Evaluation of Background Ionizing Radiation Level in Some Science Laboratories in Federal College of Education Yola

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Abstract
Radiation has always been present and is all around us. Life has evolved in a world containing significant levels of ionizing radiation. Our bodies are adopted to it. Background exposure from normal levels of the naturally occurring radioactive materials (NORMS) are present in all environmental materials and do not vary remarkably from place to place. Where human activities (Laboratory activities, pollution mining and others) have increased the relative concentration of the radionuclides, they are referred to as the technologically enhanced naturally occurring radioactive materials. Certain types of building materials are known to be radioactive. Exposure to indoor ionizing radiation like exposure to any other type of ionizing radiation results in critical health challenges. The aim of this research work is to determine the level of indoor and outdoor ionizing radiation in some science laboratories in federal college of education, Yola, These science laboratories usually harbour a number of active radiation sources. The ionizing radiation levels were measured using gamma scout (model GS2 with serial number, for the data collection 20 readings were taking for indoor and outdoor and the data measured were read on the display screen of the gamma-scout device. The gamma-scout hand held device was used obtained data for the study was adjusted to detect the alpha, beta and gamma types of radiation in µSv/hr. The mean equivalent dose rate per hour for indoor background ionizing radiation for the laboratories was found to be 0.012mSv/hr while the outdoor was 0.084µSv/hr. The mean annual equivalent dose rate of the laboratories ware compute for indoor and outdoor background radiation level to be 0.013mSv/yr and 0.22mSv/yr respectively, and it concluded that all the science laboratories in the study are in a good proportion below the world wide average dose of 2.4mSv/yr.it was recommended that periodic measurement of ionizing radiation level checking should be done all doors and windows of laboratories are open daily in other to expel some accumulated redox gases.

Key Word: *Background Ionizing Radiation, Equivalent Dose Rate,* Gamma-scout.

Introduction

Background radiation is a measure of the level of ionizing radiation present in the environment at a particular location which is not due to deliberate introduction of radiation sources. Background radiation originates from a variety of sources, both natural and artificial. These include both cosmic radiation and environmental radioactivity from naturally occurring radioactive materials (such as radon and radium), as well as man-made medical X-rays, fallout from nuclear weapons testing and nuclear accidents.

In our everyday activities we usually encounter with various type of radiation at different level of intensities in which some are useful while others are dangerous. The dangerous one which affect humans are more concerned by world health agencies, such effect of the dangerous ones is cancer, cataract, gene mutation destruction of bones and blood cells which lead to the even a death of an individual (Jwanbot, 2012). The main three sources of these radiation are cosmic, terrestrial and radioactivity that comes into human body. Ionizing radiation may be produced in man - made devices, such as X - ray tubes, or it may come from the disintegrating of radioactive nuclides, the phenomenon that is called (radioactivity).

A lot of studies have been conducted in Nigeria on the outdoor background ionizing radiation (BIR) Chad-Umoren et.al (2006. on the other hand, indoor BIR have not been investigated much despite it is one of the important studies which will revealed the existence of dangerous BIR within our buildings (Chang et al, 1999). according to Chad-Umoren et.al 2006 it is very important to investigated indoor BIR because some of the materials used in building construction consisted with one or more radioactive material, equally harmful radioactive gases e.g. radon with a higher concentration exist in indoor air than outdoor air.

Due to variation of climatic condition of our environment people used to spend more time indoor than outside (Felix et al, 2015). the world health organization and international commission for radiological protection conducted a study and the result show that people who live in a temperate climate stay outside only about 20% of their time and 80% inside their houses, offices, schools, and other buildings which may have some health implication possibly because of long exposure to dangerous radiation is higher than outdoors (Jwanbot et al 2012).

Natural radioactivity has great ionizing radiation effect on the world population due to its presence in our surrounding at different amounts, thus man by the very nature of his environment exposed to varying amount of radiation with or without his consent. The ambient radiation encompasses both the natural and artificial radioactivity in his environment (Farai and Vincent; 2006; Felix et al, 2015).

The Objectives of the Study are:

I. To determine the level of indoor ionized radiation
II. Determine the radiation level of immediate surroundings of laboratories.

Review of Related Literature

The study of Indoor BIR profiles for a building are instrumental because it gives us an opportunity to measure the risk level at which our regular users of such building and general population. studies have shown that continuous exposer to low dosage or dose rate of nuclear radiation from an irradiated building has a potential to induce cytogenetics damage in human lungs (Chad-Umoren

et.al (2006)). Chad-Umoren et.al (2007) conducted a survey of the background ionizing radiation profile within the Physics Laboratory the result revealed that there is a high level of dangerous radiation within the laboratory (indoor) with a value of t(0.871±0.03mSv/yr) than the immediate surrounding area of the laboratory (outside) with a value of (0.728±0.02mSv/yr). Felix et al, 2015 assess the background radiations at Biochemistry, Chemistry, Microbiology and Physics laboratories at Plateau State University to determine the indoor and immediate surroundings level of radiation and the found 0.256μSv/hr mean value for indoor background radiation for all the laboratories while for outdoor background radiation was found to be 0.249μSv/hr. The mean annual equivalent dose rate of the laboratories was calculated for indoor and outdoor background radiation level to be 1.54mSv/yr and 0.44mSv/yr respectively, which is a very good percentage that is below the global accepted average dose of 2.4mSv/yr.

