THE EFFECT OF RADIATION FROM DAILY-USE APPLIANCES IN EVERYDAY LIFE

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Abstract: Basic approaches to radiation protection are consistent all over the world. The International Commission on Radiological Protection (ICRP) recommends that any exposure above the natural background radiation should be kept as low as reasonably achievable, but below the individual dose limits .Several recent studies have indicated that mobile phone waves have an adverse health effect on cells of human beings. This paper analyzed the effects of electromagnetic (EM) radiation from mobile phone on human health. The electromagnetic radiation is measured in terms of specific absorption rate (SAR). The human health exposed to global system for mobile communication (GSM) frequency bands. In addition, there are thousands of substances in our everyday life besides radiation that can also cause cancer, including tobacco smoke, ultraviolet light, some chemical dyes, fungal toxins in food, viruses, and even heat. Only in exceptional cases is it possible to identify conclusively the cause of a particular cancer.

Keywords: Radiation; Type of radiation; Electrical appliances; Specific absorption Rate (SAR); Frequency bands;

1. INTRODUCTION

Radiation is the energy that travels through space in the form of particles or electromagnetic waves such as radio waves, microwaves, infra-red, visible light, ultra-violet, X-rays, gamma-rays and alpha particles, etc. Radiation can be broken down in two major classes, based on their energy and penetrating capabilities, these are ionizing and non-ionizing radiation.

Non-ionizing radiation is unable to directly alter the chemical structure of materials, and includes radio, microwaves, infra-red, and visible light. Ionizing radiation enough energy to remove electrons from atoms in the materials and they penetrate the bodies. Its ability to ionize is what makes ionization radiation potentially harmful to life. Ionization causes chemical bonds to break up; it can harm the human body because it changes the chemical bonds in the body. Ionization radiation cannot be felt, smelt, tasted, seen or heard.

An additional source of radioactivity is the ever-present cosmic radiation which bombards earth from outer space, producing a non-negligible part of the radioactivity in the biosphere. Due to the development of nuclear technology with time various beneficial applications different types of radiations in medicine, industry and agriculture and research as well as for nuclear power generation are increasing day by day. Radiations have today become an inseparable part of living environment. Besides radiations from natural sources have manmade sources such as nuclear reactors, radioisotopes, X-ray machine etc. Radiations are usefully employed in various fields such as medicine, industry, hydrology and agriculture.

2. TYPE OF RADIATION

Radiation is part of everyday life. Natural radiation occurs in rocks, soils, fresh and salt water, oceans, vegetation and from cosmic radiation. Natural radiation can be ingested with food and water, while other forms of radiation (like the gas radon) are inhaled. As such, the human body contains radioactive elements such as potassium, and carbon. Man-made sources from cosmic radiation can be found in many medical, scientific and consumer applications like X-rays, televisions, smoke detectors, mobile phones, building materials and radiopharmaceuticals (used for the treatment of diseases like cancer).Radiation is energy that travels in the form waves and makes up the electromagnetic spectrum which is divided into two major categories (see Figure.1).

2.1 Non Ionizing Radiation

Non-ionizing radiation includes both low frequency radiation and moderately high frequency radiation, including radio waves, microwaves, infrared radiation and visible light. Non-ionizing radiation has enough energy to move around the atoms in a molecule or cause them to vibrate, but not enough to remove electrons. Non-ionizing radiation is used in many common tasks: microwave radiation for telecommunications and heating food, infra-red radiation for infrared lamps to keep food warm in restaurants, radio waves for radio broadcasting.

2.2 Ionizing Radiation

Ionizing radiation includes higher frequency ultraviolet radiation, X-rays and gamma rays. Ionizing radiation has enough energy to break chemical bonds in molecules or remove tightly bound electrons from atoms, creating charged molecules or atoms (ions).The amount of damage depends on the type of radiation, the exposure pathway, the radiation's energy, and the total amount of radiation absorbed. Because damage is at the cellular level, the effect from small or even moderate exposure may not be noticeable. Most cellular damage is repaired.

However, some cells may not recover as well as others and could become damaged or cancerous. Radiation also can kill cells. High frequency sources of non-ionizing and ionizing radiation (such as the sun and ultraviolet radiation) can cause burns and tissue damage with overexposure.

