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Background Radiation: Detection, Measurement and Hazards

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Abstract : *Radiation is a form of energy. It is of two types: non-ionizing and ionizing. Among them, ionizing radiations have hazardous health effects upon human beings. Different types of cancers may arise from the overexposure to ionizing radiations like alpha- particles, beta-particles, gamma- rays, x-rays etc. Further, ionizing radiations have very important utilities in case of paper handling and use. Radiations can be used for various beneficial purposes like medical imaging, radiation therapy, improvement of quality of agriculture, industry etc. The overall radiation from various sources on a specific location on earth's surface refers to the background radiation level of that zone. Exposure to background radiation is an inescapable feature of the environment. A portable GM counter was used to quantify the total radiation level at different places. The finding of this shows a variation of radiation level. Comparatively large values of radiation counts at high altitude and low values at river side. There is no any abnormal value of radiation counts for all sample places. So, there is, generally, no significant risk of public exposure to the background radiation for sample places.*

Key words: Background Radiation, GM counter, Medical Imaging, Radiation Therapy

1. INTRODUCTION

Radiation can be referred as the energy in motion or energy in the form of waves or particles. Radiation is present everywhere around us in many forms. The sources of radiations may be of different types such as cosmic rays (radiation from outer space), radiation from the radioactive atoms present in earth's surface, radiation from our own body etc. Radiation will include: Radio waves, microwaves, infrared, visible light, ultraviolet rays, x-rays and atomic particles. Here, we are concerned with the radiation with high energy to ionize matter. Non-ionizing radiations are said non-harmful because the degree of harm produced by these radiations is very low in comparison with ionizing radiations. This study deals with the ionizing radiation **(**). So, radiation here is referred to as ionizing radiation.

In accordance with energy or ionizing power radiation can be classified as non-ionizing and ionizing radiations. Those radiations which lack the sufficient energy required to knockout electrons from outer most orbits of an atom are known as non-ionizing radiations. For example microwave radiation, radio waves, infrared radiation etc. On the other hand, the radiations which carry sufficient energy to knockout electrons from the outer most orbit of an atom are known as ionizing radiations such as and x-rays etc.

Radiations can also be classified as natural and artificial radiations. The radiations emitted naturally either from sun or from cosmic stars or from radioactive materials present in earth's surface are referred as natural radiations whereas radiations that come from artificial sources used from different purpose are known as artificial or manmade radiations which are used for medical purposes such as x-rays, Radio therapy etc.

The overall radiation coming from natural or artificial sources on a particular place is known as background radiation at that place. Life on earth has been exposed to ionizing radiation since the life was developed because radiation has been present since the formation of earth. Major sources of radiation are:

Natural sources of radiation: The main sources of natural radiation are terrestrial radiation, soil, gas, cosmic radiation, natural radioactivity in the body etc. The largest natural source of radiation is radon gas. Radon's primary pathway is from the earth, the rough the basement of houses and on the soil and rock structure beneath buildings. The other terrestrial sources are radioactive materials in rocks and soil. The main contributors are radioactive isotopes of potassium and the isotopes that are the products of the decay of Uranium and Thorium. High energy particles and -rays from outer space add to the background radiation.[8]

Artificial sources of radiation: These sources include medical diagnostic exposures such as x-rays as well as from nuclear medicine involving diagnostic procedures such as use o nuclear tracers. Very small amount of radioactive materials called tracers are put into the blood stream, and

their progress through body is monitored with a radiation detector. With this blocked or restricted blood vessels can be identified. Other consumer products that could expose people to radiation include smoking of cigarettes, burning gas lanterns, using natural gas for heating and cooking, using phosphate fertilizer, radiation from color T.V.as well as use of cell phones.

Types of ionizing radiations:

Alpha Radiation: It consists of alpha particles that are made up of two protons and two neutrons each and carry a double positive charge.

Beta Radiation: It consists of charged particles ejected out from nucleus and are physically identical to electrons.

Photon Radiation: It is an electromagnetic radiation such as -rays and x-rays.

Neutron Radiation: Spontaneous fission is only the source of neutrons. Neutrons are able to penetrate tissues and organs of human body and can be hazardous if neutron emitting nuclear substances are deposited inside the body.

Detection of Ionizing Background Radiation:

There are various instruments for the detection of ionizing background radiation. Geiger Muller (GM) counter is one of the particular type of radiation detecting instrument used here.

Radiation Hazards:

Large doses of ionizing radiations, very much larger than background level, can cause a measurable increase in cancers and leukemia (blood cancer) after some years of delay. At very high levels, radiation can cause sickness and death within weeks of exposure:

2. MATERIALS AND METHODS:

The radiation survey was carried out by the measurement of background radiation by using Geiger Muller counter at different places of syangja district. The instrument s designed by Industrial Equipment and Control Private Limited, Australia. The model of Geiger counter is characterized by CAT. No. AP 885-001 and that of GM tube has been characterized by CAT. No PA 1885-020/030. This instrument has capability of counting high energy alpha, beta and gamma particles entering inside the tube. It requires 220-240 V and 50/60 Hz AC power supply to perform radiation count. The amplifier of this counter can amplify the voltage up to 600V. It shows counts in one display screen and count rate in another display screen. This counter has also timer. So we can set the time for 10 seconds or 100 seconds. It gives low audible sound while detecting every radiation and high audible sound after completion of the time set.

Background radiations were measured at different places of syangja district involving hospital areas, signal areas, religious places and high residential areas. Measurements were performed during daytime between 10 AM to 5 PM in the month June 2016. The unit of measurement is count per 100 seconds and converted into count per minute (cpm).

