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Diurnal Variation of Background Radiation at 5 Meter Above Earth's Surface Measured Using G-M Counter and NaI(Tl) Crystal Detector.

S. T. Mane[1], T. B. Mane[2] A. K.Sharma[3]

Abstract—: Natural radioactivity of primordial radioactive nuclei present in the earth crust in soil, water, atmosphere and secondary cosmic radiations with radiation from cosmoganic radioactive nuclei forms the natural background radiation. In the present study the natural background activity were measured with G-M counter and NaI(Tl) crystal scintillation detector. Observed average activity at 5 meter height measures to be 1673 Bq/m2 with G-M counter and 1509 Bq/m2 with NaI(Tl) crystal detector and is found to be 23% less than that measured at the surface at the place of observation. The average dose rate is measured to be 0.8092 mSv/year and is well within prescribed limits recommended by ICRP. There observes small diurnal variation in activity with peak at early three-four morning hours and in the evening two-three hours after sunset with a standard deviation of 4.5%. The small increase in activity during early morning hours and in the evening hours is due to vertical and horizontal temperature inversion condition arising during this time due to it radon accumulation take place.

Index Terms Average dose rate, Background radiation, Diurnal Variation, G-M counter, , NaI(Tl) scintillation detector, radon accumulation, temperature inversion

1 INTRODUCTION

NUCLEAR radiation are present in the earth's environment since from the formation of earth .The isotopes of uranium, thorium with their decay products and potassium (40K) are widely distributed in the earth's crust. These along with the cosmic radiation are the sources of natural radiation in the environment to which the life on the earth is exposed. At surface the contribution of cosmic rays is low (< 10%) and increases with altitude. Naturally occurring radioactive nuclei are present all over the world in earth's crust, soil, ground, water & atmosphere such as primordial radionuclide 238U, 235U, 232Th with their decay products and ^{40}K, ^{87}Rb etc. & others are produced due to interaction of cosmic radiations with Earth's atmosphere like 12C, 3H. Radioactive nuclei emits α, β particles and gamma rays. Radiation emitted from the disintegration of radioactive nuclei and the cosmic rays of the solar and galactic origin constitute the natural background radiation environment.. Nuclear radiations are harmful to human and life on the earth. To assess the dose rate from natural background radiation at place to place all over the world becomes a part of national and international survey. In the present study we have used G-M counter and NaI(Tl) crystal scintillation detector and measured the background activity at a height 5 meters above the earth's surface at a place, Kankvali. (150 59'N; 720

1. S.S.P.M.'S College of Engineering,Kankvali.Tal. KankvaliDist. Sindhudurg. mane.shubhangi@yahoo.co.in

2. Shri.S.H.Kelkar College of Arts Commerce &Science, Devgad.

3. Department of Physics, Shivaji University, Kolhapur.

Experimental set up & Data Collection:

Different radiation detectors are used for the detection of nuclear radiations and all have their own merits and limitations. Gas filled detectors are suitable for α, β particles but they have less efficiency for gamma rays. High density NaI(Tl) crystal scintillation detector is found to be suitable for gamma detection. To observe the diurnal variations in background radiation we have used G-M counter and NaI(Tl) crystal scintillation detector. The detectors were calibrated with standard source of 137Cs. The efficiency of G-M counter measures to be 5.3% and that of NaI(Tl) is 70%. From the energy spectrum of the background radiation obtained using NaI(Tl) detector the Compton edge have been detected at 1.5 volt threshold voltage. The G-M counter was operated at 500 volt, tube voltage while NaI(Tl) detector at 900 volt, tube voltage and at 1.5 volt threshold voltage. Both the detectors were mounted side by side on the terrace at height 5 meters from the ground and observation were carried out. The experimental set up is presented in Fig:1.

Fig.1 Experimental set up: The G-M Counter & NaI(Tl) crystal detector.

Sr. No	Time in hours (IST)	Observed average counts per 3 minutes in G-M counter. (average over an hour)		Observed average counts per 30 seconds in NaI(Tl) crystal detector. (average over an hour)	
		25-26/01/2011	14-15/03/2011	25-26/01/2011	14-15/03/2011
1	00	46.1	46.7	1466	1619
2	1	47.8	46.4	1874	1683
3	2	47.4	44.8	1907	1769
4	3	47.8	49.6	2001	1792
5	4	48.2	48.0	2153	1794
6	5	46.1	49.8	2031	1883
7	6	51.2	47.4	1674	1898
8	7	49.7	49.8	1760	2076
9	8	49.5	52.3	1582	1987
10	9	50.4	54.4	1722	2034
11	10	49.7	45.7	1618	1853
12	11	44.5	48.0	1464	1893
13	12	45.5	47.0	1373	1887
14	13	46.1	47.6	1376	2044
15	14	45.7	50.5	1398	1880
16	15	45.4	51.2	1502	2286
17	16	43.2	51.0	1719	2172
18	17	43.3	51.7	1684	1785
19	18	44.9	48.3	1437	2066
20	19	46.9	44.2	2076	2090
21	20	46.3	44.8	2048	2002
22	21	46.1	40.0	1967	2147
23	22	47.7	46.0	1742	2116
24	23	48.3	49.7	1337	1910
	Average	47.0	47.9	170T4	1944