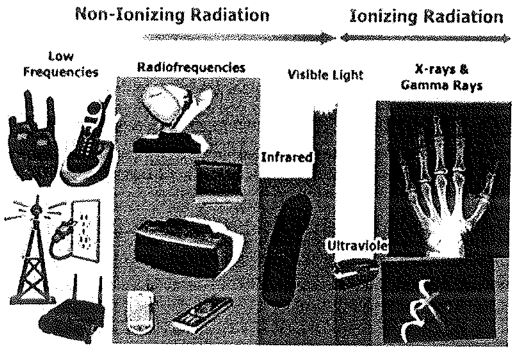

Figure 1. Different types of radiation

3. RADIATION IN EVERYDAY LIFE

Radioactivity is part of human earth and it has existed all along. Naturally occurring radioactive materials are present in the earth's crust, the floors and walls of the homes, schools, and offices and in the food which eat and drink. Part of the bodies- muscles, bones and tissues, contain naturally occurring radioactive elements. Man has always been exposed to natural radiation arising from earth as well as from outside (see in Figure.2). Most people, upon hearing the word radioactivity, think only about something harmful or even deadly; especially events such as the atomic bombs. However, upon understanding radiation, people will learn to appreciate that radiation has peaceful and beneficial applications to our everyday lives. Radioactive materials are used in a wide variety of applications in everyday life. Research laboratories, medical centers, industrial facilities, food irradiation plants and many consumer products all use or contain radioisotopes. The most common radioisotopes are seen in everyday life.

Figure 2. Source of natural radiation

3.1 Radiation from Electrical Appliances

Some sources of radiation in everyday life are using daily things in the environment such as cell-phones or mobile phones radiation, radiation from appliances such as computer or laptops, wifi-routers, tablets, earphones, wearable, tobacco smoke from smoking, medical use of radiation, microwave ovens, heating appliances, personal grooming appliances. Wireless technologies have become an integral part of our daily Life. Besides the good old TV and radio broadcasting services, phones, laptops, tablets and many other devices are exchanging increasing amounts of data by means of radio frequency (RF) electromagnetic fields (see in Figure.3).

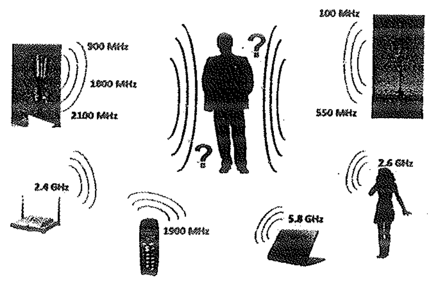

Figure 3. High frequency electromagnetic radiation from daily electrical appliances

3.1.1. Mobile Phones Radiation

Radiation in cell phone is generated in the transmitter and emitted through the antenna. Mobile or cellular phones are now an integral part of modern telecommunications. Mobile phones communicate by transmitting radio waves through a network of fixed antennas called base stations. Radiofrequency waves are electromagnetic fields. Part of the radio waves emitted by a mobile telephone handset is absorbed by the human head. The radio waves emitted by a GSM handset can have a peak power of 2 watts, and analogue phone had a maximum transmit power of 3.6 watts. Other digital mobile technologies, such as CDMA2000 and D-AMPS, use lower output power, typically below 1 watt. GSM networks operate in a number of different carrier frequency ranges. GSM networks operate in the 900 MHz or 1800 MHz bands.

3.1.2 Laptop Radiation

Laptop radiation is due to its need to be connected to wifi and bluetooth signals for browsing the internet or sending or transmitting files. They also have internal parts that are made of metal such as laptop battery and antennas that amplify these signals. Basically, laptops are full-size versions of smart phones, which means they emit radiation very similarly. This is the first study to evaluate the direct impact of laptop use on human spermatozoa. Exposure of human spermatozoa to a wireless internet connected laptop decreased motility and induced DNA fragmentation by a non-thermal effect. The keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility.

3.1.3 Wifi Routers

Wireless routers give off electromagnetic radiation which, like wireless signals, can pass through the walls. Because these system are not turned off at night, it means people are exposed to it round-the-clock. In addition, most homes will have wifi routers installed- this means the EMF signals are exposed to and have to worry about are not just limited to the home, but the neighbors, not to mention public areas as well. In addition, electromagnetic sensitivity is a fairly new condition that is proving to be more common. Sufferers report that exposure to radiation emitted by devices, especially wifi routers, are prompting symptoms that range from skin rashes to fatigue to sleep disturbance. Hypersensitivity to electromagnetic fields (EMF) is frequently claimed to be linked to a variety of non-specific somatic and neuropsychological complaints. These results demonstrate significant cognitive and neurobiological alterations pointing to a higher genuine individual vulnerability of electromagnetic hypersensitive patients.

Switch off wifi routers when not in use, and make sure all wireless devices are in airplane mode before go to sleep at night. For added peace of mind, especially for those who have infants at home or are pregnant, you can use specially designed baby blankets or belly bands that are meant to protect them from the potentially harmful effects of electromagnetic radiation at this vulnerable stages in their lives.

3.1.4 Tablets Radiation

Tablets are designed to connected via three main sources such as wifi, bluetooth and cellular connections. Tablets are also specifically to be compact and function using touch screens, which means EMF exposure is basically guaranteed. Tablets are already recognized as sources of radiation, but it is especially worrying given the prevalence of tablet use among children.

