.K.P.G.College during the winter. The average value of indoor radon concentration was 58.96 Bq/m³ . Building materials can influence the indoor radon concentrations slightly. Brick and concrete houses show higher radon levels, while wood and adobe houses present lower ones. The concentration maximum in winter, in the winter the doors closed for long hours. This is the possible cause for radon variation. The results of Radon concentration and its progeny will help the scientists and environment a lists to establish the radiation and safety standards for human beings. The LR-115 type II plastic tracks detectors provide a very useful and less expensive, method for integrated radon measurements.

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