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Preliminary Measurements of Radon Radiations in "Bare Mode" In Rampur District of Western U.P. (India)

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Abstract: *Measurement of radon, thoron concentration and their daughter products in a dwelling of Rampur city and in the surrounding villages were carried out by using Solid-state nuclear track detectors (LR-115 type II) in a bare mode. The detectors were distributed over 32 houses. The indoor radon concentration was found to vary with building material, ventilation condition, occupant's behaviour and mode of constructions of houses. The radon value was found to be lower than recommended value under normal ventilation condition. The indoor radon concentrations were found to vary from 30 Bqm^{-3} to 85.36Bqm^{-3} with an average value of 62.36 Bq/m^{3}.This value is lower than the ICRP recommended values of 200Bqm^{-}and thus are within safe limits. The outdoor radon concentration is usually low and less than average indoor levels. It is also found that, in general, the radon level in lower floors is higher than that in upper ones in all houses.*

Key Words: *Indoor radon concentration, SSNTD's, Annual Effective Dose, Uttar Pradesh, environment.*

I. Introduction

Radiations have always been a part of our natural environment. Human beings have been exposed to them since inspection. Exposure of ionizing radiation, which cant not been detected by any sense of our body, is injurious to our health. Radon and its short-lived daughters are the most important source of ionizing radiations prevalent in our environment, which are probably responsible for causing adverse affects on human lungs. In India out of 98% exposure dose from natural radioactive sources, about 52% is due to radon and its progeny. It has been well established that many building materials used in construction work contain radioactive elements such as ^{226}Ra ,^{232}Th and their decay products. Table (1.1) shows the typical concentration of ^{226}Ra in various building materials. The radon is more concentrated in the lower levels of the home (that is basement, ground floors and the first floors)[1].

Materials	Concentration of ^{226}Ra (pCi/gm)
Wood	0.03
Concrete	0.43-1.65
Brick	1.1-2.6
Tile	2.1
Nature gypsum	0.11-0.27
Insulating material (glass wool)	0.35-1.1

Table (1.1) Typical radium concentrations in some building materials.

Radon is an α-emitting radioactive gas. It is a daughter product of ^{226}Ra and decay with a half-life of 3.82 days emitting alpha particles of energy 5.49 Mev.The radioactive daughter product of radon viz ^{218}Po and ^{214}Po emit alpha particles. These daughter products are solid and have a tendency to attach themselves to aerosols in ambient air. When we breathe we also inhale radon and its daughter product along with the normal air. Although most of the radon is exhaled, its daughter products get logged to the inner walls and membranes of our respiratory system and continue causing constant damage due to their alpha activity. A series of uranium decay is shown in the fig.

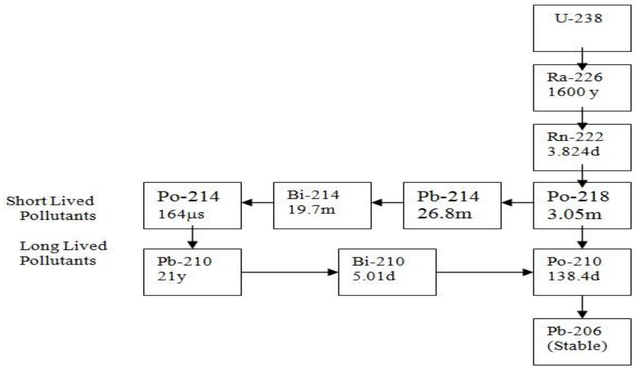

Fig.: Uranium Decay Series showing radon (the only gaseous member of the series) and its daughter products.

Thus building materials contribute significantly in increasing the natural radiation in the ambient air and posses a health hazards. Therefore measurement of indoor radon and its progeny in human dwelling is very important from the health physics point of view. As radon is a gas, it is able to diffuse through the soil and other materials around the foundation of a home. Homes tend to operate under a negative pressure, meaning that the air pressure inside the home is lower than the air pressure out side. This negative pressure comes from:

- The stack effect, by which the upward flow of warm air inside the home, creates the positive pressure area at the top of the home and a negative pressure area at the bottom [2].
- A vacuum effect caused by air vented to the outside by exhaust fans, clothes dryers, etc.
- A downwind draft effect, which is caused by wind blowing past a home [3,4].