3.1.5 Earphones Radiation

It is almost surprising to hear that earphones are sources of radiation but they do in fact, emit, aggravate radiofrequency signals to a point that using them to put distance between head and phone becomes counter-intuitive. Traditional headsets metal parts amplify radiofrequency signals, while Bluetooth headsets emit radiation wirelessly. It is important to keep in mind that the safety of earphones is dependent on the kind of earphones which are using. A conventional headset has a wire cable and wire has metal in it. This metal conducts the radiation coming from cellphone allowing it to easily travel up the wire and into the head. So wire headsets can act as an antenna attracting ambient EMF, transmitting radiation directly to brain. Like regular phone headsets, it plugs into the phone via a headset jack, but instead of transmitting sound with metal wires, the hollow air tubes conduct sound through air. The lack of metal parts means the signals are not amplified and can use them safely.

3.1.6 Wearable Radiation

Wearable radiation is as like as laptops and smartphones, etc. and connectivity to main wireless devices. They may be small and generally inconspicuous, but these devices work in tandem with smartphone or laptop, and require connectivity. This means it on rationalize seeks radio wifi signals and consistently emits radiation. The most worrying thing here is that smart watches and fitness trackers are meant to be worn on the body, typically on wrist around neck, which means are always exposed to it.

3.2 Specific Absorption Rate (SAR)

Every mobile phone radiates the high frequency electromagnetic waves. The mobile phone behaves like a transmitter as well as a receiver. When the phone call is received by the mobile phone, it behaves like a receiver and when the mobile number is dialed to another mobile phone, it behaves like a transmitter.

Although there is a vast body of material on the biological effects of radiofrequency fields, current risk assessment is still limited. Cell phones transmit and receive waves of frequencies mainly at 800, 900, 1800 and 2450 MHz. Findings on the thermal effect of acute exposure to radiofrequency fields were consistent. The radio frequency (RF) devices which are usually used in the vicinity of a human body have been increasing (see in Figure.4). Therefore, it is necessary to evaluate the interaction between the electromagnetic (EM) wave and the human, because it might be expected that human body is exposed to the EM waves radiated from the RF devices. The influence of the EM waves on the human body is dependent on the frequency (see in Figure.5). The EM waves mainly contribute the heat effect, which is generated by the absorption of the energy, above 100 kHz. The specific absorption rate (SAR) has been usually used for the primary parameter of the EM wave exposure in the standard.

$$SAR = \sigma E^2 / \rho \quad (1)$$

Where ,σ is the conductivity of the tissue, ρ is the density of the tissue, E is the electric field strength inside the tissue.

The Equation (1) shows the calculation of the specific absorption rate. The SAR in the human body affected by EM wave from the cellular phones has been widely investigated because the cellular phones are used in the vicinity of the human head. The measurement of electric field is not of the importance because it is not always possible to predict correctly the value of the incident field, especially in the complex surroundings. Thus the proposed approach is useful to predict the induced electric field around the tower, penetrated electric field inside the body and specific absorption rate (SAR) of the tissues of the human body. According to the mobile phone hand set, the mobile phone has to be designed in such a way that they do not exceed specific absorption rate (SAR) value of 2W/kg (permissible limit of International agencies). But actually field exposure during mobile phone calls under every day conditions have been measured and found that they were higher than assumed before. The photons are a result of the electromagnetic waves emitted from the antenna of a mobile phone. The waves produced by the antenna have a spherical wave front.

Figure 4. Brain damaged due to mobile phone radiation

Figure 5. Headache and brain-fever due to phone radiation

4. CONCLUSION

Basic approaches to radiation protection are consistent all over the world. The ICRP recommends that any exposure above the natural background radiation should be kept as low as reasonably achievable, but below the individual dose limits. The individual dose limit for radiation workers averaged over 5 years is 100 mSv, and for members of the general public, is 1 mSv per year. These dose limits have been established based on a prudent approach by assuming that there is no threshold dose below which there would be no effect.

It means that any additional dose will cause a proportional increase in the chance of a health effect. This relationship has not yet been established in the low dose range where the dose limits have been set. In today's fast-moving and globalized world it is almost impossible to imagine our day-to-day life without mobile-phones. It is one of the most successful inventions of the 20th century, which has become a convenient means of communication. Modern mobile phones perform many other functions as well; they can substitute for such devices as music players, cameras and organizers. There are certain harmful health effects, which might be caused by the immoderate use of cell phones. According to modern researches, the most menacing problem is connection between cell phones and cancer. Even though the data remains controversial, most scientists agree that there is a certain threat from using cell phones too much. It is reported, that people who talk on the phone for several hours a day are 50% more likely to develop brain cancer. The reason for this is the radio waves produced by mobile phones. It is calculated, that every minute the human brain receives about 220 electromagnetic impulses, which are not necessarily harmful, but which definitely affect the brain in cases of prolonged impact. Apart from cancer risk, mobile phones influence our nervous system. Today's world is a world of technology and inventions, and there are many tools which essentially facilitate our life. Mobile phones play an important role in the development of human civilization, but their excessive use brings severe problems. To reduce their harmful effects, one should always remember that mobile phone is a friend, not a master, and it should never be used too much.

