Some Aspects of Radon Radiation

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Abstract- ***In view of the fact that radon and its daughter product are major source of natural radiation exposure; the measurement of radon radiation in dwelling is assuming ever increasing importance. It is known from the recent surveys in many countries that radon and its progeny contribute significantly to total inhalation dose and its fairly established that radon when in held in large quantity causes lung disorder. The major sources of Radon are: soil that contains radon releasing material; water and natural gas that has passed through underground areas containing radon; solar heating system that use radon-emitting r o c k s to store heat granite rock; and uranium or phosphate my tallings. Generally, the radon concentration has been found to be not only varying with seasonal changes, but also with the mode of construction of houses, building material utilized and the ventilation conditions the houses with mud floors shows quite higher radon as compared to the houses with brick flooring.***

Even the radon survey in the soil gas and the dwellings has also been carried out using the Alpha Guard technique, which is based on pulse ionization chamber. The soil gas radon concentration shows a large variation from 1000Bq/m^3 to 75000Bq/m^3. The indoor radon concentration levels which have been measured in the dwelling by the alpha guard are quite different as compared to that measured in these dwellings by the nuclear track etch technique (using the SSNTDs), indicating the importance of the SSNTDs in the long-term integrated measurement of radon level in the dwellings. The occurrence of radon, its effect on the environment, measurement and protection particularly in Indian context are being discussed in this present paper.

Indexed Terms- Radon, Radon Progeny, Uranium, SSNTD, Radium

I. INTRODUCTION

Radon is a colorless, odor less, radioactive gas. We cannot see radon gas and we cannot smell it or taste it. Radon is produced when trace amounts of uranium and radium in the soil or rocks decay. The radon gas will then also decay into radioactive solid particles, called radon daughters or radon progenitors [1]. Radon-222 is a toxic gas created by the decay of radium -226. Most of the radon is normally trapped in the core bearing rock deep within the earth. But when the rock is excavated and crushed, a lot of radon gas is released into the air [2]. As the only gas in the decay chains of radioactive heavy metals, radon and its floating radioactive products can easily get into human body by inhalation. Whenever we breathe in the air containing radon, it increases our risk of getting lungs cancer [3]. Radon (the gas and its progeny) is a very powerful cancer-causing agent. Even small doses in haled repeatedly over a long time can cause lung-cancer.

Uranium tailings constantly produce large amounts of radon gas through the decay of radium in the tailings. This gas can travel thousands of kilometers with a light breeze in just a few days. As it travels, it continually deposits solid radon progeny on the ground, water and vegetation below. Radon also dissolves readily in water and can be transported by ground- water into wells and streams. Radioactive radon gas decays, producing seven radioactive decay products called “radon progeny”. These solid radioactive materials attached themselves to tiny dust particles and droplets of water vapour floating in the air.

II. HOW RADON GETS INTO HOMES

Elevated levels of radon have been found in homes all across the country. Any home in any state may have radon problem: new and old homes well sealed and

drafty homes, and homes with or without basements. Radon gas gets into all types of building, including office buildings and schools. Dig up the top 6-fit of an acre of land and you will find about 50 pounds of uranium. Uranium and its daughter products radium and radon are found in nearly all rocks and soils. As radon gas moves through underground ground fissures, it usually decays into solid particles after several feet. But it travels much further in dry, permeable soils, like gravel, or course sand. Radon is soluble in water and underground streams can carry it long distances. This unpredictable underground movement of radon gas explains why homes in low-radium areas also have high radon levels and why radon levels can vary several- fold between adjacent houses. [4].

Radon gas naturally moves into the permeable disturbed soil and gravel bed surrounding foundations and into the buildings through openings and pores in concrete. Radon from soil is by far the main source of indoor radon. Radon from outside air also settles in basements of homes because it is nine times heavier than air. Radon released by tailing from uranium mines was found to travel hundreds of miles and settle in homes. But more commonly, radon gas released from soil is drawn into basements over the top of the foundation, through bulkhead doors or uncaulked basement window wells. Radon is also pulled in by the difference in radon concentration indoors and in the soli (diffusion). Radon tries to equalize the indoor concentration and its atoms easily penetrate through the pores in concrete. The diffusion flow through an intact concrete slab driven by the concentration gradient in several times higher than the pressure-driven advective flow [5]. The common radon entry points from the base / ground into the homes is shown in the figure 1.

