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Assessment of Indoor and Outdoor Background Radiation Levels in Plateau State University Bokkos Jos, Nigeria

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Abstract
Survey taken by the world health organization (WHO) and the international commission on radiation protection (ICRP) shows that residents of temperate climate spends only about 20% of their time outdoor and about 80% indoors and certain materials use for the construction of such buildings (rocks soils) are known to be radioactive. This work set out to assess the background ionizing radiations at Biochemistry, Chemistry, Microbiology and physics laboratories all of Plateau State University Bokkos to determine the radiation levels both within the laboratories and their immediate surroundings. The gamma-scout used for the purpose of 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 radiation for the laboratories was found to be 0.256µSv/hr while the outdoor was 0.249µSv/hr. The mean annual equivalent dose rate of the laboratories were compute for indoor and outdoor background radiation level to be 1.54mSv/yr and 0.44mSv/yr respectively, and are in a good proportion below the world wide average dose of 2.4mSv/yr.
Keywords: Cancer,equivalent, dose rate, gamma-scout, background ionizing radiation.

1. Introduction

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 increase the relative concentration of the radionuclides, they are refer to as the technologically enhanced naturally occurring radioactive materials (TENORMS)(Dowdall et al, 2004). 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). Survey taken by the World Health Organization (WHO) and the international commission on radiological protection (ICRP) shows that residents of temperate climates spend only about 20% of their time outdoor and about 80% indoor(homes, schools offices or other buildings)(Chad-Umoren et al, 2007).

Materials use for building (soil and rock) are major source of radiation exposure to the population and also a means of migration for the transfer of radionuclide into the environment. Natural radioactivity in soil is mainly due to ^{238}U, ^{40}K, ^{226}Ra which cause external and internal radiological hazards due to emission of gamma rays and inhalation of radon and it's daughters (UNSCEAR, 1988). ^{222}Rn results from radioactivity of uranium - 238 and itself decays with a half life of 3.82days. when it is inhaled it penetrates into the lungs. It's most dangerous daughters are the α- emitters (^{218}Po and ^{241}Po) which emits α-particles with high energy of 6.0 MeV and 7.69 MeV respectively. The continues deposition and interaction of such high energy particles with the lung leads to its damage and the incidence of lung cancer. It has been establish that chronic exposure to even low dose rate of nuclear radiation from an irradiated building has the potential to induce cytogenetic damage in human beings (Chad-Umoren et al,2007). One of the radionuclide's around man's environment that contributes high amount of potential Lethal dose is radon; which causes the majority of deaths resulting from lung cancer (Maria et al; 2010). Of particular concern for indoor background ionizing radiation is the incidence of the invisible, odourless radioactive gas ^{222}Rn which is a member of the Uranium radioactive series. Estimate shows that of the 2.4mSv/yr annual exposure from all ionizing sources, 40% is contributed by internal exposure to radon alone (Chad-Umoren; 2007). A strong correlation between radon exposure (inhalation) and the prevalence of lungs cancer have also been reported (Chad-Umoren et al 2007; Anyakorah 2010). Figures in the ICRP (November, 2009) statement imply that the risk of death from exposure to radon at work and at home could be greater than the one observed from travelling by car and the estimated risk of lung cancer from exposure to radon could be greater than the observed risk of lung cancer from all the remaining causes. In Malaysia, cancer (stomach, breast, lung, liver, leukaemia and thyroid) is one of the major health problems, it has been certified medically that cancer is the fouth leading cause of death (Nisar et al 2014). Natural sources of radiation include; extraterrestrial cosmic radiation (consisting of 87% proton, 12% α-particles and 1% heavier nuclide) (Ghoshal, 2007) and terrestrial radiation from primordial elements in the earth.