3. RESULT AND DISCUSSION:

Background radiation counts for different places of syangja district was successfully collected with the help of GM counter. Average values and standard deviation for cpm for different places are calculated using Ms Excel tabulated as below.

Table 1: Radiation count of various places with standard deviation and Peak value of count/sec.

S.N.	Name of the place	Mean Count Per Minute	Standard Deviation (S.D)	Peak Value of count/sec	Mean ± S.D
1	Syangja Hospital	28.59	2.77	3	28.59 ± 2.77 i.e. (25.82, 31.36)
2	Radio Chowk	30.39	3.29	4	30.39 ± 3.29 i.e. (27.1, 33.68)
3	Mahendra Chowk	34.23	3.48	4	34.23 ± 3.48 i.e. (30.75, 37.71)
4	Gurung Dada	70.23	15.97	8	70.23 ± 15.97 i.e. (54.26, 90.2)
5	Aandhikhola Bank	21.63	2.94	2	21.63 ± 2.94 i.e. (18.69, 24.57)
6	NTC Office	31.52	5.26	4	31.52 ± 5.26 i.e. (26.26, 36.38)
7	Sanyas Aashram	43.98	9.58	3	43.98 ± 9.58 i.e. (34.4, 53.56)
8	Pokhari Dada	64.77	9.09	5	64.77 ± 9.09 i.e. (55.68,73.86)
9	District Hospital	40.48	6.57	3	40.48 ± 6.57 i.e. (33.91, 47.05)

Source: Data collected for project work of B.Sc. 4th year in the month June 2016.

From this table it is clear that different places have different value of mean cpm. There is also variation in the standard deviation and peak value of count/ sec. Here, peak value of count/ sec. refers to the maximum value of count/sec.

These average values of background radiation counts for various places are plotted in a bar diagram taking name of places along x-axis and count/minute along Y-axis as shown below.

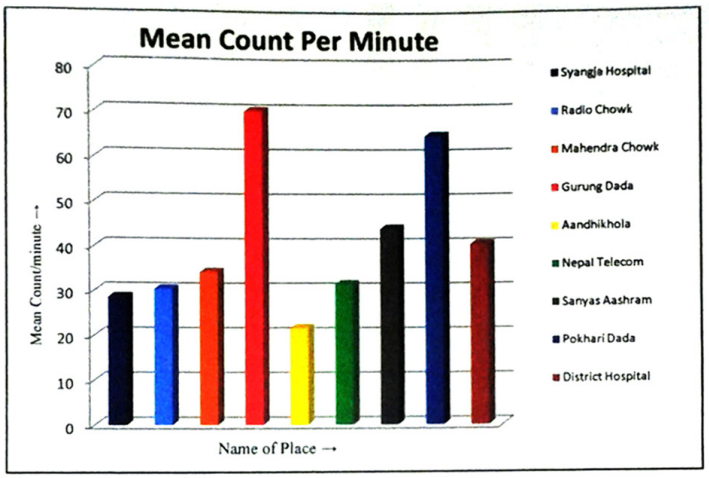

Fig. Variation of peak values of count/sec for different places.

There are no significantly large fluctuations in the arrival of radioactive particles inside GM tube for six places while moving it at variety of regions of the someplace. So counts are placed in some category. But for three places there are significant fluctuations in the count rates while moving the device at several places. So the data are further categorized into two or three parts and average values and standard deviations of separate parts have also been calculated as tabulated below.

Table: 2 Variety of observations at three places

S.N.	Places	Variety of Regions	Mean Count Per Minute	Standard Deviation
1	Gurung Dada	Inside Room	78.73	7.41
		Outside Room	46.44	2.99
2	Pokhari Dada	Inside Room	68.44	7.33
		Outside Room	53.76	1.73
3	Sanyas Aashram/Temple	Outside Temple/Aashram	32.7	5.9
		Near Shivalinga	41.88	3.94
		Near Saligran Stones and Ancient Statue	52.67	2.3

Source: Data collected for project work of B.Sc. 4th year in the month June 2016.

Several studies had already been performed to know about the extent of occupational exposure to the radiations at hospitals. But this study does not focus on occupational exposures rather it focuses on public exposure to background radiation level. Observations have been carried out outside hospital so as to check whether the ionizing radiations used in hospital have higher range o produce harm to public.

4. CONCLUSIONS

From the study carried out to evaluate the background count per minute in the selected sites of Syangja district following conclusions are drawn:

1. The minimum value of radiation was observed at the bank of Aadhikhola river(i.e. 21.63cpm).
2. A little high value of background radiation has been observed at Shree Champagiri Sanyas Aashram(i.e. 49.98cpm).
3. Maximum values of cpm are obtained at two nearly located places: Gurung Dada and Pokhari Dada(70.23 and 64.77cpm respectively). This may be due to the high exposure to cosmic rays being located at high altitude.
4. No significant radiation hazard due to background radiation is observed in the people at places with high cpm and low cpm.

It is clearly verified from this study that radio activity is not a continuous phenomenon because radiations are observed in the form of discrete counts and count number is not same in a fixed time while several observations are taken.

5. LIMITATIONS

Main limitation is in choosing the instrument for the measurement of background radiation count because GM counter gives only the count rates. We did not find any conversion factor for converting count rates into equivalent dose for this model of GM counter.

6. SUGGESTIONS FOR FURTHER WORKS

Some possibilities of further works which can be generated by analyzing this study may as follows:

1. Study of background radiation level of syangja may be carried out by choosing other places than mentioned above and other districts of Nepal.
2. Study of background radiation level by using specific model of GM counter having conversion formula for converting the count rate into dose may be carried out for the better results.
3. Search of conversion rule is necessary which will be in a position to elaborate about the health effects of background radiation count.

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