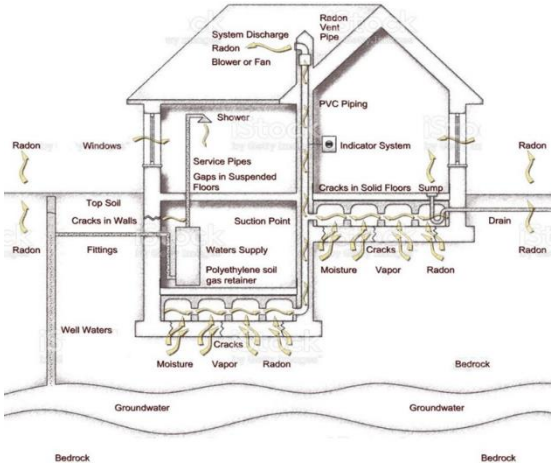

Figure 1: The common radon entry points from basement /ground into home

III. RISK FROM RADON

Radiation is called “complete carcinogen” unlike chemical carcinogen, it alone can initiate, promote and propagate cancer. The primary site of radioactive exposure to most people is their home. The average person receives a higher radiation dose from radon at home than from all other natural or manmade sources combined [6] (Table 1). Radon is a very proven and potent “class A” carcinogen. Safety limits on toxins or carcinogen in food or water are set at levels thousand times less lethal than what is the risk from radon in an average American home “Radon in homes causes more death than fires, drowning and air plane crash combined” (EPA).

Table: 1

The leading three causes of cancer death			
Men		Women	
Lung Cancer	33%	Lung Cancer	24%
Prostate Cancer	12%	Breast Cancer	18%
Colorectal Cancer	10%	Colorectal Cancer	11%

The radon gas which diffuses continuously from the soil to the atmosphere, are ever present in the indoor air. These radioactive gasses half live 3.82 days for radon-222 and 55second for radon-220 decay to short live products. In the atmosphere, the radon progeny exists both to attached and un-attached forms. In the inhaling process, the get deposited on the walls of respiratory tract including the lungs. These short live progeny nuclides decay of with the emission of alpha

particle, which in turn irradiates the cell of lungs tissues. On the other hand, the major part of radon gas that that is inhaled is exhaled out before that is decayed inside the lungs. Therefore, the hazard of indoor radon mostly comes from short-lived progeny nuclides rather than the radon gas itself [7].

We and our family receive the greatest radiation dose in your home. That's where you spend most time - 70 to 75 percent, more for small children [8]. Children are known to be more radiosensitive than adults. Children are more susceptible to radon-induced cancer due to their rapidly dividing cells and higher breathing rates. It is compounded by their heavier exposure to radon by spending more time inside the house and/or in the basement. (Source: Dr. Gordon Edwards - Estimating Lung Cancers). Recent research in Europe confirms that radon is much more harmful to children than to adults. Lung cancer incidence as a result of radon exposure is estimated to be about ten times higher for people exposed at the age of about 15 than at about 50[9]. The variation of mortality risk for the human being with radon level is shown in figure 2.

Table: 2

Radon Level (pCi/L	Mortality Risk		
	Never Smokers	Current smokers	General Population
20	3.6%	26.3%	10.5%
10	1.8%	15.0%	5.6%
8	1.5%	12.0%	4.5%
4	0.6%	6.1%	2.2%
2	0.4%	3.2%	1.2%
1.25	0.2%	2.0%	0.7%
0.4	0.1%	0.6%	0.2%

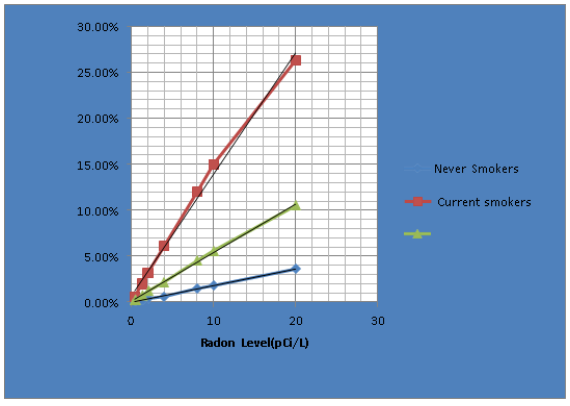

Figure 2: Variation of Mortality risk with radon level.

After radon gas is inhaled, it readily dissolves in the blood and circulates through the body, organs and the tissues, until it again exhaled through the lungs or skin. Equilibrium is established between the ambient and the internal radon concentration. Since the radioactive half life time of radon-222 is 3.8 days, most radon atoms harmlessly leave the body before they can disintegrate. (Table 2). The problem is not radon, but rather the radioactive particles it produces. As radon atoms undergo radioactive decay, they disintegrate into radiation and radon progeny ("daughters") - solid heavy metal particles of lead. Polonium and Bismuth. This minute electrically charged and chemically active particles float in the air and when breathed in, some (less than1%) get trapped permanently in the airways. The accumulate radioactivity in the airways is proportional to the radon level.