This negative pressure differential tends to be strongest in basements and during the heating season. It acts as a vacuum that pulls radon-rich air into the lower areas of the home through any dirt floor areas or unsealed sumps or cracks, fissures, or pores in the building materials. Although numerous factors can influence the radon entry diffusion / convection mechanism (e.g. atmospheric pressure, indoor-outdoor-temperature differentials, humidity, rainfall, and atmospheric pressure) in homes having natural ventilation, the predominant factors influencing radon entry are the indoor-outdoor differential pressure and in some cases the wind velocity. The variations of radon concentrations in air depend on the place time, height above ground, and on the metrological conditions. The resulting radon and progeny concentrations are also influenced by ventilation and heating systems and by architectural style of the building. Building materials that made from stone, sand, and or byproducts may contain uranium and radium and generate radon. Many of these materials such as brick, wallboard or concrete are sufficient porous to allow radon to escape in to the air.

Since most of the houses in the villages of this area are constructed with local stone and soil (mud house), so that there are possibilities of high radon concentrations inside the houses. The radon values recorded in mud house of the region have significant effect importance. This study will enable us to identify the environmental problem concerning radiation hazards.

II. Study Area

The measurement of radon-thoron concentration and their progeny were made in the houses of Rampur district of western U.P. (India). Most of the houses in the Rampur city are constructed of cement and brick where as in the surrounding villages the walls and floors are made of local sandstone and rock with a mud paste. The houses in the villages have poor ventilation condition, commonly with one door and one small window and some without ventilation.

III. Experimental Measurements

Solid State Nuclear Track Detectors (SSNTD's) are employed for the passive time integrated measurements of the radon concentration (^{222}Rn).LR-115 type-II passive tracks detectors were used in the present measurements. Detectors of small size 2cmx2cm were used as a passive detectors in a "BARE'' mode[5] for recording the alpha particles emitted by radon-222 gas present in our ambient air and also its short lived daughters typically ^{218}Po and ^{214}Po which generally attach themselves to the aerosols. The detectors were fixed on glass slide and mounted on the walls at a height of about 200cm from the ground with their sensitive surfaces facing the air. After the exposure period of three months, the detectors were etched for two hours in 2.5N NaOH solution maintained at 60^{o}C in constant temperature bath. At the end of etching, the detectors are removed, washed in distilled water. After drying the detectors are ready to count under an optical microscope for track density measurements. The measured track density was converted in to Bq/m^3 by using a calibration factor (.02 tracks/cm^2 d = Bq/m^3) determined by the Bhabha Atomic Research Centre, Bombay (K.P.Eappen et al., 2004)[6].

Table 1. 2: Observed Indoor radon concentrations at different places in Rampur District

S.No.	Sample Code	Place	Radon concentration (Bq/m^3)	EEC_{RN} (Bq/m^3)
1	RRM08	Patwai	50.12	35.08
2	RRM16	Guuyan Talab	49.35	34.54
3	RRM17	Kila Rampur	34.12	23.88
4	RRM22	Ekta Vihar	27.50	19.25
5	RRM27	Shah Enclave	30.22	21.15
6	RRM29	Diamond Road	44.12	30.88
7	RRM32	Teacher Colony	28.18	19.72

Table 1. 3: Observed Outdoor radon concentrations at different places in Rampur District