5. ACKNOWLEDGEMDENTS

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6. REFERENCES

[1] Leonie Munro, "Basic of radiation Protection for Everyday Use", Radiography, King Edward VIII Hospital , South Africa , 2004

[2] David Coggon, "Mobile Telecommunication and Health Research Program", MTHR Program Management Committee,2012.

[3] "Radiation Exposure Activities", Environmental Protection Agency, United State(2012)

[4] Inna Vishik, "The Truth About Cell Phone Radiation", University of California, Davis, on Quora: (2018).

Estimation of Annual Effective Dose from Radon Concentration along the Beaches in Rakhine Division

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Abstract: In the last decade, the radon issue has become one of the major problems of radiation protection. Radon exposure occurs when using water for showering, washing dishes, cooking and drinking water, swimming for relaxing, etc. In this study, Radon levels were measured in sea water samples collected at coastline zone from Ngapali town ship in Rakhine Division, Myanmar. A total of three sea water samples from Ngapali beach, Pearl Island beach and Kyway Chaing beach were collected and measured for the radon concentration. The measurements were performed by using a RAD7 portable radon detector. The measurements of radon concentration range are 0pCi/L to 1pCi/L from Ngapali beach, 3pCi/L to 29pCi/L from Pearl island beach and 0pCi/L to 1pCi/L from Kyway Chaing beach in sea water samples. Results for all samples of water are presented and compared with maximum contamination limit (MCL) recommended by United State Environmental Protection Agency (USEPA) which is 300pCi/L.

Keywords: Inhalation dose, Ingestion dose, Radon concentration, RAD7 radon detector

1. INTRODUCTION

Environmental radiation originates from a number of naturally occurring and human-made sources. Radiation exposure can occur by ingesting, inhaling, injecting, or absorbing radioactive materials. Radiological hazards may be possible due to the presence of large content of radioactive substances in drinking water. The most common radionuclides in drinking water are uranium, radium, and radon. Radon is a radioactive, inert gas having highest density of among all noble gases. Radon gas and its radioactive isotopes have special attention among all other naturally occurring radioactive minerals, because it has the largest amount of total annual effective dose to human. Inhalation of radon gas is the second most important cause of lung cancer after smoking and the majority of radon induced lung cancers are caused by low and moderate radon concentrations rather than by high radon concentrations because in general, less people are exposed to high indoor radon concentrations. It has been measured in water in many parts of the world, mostly for the risk assessments due to consumption of drinking water. Radon in water can follow two different parts to enter the human body. Firstly, radon can escape from household water and become a source for indoor radon, which can then enter the human body through the respiratory tract to deliver the radiation dose. Secondly, radon in drinking water or mineral drinks can enter the human body directly through the gastrointestinal (GI) tract and deliver a whole body radiation dose, the largest dose being received by the stomach. In the present study, the water samples were taken from three regions of beaches and to see the variation of radon concentration in water samples. The objective of the study is to calculate inhalation and ingestion doses in the water samples for health hazards point of view.

2. THEORY OF RADON

Radon is a chemical element with symbol Rn and atomic number 86. It is a radioactive and radon is a naturally occurring odorless, colorless, tasteless and inert gas. It occurs naturally in minute quantities as an intermediate step in the normal radioactive decay chains through which thorium and uranium slowly decay in lead and various other short-lived radioactive elements, radon its self is the immediate decay product of radium. Its most stable isotope Rn-222 has a half -life of only 3.8 days, making radon one of the rarest elements since it decays away so quickly. However since thorium and uranium are two the most common radioactive elements on the earth, and they have three isotopes with very long half –lives , on the order of several billions of years, radon will be present on the earth long into the future in spite of its short half-life as it continually being generated. The decay of radon produces many other short-lived nuclides known as radon daughter, ending at stable isotopes of lead (see Figure. 1).