. Table No. 1: Data collected on25-26/01/2011 and 14-1503/2011

To minimize the statistical fluctuations in the observed count rate the readings were recorded for every 3 minute in G-M counter and for every 30 seconds in NaI(Tl) detector and it’s average over an hour was taken

Results and discussion:

Both the detectors were simultaneously operated for nine different days at the place Kankvali (15^0 59’N; 72^0 34’E).With G-M counter, counts for every 3 minutes interval were recorded while in NaI(Tl) detector, counts for every 30 seconds were recorded and average over an hour were calculated. Average counts in an hour were plotted for 24 hours IST. Data obtained from G-M counter is graphically presented in Fig.No.2 and that of NaI(Tl) detector is in Fig.No.3. Observed counts were corrected for geometrical and intrinsic efficiency of both the detectors. Compton scattered electrons counts were subtracted from NaI(Tl) detector counts at Compton edge. The Compton edge was detected from the background radiation energy spectrum and it has been observed at 1.5 volts threshold voltage. From the dimensions of the detectors the activity in Bq/m^2 were obtained. Using standard conversion factor used for the energy range of background radiation and corresponding to the G-M tube specifications, the observed activity were converted into dose rate in mSv/year. The results obtained from study are listed below.

1.The observed average activity at 5 meter height measures to be 1673 Bq/m2 with G-M counter.

2. The observed average activity at 5 meter height measures to be 1509 Bq/m2 with NaI(Tl) crystal detector.

3. The activity measured with two detectors is nearly equal and comparable.

4. The observed activity at height 5 meters is found to be 23% less than that measured at the surface at the same place.

5. The average dose rate is measured to be 0.8092 mSv/year and is well within prescribed limits recommended by ICRP, which is 1 mSv/year for non-nuclear energy workers and 20 mSv/year for nuclear energy workers.

6. There observes small diurnal variation in activity with peak at early three-four morning hours and in the evening two-three hours after sunset.

7. The diurnal variation in activity shows standard deviation of 4.5% about the average value.

8. The rise in the measured activity during morning and evening hours is attributed to the rise in the radon concentration during this hours due to it’s accumulation in lower atmosphere vertical and horizontal temperature inversion condition arising during this period on account of which winds stop blowing during the period.

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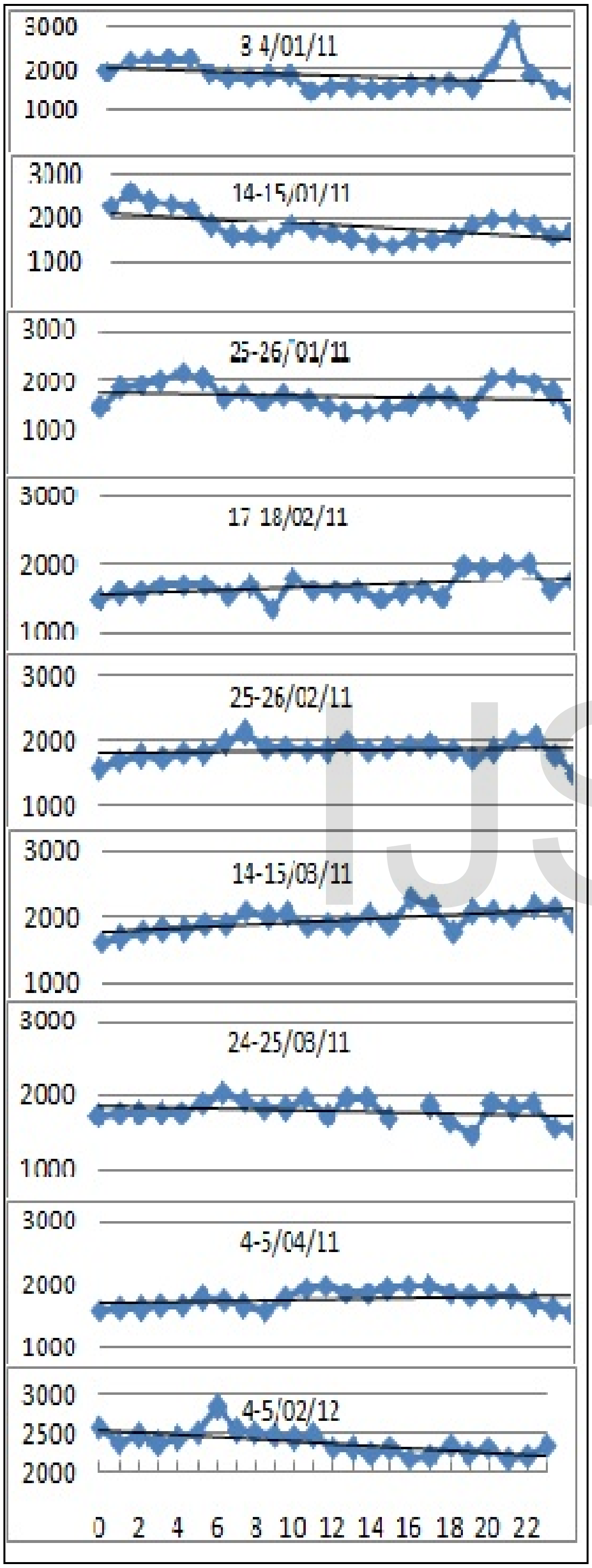