Most of the radiation dose to human is not from radon itself but from the radon daughters, most notably polonium-2018 (Radioactive half-life 3-minutes, alpha particles) and polonium-214(half-life 0.164 milliseconds, alpha), along with Bismuth-214(half-life19.7 minutes, beta). At each step of the decay chain the radon progeny particles emit ionizing radiation-alpha and beta particles and gamma rays. Ionizing radiation which have enough power to knock out electron from atom and convert them to ions. Kills or damages living cells, causing generating mutations and cancer. The radon daughters also emit beta particle and gamma rays that travel further through the body. Beta particles travel up to 1 to 2 centimeters in human tissues. Most gamma rays, being more energetic than X-rays, pass through the body to the outside. Because the absorbed beta and gamma radiation is spread over a large volume, it is less concentrated and less harmful. The concentrated ionizing radiation of heavy alpha particles is much more damaging and accounts for more than 85% of the damage to lungs [10]. Table 3 &4.

Table: 3

Risk factor per WLM			
Gender	Smoking Category	Risk per WLM (10^{-4})	Expected life span(yrs)
Male	ES	10.6	71.5
	NS	1.74	72.8
	Population	6.40	72.1

Female	ES	8.51	78.0
	NS	1.61	79.4
	Population	4.39	78.8
Male & Female	ES	9.68	74.2
	NS	1.67	76.4
	Population	5.38	75.4

Table: 4

Radon Level (pCi/L)	Population Moralit y	Risk Comparison		
29	10.5%	90	times the risk dying by	drowning
10	5.6%	80	"	home fire
8	4.5%	6	"	violent crime
4	2.3%	3	times the risk of dying in a	car crash
2	1.2%	40	"	airplane crash

IV. MINIMIZATION OF RADON LEVELS

Many of the 21,000-lung cancer death is caused by radon in each year are preventable. The "action" and consider action of 4 or 2p Ci/ L are merely cost/benefit guidelines - EPA has left the radon mitigation decision and responsibility up to the individual homeowner. The lower the radon level in your home, the lower family's risk of lung cancer.

We should always try to reduce the radon level in our home to a practical minimum. Radon Seal penetrating concrete sealer has made radon mitigation simple and affordable for homeowners. Many achieve radon levels below 2pCi/L or when starting at below 4pCi/L, reduce radon by at least 50%. Moreover, homeowners can avoid the unsightly piping and energy losses of a fan system, as well as a plume of heavy radioactive gas [11]. The following quick, inexpensive steps advised by the EPA can be taken to help lower our risks from radon exposure:

1. Stop smoking and discourage smoking in our home; it may increase t h e risk of radon exposure. (Table 5 & 6)
2. Spend less time in areas with higher concentrations of radon, such as the basement. (Fig. 1)
3. Whenever practical, increase the airflow into and through our house, especially in the basement.
4. If you rhomehasacrawl spacebeneath, keepthevents on all sides the house fullyopenallyear.
5. We should always try to buy a radon resistance home (Fig.2). The techniques may vary for different foundations and site requirements, but the basic elements are:

A. Gas Permeable layer
B. Plastic sheeting
C. Sealing and Caulking
D. Vent Pipe
E. Junction Box

6. The basics steps should be followed when buying a new home:

A. Check your area's radon potential
B. Install a radon reduction system
C. Remember: Test your home
D. If radon levels are still high, Activate

Table: 5

Radon risk if you smoke		
Radon Level(pCi/L)	If 1,000 people who smoked were exposed to this level over a life time	The risk cancer from radon exposure compress to …
20	About 260 people could get lung cancer	250 times the risk of drowning
10	About 150 people could get lung cancer	200 times the risk of dying in a home fire
8	About 120 people could get lung cancer	30 times the risk of dying in a fall
4	About 62 people could get lung cancer	5 times the risk of dying in a car crash
2	About 32 people could get lung cancer	6 times the risk of dying from poison
1.3	About 20 people could get lung cancer	Average indoor radon level
0.4	About 3 people could get lung cancer	Average outdoor radon level

Table: 6

Radon risk if you have never smoked		
Radon Level(pCi/L)	If 1,000 people who smoked were exposed to this level over a life time	The risk cancer from radon exposure compress to …
20	About 36 people could get lung cancer	35 times the risk of drowning
10	About 18people could get lung cancer	20 times the risk of dying in a home fire
8	About 15 people could get lung cancer	4 times the risk of dying in a fall
4	About 7 people could get lung cancer	The risk of dying in a car crash
2	About 4 people could get lung cancer	The risk of dying from poison
1.3	About 2 people could get lung cancer	Average indoor radon level
0.4	---	Average outdoor radon level

CONCLUSION

The main purpose of this paper is to introduce about the radon radiation. *As* the radon affect us very much, therefore continuous measurements of radon both in soil-gas and sprig/groundwater at several sites in a well-organized grid pattern are necessary to make. Moreover, some quick inexpensive steps have been discussed to reduce risk from radon exposure.

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