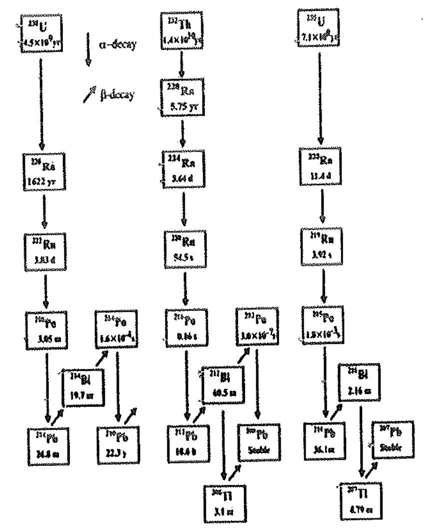


Figure 1.The natural radioactive decay series

2.1 Radon and Health

High concentration of radon and its decay product is widely known to be dangerous to human health. It is possibly associated with different types of cancer and especially with lung cancer. Emission percentage of radon into atmosphere coming from a few meters above the ground is at least 80%. Radon is a natural radioactive gas which is found everywhere and cannot be avoided. It has very serious effect on human health due to large scale abundance of tis parents and its longer half-life. Radon has been considered as second leading cause of lung cancer after smoking. A 2.4 mSv average annual dose has been estimated from natural radiation sources to the world population. Two-third of average annual dose is the internal exposure and one-third is external exposure. Inhalation of radon gas and its daughters will expose the lung tissue to short-lived alpha emitting radionuclides, which will increase the risk of lung cancer. One of the major factors of increasing skin cancer is radon gas, where it is due to deposition of radon on the skin, the alpha particles are suspected to include damage to the epithelial cell.

2.2 Natural Radioactivity in Drinking Water

The naturally occurring radionuclides which may be present in drinking water are radon-222 and its short-lived daughters and uranium-238, uranium-234, radium-226, lead-210 and polonium-210. From the dose point of view the most important of these are radon-222, polonium-210 and lead-210. In cases in which the radon concentration of the water is high, several thousands of Bq/L and the amount of radon has been decreased through aeration, short-lived radon daughters may also be a cause of high doses.

Most of the dose to the population from natural radioactivity in drinking water is due to radon through inhalation and ingestion. In most situations, the levels of other nuclides are so low that there is no need for remedial action. High radon concentrations indicate the potential presence of other nuclides in the uranium decay series in the water, although the correlation is not always unambiguous. Only when the radon concentration of water is high there is reason to suspect that the concentrations of other nuclides may also be high.

3. METHODOLOGY AND THEORETICAL CALCULATION

The main objectives of this study were to measure the radon concentration, radon exhalation rate from sea waters. The three sea water samples were collected from different beaches in Rakhine Division. These sea water samples were collected from Ngapali beach, Pearl Island beach and Kyway Chaing beach (see Figure. 2).

3.1 Sample Preparation

The water samples were collected one liter that was far at least five feet from the beach. It has been filtered the samples because the samples were to be cleared and pure for sea water. And then the samples were detected for radon concentration in the water sample by using RAD7(Department of Medical

Research, Lower Myanmar) electronic radon monitor.

3.2 Experimental Method

Radon concentrations in the collected samples were analyzed by RAD7 (DURRIGE Company). For the measurement of Rn-222, the procedure of the RAD7 method is simpler and easier than the scintillation cell method. However, the detection efficiency of RAD7 is much lower than the scintillation cell method. On the other hand, RAD7 accurately determines Rn-222 for high activity since it discriminates Po-218 and Po-214 peaks using silicon barrier alpha detector. For a long time period, both counting for both nuclides may be combined in order to increase counting efficiency. Thus, the scintillation cell method is recommended for extremely low-level activity water (i.e., surface open-ocean water), and RAD7 method (see Figure. 3) is recommended for the higher activity water such as coastal water and groundwater.

3.3 Dose Due to Dissolve in Rn-222 In Water

As far as the radiation dose to people from waterborne radon is concerned, it is believed to be a higher risk than all other contaminants in water. By using the measured Rn-222 concentration of water samples, the effective dose for population of the region was estimated, and the results are shown in Table. The effective dose of the ingestion mainly depends upon the amount of water consumed by a human being in a day. The dose due to inhalation and ingestion are calculated by using equation (1) and (2).

$$E_{WIg}\,(nSvyr^{-1}) = C_{RnW} \times C_W \times 10^{-3} \times (EDC) \quad (1)$$

Where E_{Wig} is the effective dose for ingestion, C_{RnW} is the radon concentration in water (Bql^{-1}) and C_W is weight estimate of water consumption (60 lyr^{-1}) respectively and (EDC) is the effective dose coefficient for ingestion $3.5nSvBq^{-1}$.

$$E_{WIh}(nSvyr^{-1}) = C_{RnW} \times R_{aW} \times F \times O \times (DCF) \quad (2)$$

Where E_{WIh} is the effective dose for inhalation, C_{RnW} is the indoor radon concentrations (Bql^{-1}), R_{aW} is the ratio of radon in air to radon in water (10^{-4}), F is the equilibrium factor between radon and its decay products (0.4), O is the average indoor occupancy factor (7000 hyr^{-1}), DCF is the dose conversion factor for radon exposure factor (9 $nSvh^{-1}(Bqm^{-3})^{-1}$).