S.No.	Sample Code	Place	Floor	Rn conc (Bq/m^3)	EEC_{RN} (Bq/m^3)
Residential Buildings:					
1	RRM03*	Ajitpur	Ground	69	27.60
2	RRM04*	Haji Nagar	Ground	70.20	28.08
3	RRM06*	Patwai	Ground	80.50	32.20
4	RRM07*	Patwai	First	69.25	27.70
5	RRM09*	Patwai	Ground	79	31.60
6	RRM10*	Patwai	Ground	85.36	34.14
7	RRM11*	Kathkuyan	Ground	57	22.80
8	RRM12	Guyya Talab	First	51.12	20.44
9	RRM13	Teacher Colony	Ground	80.10	32.04
10	RRM14*	Khusru Bagh	First	57.62	23.04
11	RRM15	Bazoli Tola	Ground	50.23	20.09
12	RRM18	Guiyan Talab	First	49.29	19.71
13	RRM19	Mazar chupshah	Ground	53	21.20
14	RRM20	Bazar Safdarganj	Ground	69	27.60
15	RRM21	Zeena Inayat	Ground	57.12	22.85
16	RRM24	Old Avas Vikas	Ground	54.67	21.86
17	RRM25	Old Avas Vikas	Ground	53.72	21.49
18	RRM26	Shah Enclave	Ground	61.27	24.50
19	RRM28	Diamond Road	Ground	60.12	24.06
Other Buildings:					
20	RRM01	Physics Lab.	First	48.20	19.28
21	RRM02	Khusru Bagh	Ground	67.76	27.10
22	RRM05*	Haji Nagar	Ground	81.50	32.60
23	RRM23	Ekta Vihar	First	51.06	20.42
24	RRM30	Zulfiqar School	Ground	58	23.20
25	RRM31	Kathkuyan	First	30	12.00

* Mud house.

IV. Result And Discussion

The result of radon measurements in the dwellings of Rampur city and in the surrounding villages are shown in the table (1.2) and (1.3). Most of the houses in the Rampur city are constructed of cement bricks where as in the surrounding villages the walls and floors are made of local sandstone, and rocks with a mud paste. The resulting concentration of short-lived radon daughters, expressed in term of an equilibrium-equivalent radon concentration (EEC_{RN}), is related to the activity concentration (A_{RN}) of radon by the relation[7] (ICRP, 1987):

$$EEC_{RN} = F.A_{RN}$$

Where F is an equilibrium factor. On the basis of ICRP recommendations, the equilibrium factor for radon daughters in indoor air in the range 0.3-0.6, which is assumed to be 0.40 for the mid-point of the range of reported values. The mean equilibrium factor in out door air is 0.7 and somewhat higher than indoor air[8] (UNSCEAR, 1982).

The minimum and maximum value of indoor radon concentration is 30Bq/m^3 and 85.36Bq/m^3 respectively .The average indoor radon concentration in this area are found to be approximately 62.36Bq/m^3. The observed radon values in mud houses are found more than the houses constructed with cement and bricks, which are lower than the ICRP, recommended value (200Bq/m^3). The mud houses are constructed with soil and stone, which allow more radon to diffuse inside the room from ground floor and walls of the room. While in the other building the flow of radon was protected by the coating of cement on walls and floor of the room. The houses in the villages have poor ventilation condition, commonly with one door and one small window and some without ventilation. In the survey of radon concentration it is observed that the radon concentration decreases with volume for similar ventilation condition and also the upper floor have lower radon concentration than the ground floor. The international commission on radiation protection[9] (ICRP-65, 1993) has recommended that the action level for radon concentration should be in the range 200-600Bqm^{-3}.The measured radon concentration values are below the recommended action level.

V. Conclutions

The radon concentrations were measured in 32 dwellings of Rampur district of western U.P. Significant variations of radon concentrations were found in the different types of houses. The mud houses show the maximum radon concentration. These high values may be due to high emanation from the ground surface and from the building materials of the houses[10] (Ramola et al., 1988). The kitchen also shows the maximum variation of radon concentration, which may be due to some extra contribution of radon from fuels such as gas, kerosene and water. The minimum and maximum value of radon concentration varies from 30Bq/m^3 to 85.36Bq/m^3 with an average value of 62.36Bq/m^3 in these dwellings. The data in the tables (1.2) and (1.3) shows that the region is in safe limit from the radiation protection point of view.

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