Computation of Radiological Risk Assessment of Indoor Radon Concentration Using SSNTDs

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ABSTRACT
A passive technique using solid state nuclear track detectors i.e. LR-115 films has been used for the measurement and computation of indoor radon concentration in the 10 different locations including the offices and dwellings in the GZS PTU campus Bathinda, India during the period from Jan- April 2014. The measured indoor radon values in the study area varies from 40 to 120 Bq m^{-3} with an average value of 80 Bq m^{-3}. The measured values are less than the recommended action level 200-300 Bq m^{-3} (ICRP,2009). The indoor radon values obtained in the almost 90% of the samples are more than the world average of 40 Bq m^{-3}. The calculated annual average dose received by the residents of the study area varies from 0.68 mSv to 2.05 mSv with an average value of 1.367 mSv which was calculated using parameters introduced in report by UNSCEAR (2000). These values are less than the recommended levels of 3-10 mSv. Hence there is no visible radiological risk to the residents of the study area.

KEYWORDS: *Computation, LR-115, Dwellings, Radon, Dose, Radiological.*

INTRODUCTION:

Humans have been exposed to radiation from natural sources like cosmic rays, air, earth and water. Exposure comes from the man-made sources, arising from the application of nuclear energy in industry, medicine and from other technology. Radioactivity on the earth is from the time earth came into existence. Radon ^{222}Rn is a radioactive, colorless, odorless, tasteless noble gas, occurring naturally as the decay product of uranium. It is one of the densest substances that remains as a gas under normal conditions and is considered to be a health hazard due to its radioactivity. It has a half life of 3.82 days. Naturally occurring radon ^{222}Rn in indoor air is a significant cause of lung cancer and the houses are an important exposure location due to the large proportion of time spent at home. It has been concluded that the inhalation of short of short lived progeny of Radon (^{222}Rn) can cause lung cancers. Many worldwide studies have been carried out in various countries to determine level of radon and its progeny in the dwelling and health effects to the residents.

MATERIAL AND METHODS:

For "Measurement of Indoor Radon Concentration in GZS PTU Campus, Bathinda using LR-115 films", a solid state detector is used. The chemical composition Cellulose Nitrate, manufactured by Kodak pathe in France is used to detect alpha particles. The track etch detector technique has been used for this purpose, the LR-115 type II plastic track detectors having a size of about 1.5 cm x 1.5 cm fixed on glass slides were suspended from the ceiling in the centre of room in the bare mode technique for 40 days in 10 different location.