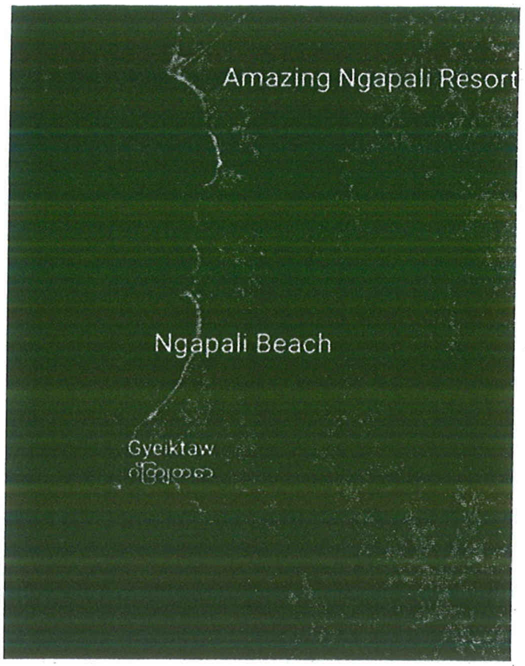


Figure 2. The map of Rakhine Division

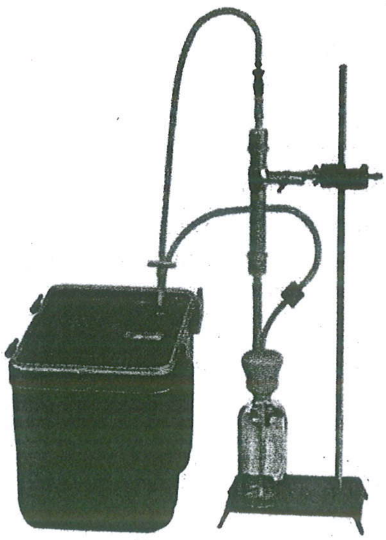


Figure 3. The RAD7 electronic radon detector

4. RESULTS AND DISCUSSION

The range of radon concentration in water samples were 0.00 Bql^{-1} to 0.0444 Bql^{-1} from Ngapali beach, 0.111 Bql^{-1} to 1.037 Bql^{-1} from Pearl Island beach and 0.00 Bql^{-1} to 0.037 $Bql^{-1}$from Kyway Chaing beach. All the values of radon concentration have been varied from 1.073 Bql^{-1} to 0.037 Bql^{-1} for three different beaches as shown in Table (1). The annual effective dose due to ingestion of radon in water sample of Ngapali beach is 0.009324$nSvyr^{-1}$ and inhalation dose is 0.1119$nSvyr^{-1}$. The total effective dose due to radon contents in water sample for Ngapali beach is 0.121224$nSvyr^{-1}$.The ingestion dose of water sample for Pearl Island beach was 0.22533$nSvyr^{-1}$ and inhalation dose was 2.704 $nSvyr^{-1}$.The total dose for Pearl Island beach was is 2.92933 $nSvyr^{-1}$. For Kyway Chaing beach, the total dose is 0.10101 $nSvy^{-1}$ and ingestion dose and inhalation dose are 0.00777 $nSvy^{-1}$ and 0.09324 $nSvy^{-1}$. Table (2) and (3) are shown in the ingestion and inhalation dose of radon concentration in water samples. The concerning graphs of dose result for Table (1), (2) and (3) were shown in Figure (4), (5) and (6). Figure (7) was the comparison graph for all beaches. Among these results, the total dose for Pearl Island beach is the largest and for Kyway Chaing beach is the smallest value. Moreover, the total annual dose of all these regions is found well within the recommended limit of 100 $\mu Svyr^{-1}$ suggested by WHO (World Health Organization).

Table 1. Radon concentration in water samples and their ingestion dose

No.	Sample Name	Radon Concentration (Bql^{-1})	Ingestion Dose ($nSvyr^{-1}$)
1.	Ngapali beach	0.0444	0.009324
2.	Pearl Island beach	1.073	0.22533
3.	Kyway Chaing beach	0.037	0.00777

Table 2. Radon concentration in water samples and their inhalation dose

No.	Sample Name	Radon Concentration (Bql^{-1})	Inhalation Dose ($nSvyr^{-1}$)
1.	Ngapali beach	0.0444	0.1119
2.	Pearl Island beach	1.073	2.704
3.	Kyway Chaing beach	0.037	0.09324

Table 3. Total dose results in water samples for three beaches

No.	Location	Inhalation Dose ($nSvyr^{-1}$)	Ingestion Dose ($nSvyr^{-1}$)	Total Dose ($nSvyr^{-1}$)
1.	Ngapali beach	0.1119	0.009324	0.121224
2.	Pearl Island beach	2.704	0.22533	2.92933
3.	Kyway Chaing beach	0.09324	0.00777	0.10101