Radiation dose depend on the intensity and energy of radiation, type of radiation, exposure time, the area exposed and the depth of energy deposition. Quantities, such as the absorbed dose, the effective dose and the equivalent dose have been introduced to specified the dose received and the biological effectiveness of that dose (Akpa, 2010). The absorbed dose (D); specifies the amount of radiation absorbed per unit mass of material. Its S.I unit is gray. ($1Gy=1Jkg^{-1}$). The absorbed dose rate (DR); is the rate at which an absorbed dose is received its units are (Gys^{-1} and $mGyhr^{-1}$). It is however important to mention that the biological effect depend not only on the total dose the tissue is exposed to, but also on the rate at which the dose was received. The equivalent dose rate (EDR); The absorbed dose do not give an accurate indication of the harm that radiation can do since equal absorbed doses do not necessarily have the same biological effects. An absorbed dose of 0.1Gy of alpha radiation is more harmful than an absorbed dose of 0.1Gy of beta or gamma radiation. To reflect damage done in biological systems from different types of radiation, the equivalent dose is used. It is define in terms of the absorbed dose weighted by a factor which depends on the type of radiation. It unit is Sievert (Sv). Exposure to ionizing radiation poses a high risk and this risk may include cancer induction, radiation catractogenesis, indirect chromososal transformation. The practice being to keep one's exposure to ionizing radiation as low as reasonably possible is known as the ALARA principle (Norman, 2008). However, Radon (^{222}Rn) finds it's way indoor through building materials, diffusion, convection and through the soil under the building. Some of the materials used in the construction of buildings are known to be radioactive (Huyumbu et al, 1995). Considering these source of indoor background ionizing radiation, and the cold nature of the university, it is obvious that laboratory technologies, staff as well as students spend more time inside the laboratory either in search of warmness or carrying out research. Hence background ionizing radiation profile within and without those laboratories is crucial to assess the level of health risk of exposure to which the occupants and users of such laboratories are exposed when compare to the average effective dose of about 2.4mSv/yr reported by (UNSCEAR, 2000).

2. Materials and Method.

The indoor and outdoor background radiation of Biochemistry, Chemistry, Microbiology and Physics laboratories were survey using gamma-scout. The selection switch of the gamma- scout was adjusted to the right hand side in order to detect the alpha, beta and gamma types of radiation in µSv/hr. The gamma-scout was oriented vertically upward through the survey. In all the laboratories selected for survey, Fourty readings were taking in each case (indoor and outdoor). The data measured were read directly from the display screen of the gamma-scout. The equivalent dose reading in µSv/hr was what we measure in all the laboratories investigated in this study.

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.

$$Y\ (\mu Sv/hr) \times 8760\ (hr/yr) \times 0.8 \div 1000. = IAEDR\ (mSv/yr) \qquad (i)$$

$$Z(\mu Sv/hr) \times 8760\ (hr/yr) \times 0.2 \div 1000. = OAEDR\ (mSv/yr) \qquad (ii)$$

Where;

Y and Z are the indoor and outdoor meter's readings while IAEDR and OEDR are the indoor and outdoor annual effective dose rates respectively.

3. Results.

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 Code	Laboratory name	Mean Y(µSv/hr)	IAEDR (mSv/yr)
A	Biochemistry	0.241±0.03	1.69±0.21
B	Chemistry	0.189±0.02	1.39±0.14
C	Microbiology	0.271±0.04	1.89±0.28
D	Physics	0.312±0.04	2.186±0.28
		Ave= 0.256±0.03	Ave= 1.54±0.23

Table 2. Mean outdoor gamma-scout sensor reading.

Laboratory code	Laboratory name	Mean Z(μSv/hr)	IAEDR (mSv/yr)
A	Biochemistry	0.194±0.04	0.34±0.07
B	Chemistry	0.239±0.02	0.42±0.03
C	Microbiology	0.278±0.02	0.49±0.03
D	Physics	0.286±0.03	0.05±0.05
		Ave=0.249±0.28	Ave=0.44±0.05

4. Discussion 0f Results

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 this university science laboratories indoor was found to be 0.256±0.03 μSv/hr while the outdoor was found to be 0.249±0.28 μSv/hr. The mean indoor and outdoor annual equivalent dose rates of these selected laboratories were compute as 1.54±0.23 and 0.44±0.05 mSv/yr respectively. It is concluded that staffs using these laboratories as offices (Laboratory technologies) and students using these laboratories and their immediate neighbourhood 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(0AEDR) 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

For the purpose of assessing the health risks of the occupants and users of such laboratories, there is a need for regular and periodic monitoring of the background ionizing radiation level in such laboratories. The laboratory windows should at least be open daily to allowed for proper ventilation and prevent the accumulation of ionizing radiation inside the building. Similar research should be carry out to assess the indoor background ionizing radiation of some selected offices of the university especially those whose roof is made of concrete and their windows inside the building as well as those offices surrounded by rocks.

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