Jwanbot et al 2012 carryout a profile measurement of background ionize radiation in Chemistry Research Laboratory and Physics laboratory at University of Jos using gamma scout. At Chemistry Research Laboratory results the level of radiation was found to be 2.111mSv/yr for indoor, while the outdoor radiation level result was 2.021mSv/yr, for Physics laboratory the indoor result was 2.733mSv/yr and the outdoor results was 2.435mSv/yr. the results of their study revealed that within the two laboratories there is high level of harmful ionizing radiation than outside, around their immediate environs. However, staff, students and other users that use the laboratories and their immediate neighborhood are exposed to insignificant health risks as the values of the mean dose equivalent recorded in this work are consistently less than the worldwide average dose of 2.4mSv/yr. In a recent study by Eshiett et al 2017 on the determination of background radiation level at radiology department of Federal Medical Centre Keffi show a low level of background radiation with mean value of 0.11 to 0.13 microSv/hr is within the permissible value compare to the international standard value of 2.4mSv/yr. particular concern for indoor BIR is the incidence of the invisible, odorless, colorless radioactive gas 222Rn which is a member of the Uranium radioactive series. Estimates show that of the 2.4mSv/yr annual exposure from all ionizing sources 40% is contributed by internal exposure to radon alone [13]. There is a strong correlation between radon exposure (inhalation) and the prevalence of lung cancer (CHAD-UMOREN, 2006, JWANBOT, 2012, Vucic, 1999).the of ^{222}Rn from the radioactivity of ^{238}U and itself decays with a half-life of 3.82 days. When it is inhaled it penetrates the lung. Its most dangerous daughters are the α emitters ^{218}Po and ^{214}Po which emit α particles with energy of 6.0MeV and 7.69MeV, respectively. The continuous deposition and interaction of such high energy particles with the lung lead to its damage and the incidence of lung cancer. ^{222}Rn finds its way indoors through building materials, through diffusion and convection and through the soil under the building (CHAD-UMOREN, 2006, JWANBOT, 2012, Vucic, 1999, CCOHS, 2007).

The ionized radiation that is present in our environment is called background radiation. It originates from both natural and artificial sources like cosmic radiation, and environmental radioactivity such as naturally occurring radioactive materials including radon, radium and fallout from nuclear weapons testing and nuclear accidents (Eshiett et al 2017, Okoye, 2013).

The major source in which people are exposed to is the naturally occurring background radiation, its level usually ranges from about 1.5 to 3.5 msv/yr as well. Background level of radiation in the natural environment always surrounds us it is abundant (Eshiett et al 2017)

In this research the background ionizing radiation levels within the Biology, Chemistry Integrated science, Physics and Centre of excellence Laboratory and their immediate environment at Federal College of Education, Yola will be assessing to enable us determined the level of risk to which staff, students and other users are exposed and compared to International accepted levels. This is needful because beside the regular sources of indoor background ionizing radiation mentioned earlier, the Laboratories harbour a number of active radiation sources.

Methodology

In collecting the data from five science laboratories in Federal College of Education Yola. Four of the laboratories are located within the school of science are Biology, Chemistry, Integrated Science and Physics and the other one is located at Centre for Excellence. The instrument use to collect the data was hand held device called

gamma-scout (model GS2 with serial number A20) was used. The background radiation level were measured both indoor and outdoor of the selected laboratories. For this research work 20 readings were taken for indoors and outdoors in each area. The selection switch of the gamma-scout was adjusted to the right hand side (that is $\alpha + \beta+\gamma$) in order to detect the types of radiation in µSv/hr. The data measured were read on the display screen of the gamma-scout.

. In all the laboratories selected for this research, 20 reading were taking for each case (indoor) and the immediate vicinity (outdoor) of the laboratories selected for the purpose of comparism. The analysis of data collected base on UNSCEAR, 1988 recommended indoor and outdoor occupancy factors of 0.8 and 0.2 respectively. This occupancy factor is the proportion of the total time during which an individual is exposed to a radiation field. Eight thousand seven hundred and sixty hours per year (8760hr/yr) were used.