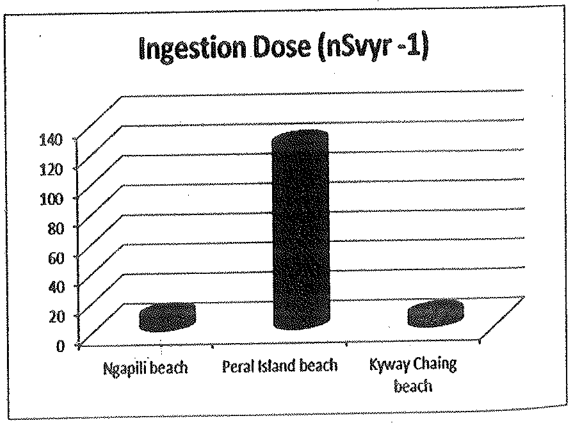


Figure 4. The graph for ingestion dose of the three beaches

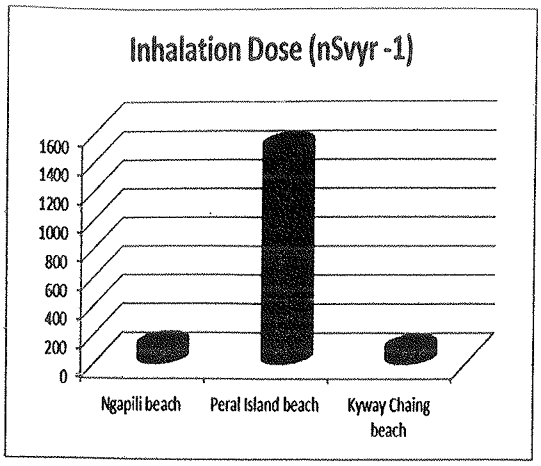


Figure 5. The graph for inhalation dose of the three beaches

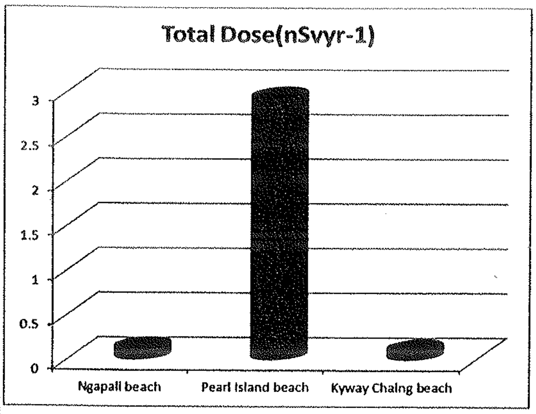
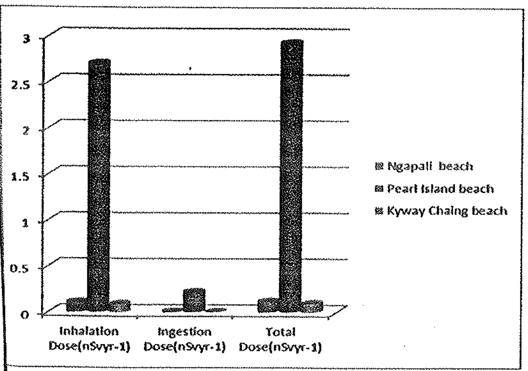


Figure 6. The graph for total dose of the three beaches



igure 7. Comparison graph of all doses for three eaches

5. CONCLUSIONS

The values of radon concentration from water samples in all three region beaches were well below the recorded values of radon concentration were within the recommended safe limit of 4Bq/l to 40Bq/l by UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) and the limit recommended by European Commission. The total annual effective dose due to inhalation and ingestion of radon from water samples were below than $100\mu Svyr^{-1}$ suggested by WHO (World Health Organization). The purpose of this study was to assess the radiological risk, if any, to human health due to consumption of drinking water or sea water that is available for studied areas. Hence the water of the studied area is not dangerous for the inhabitants of those regions.

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7. REFERENCES

[1] G.Akerblom(chairman). Naturally Occurring Radioactivity in the Nordic Countries– Recommendations. Swedish Radiation Protection Institute, 2000.

[2] C.A.McMahon. Radioactivity Monitoring of the Irish Marine Environment 2002.Radiological Protection Institute of Ireland, December 2005.

[3] Guebuem. Measurement and Application of Radium and Radon in the Environment. School of Earth and Environmental Sciences, Seoul National University, 2011.

[4] Z.A Tayyeb and A. R. Kinsara. A Study on the Radon Concentrations in Water in Jeddah and the Associated Health Effects. Nuclear Engineering Department , King Abdulaziz University, 1997.

Radiation Hazard Index from Soil Samples around the Beaches

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Abstract: Naturally radionuclides come from the atmosphere as a result of radiation from outer space, earth's crust such as rocks, mineral ores and soil. The process of natural decay of radionuclides that emits radiation can infect humans and other living things. The radon concentration and natural radioactivity in soil samples have been determined. The soil gas radon measurement was performed with RAD7 radon monitor coupled with a soil gas probe. This study aimed at determining the correlation between the radioactivity of the soil and it radon concentration and soil samples were taken at various locations around the beaches. Soil samples were collected from the different beaches in Myanmar. It was found that radon concentration of the soil gas in the study area ranged 12.3 ± 14 Bqm^{-3} from Ngapali beach, 6.72 ± 9 Bqm^{-3} from Pearl island beach and 0.97 ± 1.9 Bqm^{-3} from White sand Island beach, respectively. To assess the radiological hazards of natural radioactivity, the dissolved radon in soft tissue ($D_{soft\ tissue}$), dose rate for lung and the annual effective dose was calculated and compared to the world average values. All the determined radiological indices values are within the recommendation limits.