Fig.2: day variation of observed counts for different

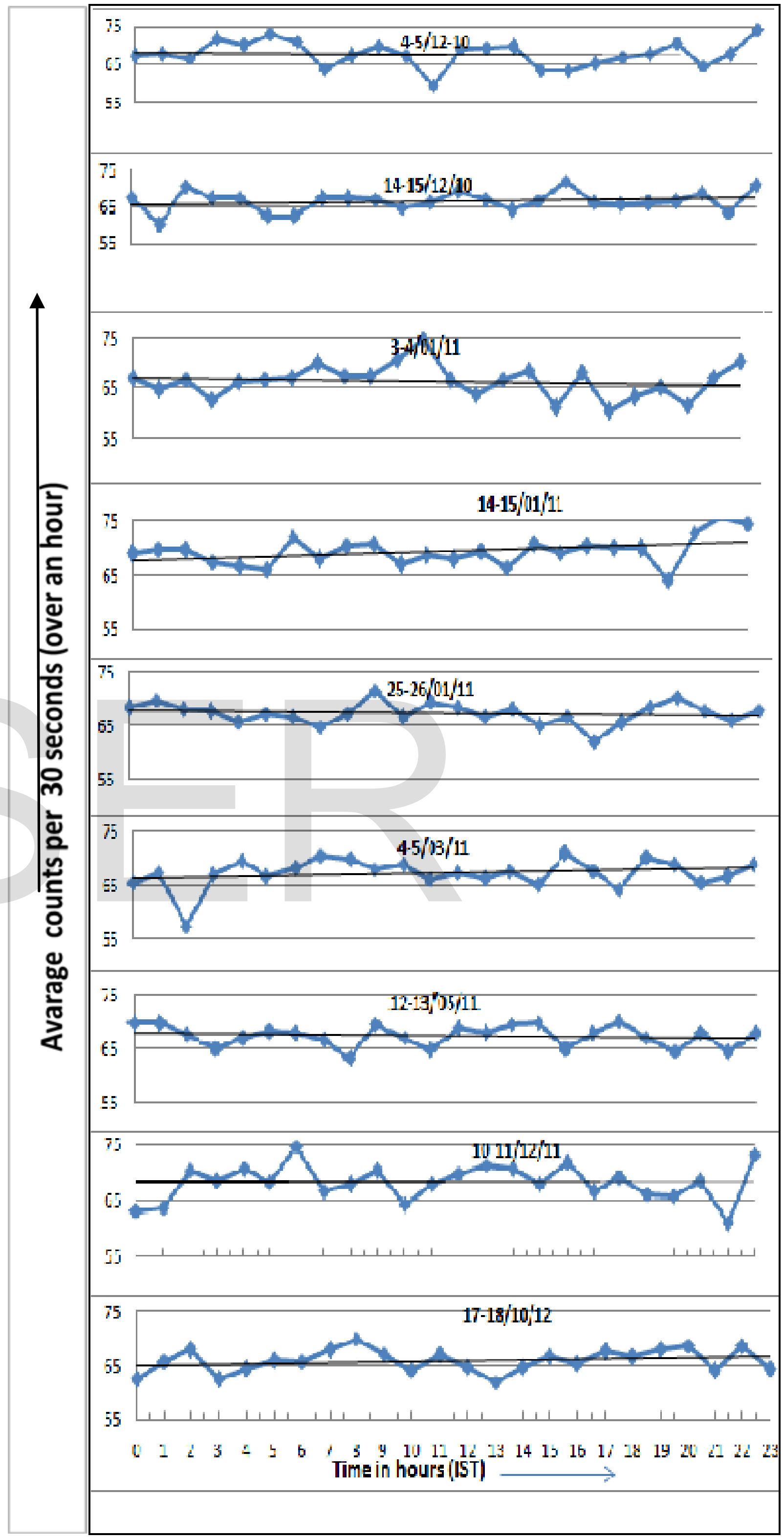

Fig.3: day variation of observed counts for different days of observation measured using G.M.Counter

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