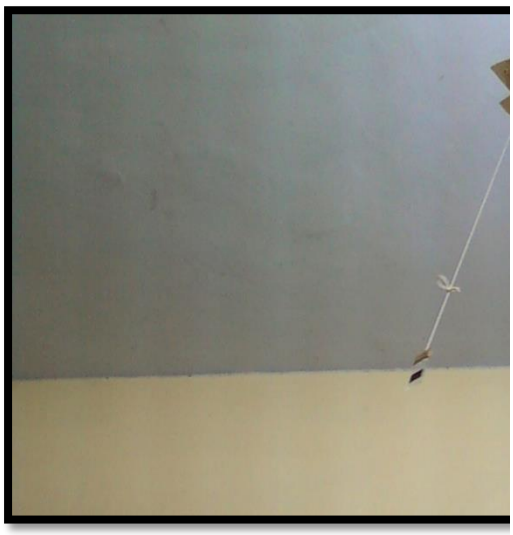

FIG: LR-115 SAMPLE

The exposed detectors were etched in 2.5 N NaOH solutions for 90 minutes in constant temperature bath of 60 degree. After etching the detectors were throughly washed and scanned manually for track density measurements using an optical microscope with a magnification of X400. For radon concentration calculations, track density was converted into working level concentration using 1 Tracks $cm^{-2}day^{-1}$ is equal to 50 Bq m^{-3}. Also equilibrium factors (F) of value 0.4 for dwellings have been used. Radon concentration in Becquerel per cubic meters (Bqm^{-3}) is calculated using the formula (Jojo et al., 1994; ICRP, 1993): Radon concentration 1Bqm^{-3} is equal to 0.0156 $Mjhm^{-3}$ and 1$Mjhm^{-3}$ is equal to 0.2825 WLM^{-1}. Calculations have been made using the conversion factors given elsewhere (ICRP, 1993; Raghavayya, 1994). ICRP assumes 80% occupancy (7000 h/yr) indoors. One working level month (WLM) corresponds to the exposure of an individual to radon progeny of 1WL concentration (2.08 x 10^{-2} mJm^{-3}) for a duration of 170 h which results in 1 WLM equivalent to 3.54 $mJhm^{-3}$. The conversion factors of 3 x 10^{-2} WLM^{-1} and 3.88 mSv WLM^{-1} (ICRP, 1993) are used for calculating the lifetime fatality risk and the annual effective dose, respectively.

RESULTS AND DISCUSSION

The computed values of indoor radon concentration in GZS PTU Campus, Bathinda are given in Table given below. The measured indoor radon concentration varies from 40 – 120 Bqm^{-3} with an average value of 80 Bqm^{-3}. Calculated values of life time fatality risk ranges from 0.53-1.58 x 10^{-4} with an average value of 1.05 x 10^{-4} and value of annual effective dose lies from 0.68 to 2.05 mSv $year^{-1}$. It has been observed that an average indoor radon concentration value is more than the world average (UNSCEAR, 2000).

The annual average indoor radon value in the study area varies from 40-120 Bqm^{-3} with an average value of 80 Bqm^{-3}.These values are 2–3 times more than the world average of 40Bqm^{-3} (UNSCEAR, 2000). This may be due to the difference in the concentration of radioactive elements, viz. Uranium and Radium in the soil and building materials of the study area, which has also been reported in studies of soil samples from similar geological conditions in Malwa region of Punjab (Mehra et al., 2006; Mehra et al., 2007). However these values are less than the lower limit of the range of the action level (200–300 Bqm^{-3}) recommended by the International Commission on Radiological Protection (ICRP, 2009). . These values are also in safe limit as compare to the studies of Mehra R. et, al. (2006) in the Malwa region, Punjab which vary from 54-168Bqm^{-3} with an average value of 82Bqm^{-3}. These values are also comparable with the studies in dwellings in Western Haryana, India by S Kansal et.al.(2012) which vary from 76 to 115.46 Bqm^{-3}.

CONCLUSIONS:

The measured values of Indoor Radon Concentration in GZS PTU CAMPUS BATHINDA are comparable with recommended values. These values are below the recommended action level 200-300 Bqm^{-3} (ICRP, 2009). An average value of radon concentration is also more

than the world average value of 40Bqm^{-3} (UNSCEAR, 2009). Annual effective dose is less than the lower limit of recommended action level of 3-10 mSv year$^{-`1}$. Hence there is no visible radiological risk to the residents of the study area.

Table: The values of indoor concentration in GZS PTU Campus, Bathinda

S.NO.	Sample location	Radon Conc.(Bqm^{-3})	Annual exposure to occupants		Life time fatality risk x 10^{-4}	Average Annual Dose (mSv year^{-1})
			Mjhm^{-3}	WLM		
1	Physics lab research room	70	1.092	0.308	0.92	1.2
2	Acadamic department Dean office	100	1.56	0.441	1.32	1.71
3	Physics lab store room	110	1.716	0.485	1.45	1.88
4	Library hall	40	0.624	0.176	0.53	0.68
5	Campus colony L-25	60	0.936	0.264	0.79	1.02
6	Chemistry lab store room	120	1.872	0.529	1.58	2.05
7	Workshop W-05 room	90	1.404	0.397	1.19	1.54
8	Campus colony AP-15	80	1.248	0.353	1.06	1.37
9	Entry gate guard's room	70	1.092	0.308	0.92	1.2
10	Mechanical computer cell	60	0.936	0.264	0.79	1.02
	Min.	40			0.53	0.68
	Max.	120			1.58	2.05
	Avg.	80			1.05	1.367