INDOOR RADON ACTIVITY CONCENTRATIONS IN NONGSTOIN TOWN, WEST KHASI HILLS DISTRICT, MEGHALAYA

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Abstract: Inhalation of Radon (^{222}Rn) and its progeny are the major sources of natural background radiation exposure. The present paper reports the result of an indoor Radon study carried out in dwellings of Nongstoin town located in West Khasi Hills District, Meghalaya, India. The survey is carried out using LR-115 type2 Solid State Nuclear Tracks Detectors (SSNTDS) in the bare mode. The overall radon activity concentration measured has been found to vary from 11.1 to 389.7 Bq.m^{-3} with an arithmetic mean value of 61.1 ± 76.5 Bq.m^{-3} and a geometric mean value of 41.6±2.24 Bq.m^{-3}. The measured dose received by the residents is found to be well below the limits prescribed by World Health Organization.

Keywords: LR-115 type 2; Radon; Annual Effective Dose

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1. Introduction:

Exposure to natural ionizing radiation is a continuous and unavoidable feature of life on earth. Among all sources of natural background radiation that can deliver significant radiation dose to the human body, it is estimated that 50-55% of this natural background radiation is contributed by radon and its progeny. Radon results from the decay of radium (Ra-226) in the naturally occurring uranium series [1-8]. Being a noble gas and having a comparatively long half-life of 3.8 days, it can easily diffuse into the indoor environment of dwellings through the soil, rock and building materials. Radon decays into electrically charged progenies that adhere to tiny dust particle in indoor air which when inhaled can get attached to the lining of the lung [4, 10-12]. The deposited atoms decay by emitting alpha radiation, which has the potential to damage the cells and disrupt the DNA of the lungs [2].

In this paper, we have reported the indoor radon activity concentration measured in densely populated Nongstoin region, which is the headquarters of West Khasi Hills District of Meghalaya. We suspect that the growing mining activities for coal, iron ore, granite, etc around the study area and localization of rich uranium deposits in Kylleng-Pyndengsohiong (Mawthabah) areas in nearby district might have an effect on the dispersion of the natural radionuclide to the indoor environment of the region. The study was carried out from January to May 2014.

2. Experimental technique:

In the present study, LR-115 type2 SSNTDs in the bare mode are used for the measurement of radon activity concentrations in the indoor environment (dwellings) [4]. The LR-115 type2 films are cut into 2.5x2.5 cm^2 sizes and pasted onto a cardboard of dimension 6x9 cm^2. The setup is then hung with a thread at the centre of the selected room at least 10 cm away from the nearest walls and about 2 m above the floor. After an exposure of 5 months, the films are retrieved and chemically etched in a 2.5N NaOH solution for 90 minutes at 60^{o}C. Subsequently, the alpha particle tracks are observed under an optical microscope and counted manually at 150x magnification of the microscope. The tracks density observed is then converted to corresponding radon concentration using the formula:

$$C_{Rn} = \frac{\rho}{KT}$$

where, ρ is the track density (number of tracks counted per square centimeter of the film), K is the calibration factor (=0.019 tracks. $m^{-2}.d^{-1}$. $(Bq.m^{-3})^{-1}$) and T is the exposure time in days [9].

3. Result and discussion:

The indoor radon concentration levels recorded at three sites near Nongstoin town are given in table 2. The annual exposure, the annual effective dose (AED) and average lifetime risk associated with dwellings in the three study sites have also been calculated and is presented in table 2. At Pyndengrei Pdengshnong site, the measured radon activity concentration has been found to vary from 11.1 to 142.3 $Bq.m^{-3}$ with the arithmetic mean value of 45.8 ± 39.5 $Bq.m^{-3}$ and geometric mean value of 33.7± 2.2 $Bq.m^{-3}$; the highest values were measured at Pyndengrei, MawKhmahwir/thadwang site with values ranging between 14.9 to 391.3 $Bq.m^{-3}$ with the arithmetic mean value of 118.9 ± 154.5 $Bq.m^{-3}$ and geometric mean value of 63.5 ± 3.06 $Bq.m^{-3}$. At New Nongstoin site, the radon activity measured has been found to vary from 18.3 to 70.3 $Bq.m^{-3}$ with the arithmetic mean value of 45.8 ± 17.4 $Bq.m^{-3}$ and geometric mean of 42.6 ±1.5 $Bq.m^{-3}$.

Table 1: Location of the study sites with the detector codes used.

Code name of the detector	Lattitude			Longtitude		
	Degrees	minutes	seconds	Degrees	minutes	seconds
A1	25	32	4.7	91	15	39.4
A2	25	32	3.2	91	15	35.8
A3	25	32	3.2	91	15	35.8
A4	25	32	5.7	91	15	36.4
A5	25	32	5.7	91	15	36.4
A6	25	32	5	91	15	31
A7	25	32	5	91	15	31
A8	25	32	8.4	91	15	36.6
A9	25	32	8.4	91	15	36.6
A10	25	32	6.5	91	15	38.9
A11	25	32	6.5	91	15	38.9
B1	25	32	22.7	91	15	55.2
B2	25	32	18.5	91	15	39.2
B3	25	32	2.7	91	15	39.4
B4	25	32	2.7	91	15	39.4
B5	25	32	2.7	91	15	39.4
C1	25	31	47.1	91	15	35
C2	25	31	47.1	91	15	35
C3	25	31	38	91	15	44
C4	25	31	38	91	15	44
C5	25	31	2.2	91	15	57.3
C6	25	31	31.1	91	15	51.4
C7	25	31	2.2	91	15	57.3
C8	25	31	23.2	91	16	16.4