Equation (i) and (ii) were used to convert these dose rate in µSv/hr into an equivalent dose rate in

mSv/yr. P (µSv/hr) × 8760 (hr/yr) × 0.8 ÷ 1000. = IAEDR (mSv/yr) ……. eqn i

Q(µSv/hr) × 8760 (hr/yr) × 0.2 ÷ 1000. = OAEDR (mSv/yr) ……. eqn ii

Where; P and Q are the indoor and outdoor meter's readings and IAEDR and OEDR are the indoor and outdoor annual effective dose rates respectively (Felex.et.al 2015)

Results and Discussion

The mean value of the sensor reading at all the laboratories were computed and presented in table 1 and table 2. As shown below.

Table 1. Mean indoor gamma-scout sensor reading.

Laboratory Name	Mean P(µSv/hr)	IAEDR (mSv/yr)
BIO	0.021	0.140
CHEM	0.025	0.175
ISC	0.027	0.186
PHY	0.028	0.196
BIO	0.021	0.140
Average	**0.012**	**0.084**

Table 2. Mean Outdoor gamma-scout sensor reading.

Laboratory Name	Mean Q(μSv/hr)	OAEDR (mSv/yr)
BIO	0.023	0.040
CHEM	0.024	0.041
ISC	0.022	0.039
PHY	0.028	0.048
Average	**0.013**	**0.022**

The gamma–scout mean readings and the annual equivalent dose readings obtained by using equations (i) and (ii) of both indoor and outdoor measurements are presented on table 1 and table 2 respectively. The mean equivalent dose rate per hour for

In Biology laboratory indoor mean dose equivalent was found to be 0.021 μSv/hr while the outdoor annual equivalent dose rateI was found to be 0.140 mSv/hr. The mean indoor for Chemistry laboratory was found to be 0.025 μSv/hr and he annual equivalent dose rate was found to be 0.175 mSv/hr. Integrated Science laboratory the indoor mean dose equivalent was found to be 0.027 μSv/hr and the indoor annual equivalent dose rate was found to be 0.186 mSv/hr, the radiation level for Physics laboratory indoor mean equivalent dose rate was found to 0.028 μSv/hr while the annual equivalent dose rate was found to be 0.196 mSv/hr.

Table 2 shows the results obtained from various science laboratory in the college, the outdoor mean dose equivalent for Biology laboratory was found to be 0.023 μSv/hr and the outdoor annual equivalent dose rate was found to be 0.040 mSv/hr, in Chemistry laboratory the results shows that the outdoor mean equivalent was 0.024 μSv/hr and the annual equivalent dose rate was 0.041 mSv/hr.

Therefore, the overall average mean equivalent dose for all the selected science laboratory in the college was found to be0.012(μSv/hr) and the overall average value for indoor mean equivalent dose rate dose is 0.084(mSv/yr) while the overall average mean value for equivalent dose was 0.013(μSv/hr) for outdoor readings and the value for equivalent dose rate was 0.022(mSv/yr). It is concluded that staffs using these laboratories as offices (Laboratory technologies) and students using these laboratories and their immediate neighborhood are exposed to an insignificant health risk of ionizing radiation since the values of the mean indoor and outdoor annual equivalent dose rate recorded in this research are less than the world wide average dose of 2.4mSv/yr for a human being (ICRP, 1990). The mean indoor annual equivalent dose rates(IAEDR) is higher compare to the outdoor annual equivalent dose rates(OAEDR) possibly because of the following reasons; The rock s used for the foundation of the buildings were mostly igneous rocks which are believed to be rich in minerals like zircon, monazite, Uranite, potassium, feldspars and Biotite (Solomon et al,2002; Wertz, 1998). The presence of radon gas in air within the selected laboratories, residual of radioactivity equipment such as Uranium sources which were acquired for experiments in the laboratories, building (earth) materials used in the construction of the laboratories. The sand and soil used for the building construction may contain traces of uranium and thorium since Jos-Plateau is a high background area and also because of tin tailings which are rich i monazite (Ibeanu, 2004; Jwanbot et al, 2010).

Recommendation

This research work is aimed at determine the level of indoor ionized radiation and it immediate surroundings of science laboratories in the college for the purpose of assessing the health risks of the occupants and users of such laboratories, therefore, the users ensure that all the windows and doors are open daily for proper and adequate ventilation in other to expel the accumulation of ionized radiation inside the laboratories, also regular and periodic checking of the level of background ionizing radiation in such laboratories are very necessary . Similar research should be carry out to assess the indoor background ionizing radiation of some selected offices of the in the college especially those whose roof is made of concrete and their windows inside the building.

Conclusion

It is concluded that level of indoor ionizing radiation in the selected science laboratories is higher than the outdoor, around their immediate environs. Therefore, staff, students and other users that use the laboratories and their immediate neighborhood are exposed to insignificant health risks as the values of the mean dose equivalent recorded in this research work both the indoor and the outdoor are consistently far less than the worldwide average dose of 2.4mSv/yr (ICRP, 1990).

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