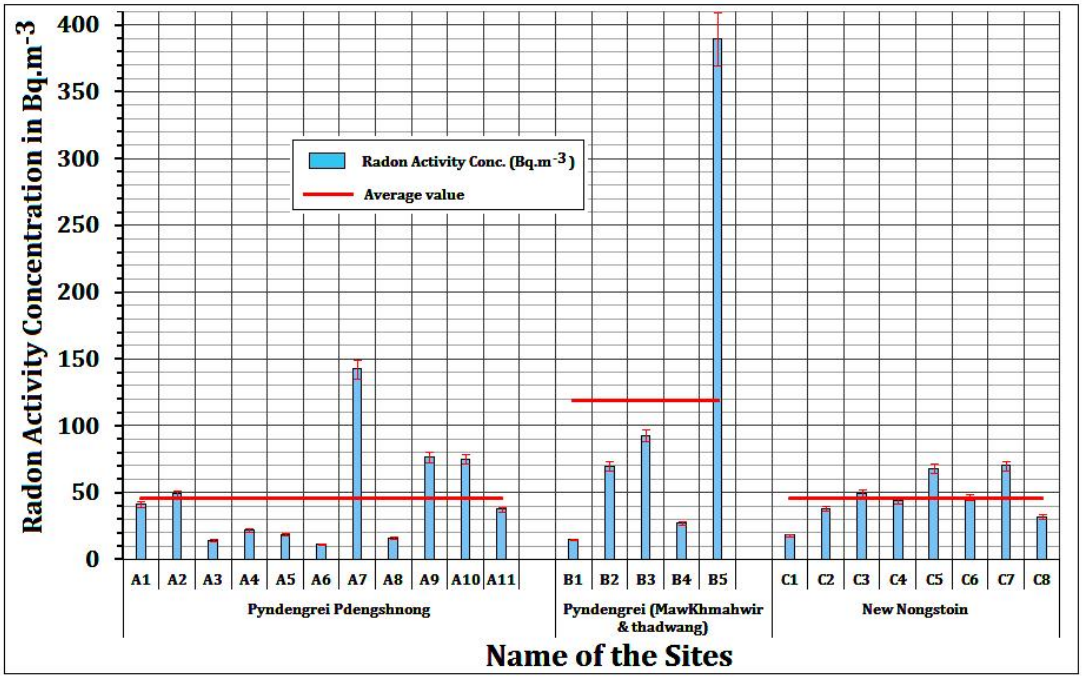

Figure 1: Distribution of radon activity concentration at the three sites in Nongstoin town with their average values indicated by the red horizontal line.

Table 2: List of the name of sites where the detectors were exposed with the Annual average indoor radon activity concentration, the annual exposure to occupants, the annual effective dose (AED) received by occupant and their lifetime fatality risk estimates.

Name of sites	Detectors code	Radon concentration (in Bq.m^{-3})	Average radon concentration in (Bq.m^{-3})				Annual Radon concentration in Bq.m^{-3}	Annual Exposure		Lifetime fatality risk x10^{-4}	AED (mSv.y^{-1})
			A.M	G.M	S.D	G.S.D		WLM	mJhm^{-3}		
Pyndengrei Pdengshnong	A1	41.17	45.82	33.73	39.54	2.18	41.33	0.03	0.10	0.08	1.09
	A2	49.42					49.61	0.03	0.12	0.10	1.31
	A3	14.18					14.24	0.01	0.03	0.03	0.38
	A4	21.91					21.99	0.01	0.05	0.04	0.58
	A5	18.70					18.77	0.01	0.04	0.04	0.50
	A6	11.11					11.16	0.01	0.03	0.02	0.29
	A7	142.32					142.89	0.09	0.34	0.28	3.77
	A8	15.88					15.94	0.01	0.04	0.03	0.42
	A9	76.57					76.87	0.05	0.18	0.15	2.03
	A10	75.18					75.48	0.05	0.18	0.15	1.99
	A11	37.61					37.76	0.03	0.09	0.08	1.00
Pyndengrei MawKhmahwir/ thadwang	B1	14.82	118.95	63.49	154.60	3.06	14.88	0.01	0.04	0.03	0.39
	B2	69.88					70.16	0.05	0.17	0.14	1.85
	B3	92.81					93.18	0.06	0.22	0.19	2.46
	B4	27.54					27.65	0.02	0.07	0.06	0.73
	B5	389.71					391.27	0.26	0.92	0.78	10.33
New Nongstoin	C1	18.27	45.85	42.58	17.39	1.49	18.34	0.01	0.04	0.04	0.48
	C2	38.12					38.28	0.03	0.09	0.08	1.01
	C3	49.70					49.90	0.03	0.12	0.10	1.32

	C4	44.01					44.18	0.03	0.10	0.09	1.17
	C5	67.94					68.21	0.05	0.16	0.14	1.80
	C6	46.38					46.56	0.03	0.11	0.09	1.23
	C7	70.33					70.61	0.05	0.17	0.14	1.86
	C8	32.02					32.14	0.02	0.08	0.06	0.85

Distribution of radon concentration levels among the 24 dwellings in Nongstoin town is shown in Fig. 1. The error bars represent the counting errors and the red horizontal line denotes the average of the radon activity concentration at the respective sites.

4. Conclusion:

It is found that in 92% dwellings, the radon concentration is below the recommended action level (< 100 $Bq.m^{-3}$) given by the World Health Organization (WHO). In all of the dwellings studied, the annual effective dose (AED) received by the resident ranges between 0.29 $mSv.y^{-1}$ and 3.7$mSv.y^{-1}$ which is lower than the prescribed limits set by WHO viz. 10 $mSv.y^{-1}$ [13] except for a site located in Pyndengrei, MawKhmahwir/ thadwang for which the value is 10.3 $mSv.y^{-1}$. Hence, the present study shows that no significant health hazard is posed by the radiological environment in the Nongstoin town.

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