Keywords: Annual effective dose; dose rate for soft tissue; dose rate for lung; RAD7 radon monitor;

1. INTRODUCTION

There are basically three sources of naturally occurring radiation. One is cosmic radiation which is believed to have originated at the birth of the Universe. Cosmic rays are high energy particles from extraterrestrial sources that bombard the earth. The second is the cosmogony radioactivity which evolves from the interaction of cosmic radiation with the atmosphere, although its contribution to overall dose from naturally occurring radiation is insignificant. The third is the primordial radioactivity which has been in existence since the creation of the earth. The primordial radioactivity consists of a long series of isotopes of radioactive elements often called radionuclides. They include two isotopes of uranium, U-235 and U-238 and one isotopes of thorium Th-232. In addition to aforementioned radionuclides, K-40 is one of other single long lived primordial radionuclides, but it is the most important due to its significant contribution to human radiation dose. Radionuclides are present in soil, water, air and even in human being. The concentrations of these radionuclides varies from place to place and differs by lithological composition such that higher concentrations are associated with granitic rocks and variably lower concentrations are associated with sedimentary rocks depending on the source rocks. There is the existence of gaseous radionuclides Rn-222 (radon) and Rn-220 (thoron) in both U-238 and Th-232 decay series respectively. Radon gas is produced from rock and soils. When the gas is produced, it moves through cracks in the rocks and pore spaces in the soil to atmosphere. The concentrations of Rn-222 and Rn-220 in any soil depend on the Uranium and Thorium contents of the soils respectively. Radon can transfer freely through the soil and this depends on a number of factors, namely rate of diffusion, effective permeability of the soil and radon half-life. It has been established that the radon is a causative agent of lung cancer when existing in high concentrations.

2. NATURAL RADIOACTIVITY

The predominant part of the natural radiation in our environment and in humans is caused by the primordial radionuclides in the decay series starting with the uranium -238, thorium -232, uranium -235 and potassium -40, and by cosmic radiation. The primordial radionuclides are present in bedrock, soil, building materials, water and air in the human body. The contents of natural radioactivity substances vary widely between different rocks and soil types, due to the different ways in which they were formed. The internal radiation in the human body is caused by natural radionuclides in food, water and air.

The cosmic radiation increases with increased height above sea level. The average radiation which normally occurs in an area is called the background radiation. The level of this radiation depends on local conditions. There is no justification for protection ourselves against radiation at levels which are average for a country. Locally, however, the level of the natural radiation can be so high that protective measures may be justified or fully necessary.

2.1. Analysis of Radioactivity in Soil

Where the surface layers of the ground consist of soil, the intensity of the gamma radiation from the ground depends on the concentrations of the radioactive substances in the soil. Gravel, sand, slit and clay are soil types, which have been transported by water and then settled. For gravel and coarse sand, the contents of radioactive substances depend on the rock from which they originated. Sand and slit have consistently low contents of uranium and thorium since the radioactive elements have been carried away with the water. The clays have adsorbed uranium, radium and thorium from the water and they have often higher contents of these substances than sand and slit.

The gamma radiation outdoors originates from radioactive substances in the ground. The part of the gamma radiation which originates from naturally radioactive substances, depends on their concentrations in rocks and the soil cover. Because of the self-absorption in the soil cover, more than 90% of the gamma radiation above the ground originates in the upper-most 20 cm of the soil layer. The shielding effect of the air mass within a few meters from the ground is so small that it is of no significance for the exposure to a person in the area.

2.2. Radon Decay Chain

When the earth was formed, billions of years ago, there was probably many radioactive elements included in the mix of material that became the earth. A radioactive element is unstable. At some indeterminate moment, it will change to another element, emitting some form of radiation in the process. Each has a half-life measured in billions of years, and each stands at the top of a natural radioactive decay chain. A natural radioactive transformation is accompanied by the emission of one or more of alpha, beta or gamma radiation. A decay chain is a series of distinct transformations. The radon isotope is the first element, in each of the decay chains, that is not a metal. It is, in fact, an inert or noble gas. So it can escape any chemical compound its parent (radium) was in, and diffuse into the air. Radon-222 decay chain was shown in Figure (1).

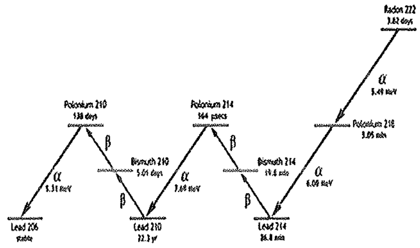

Figure1. Radon Decay Chain

3. MATERIALS AND METHODS

The aim of this study was to estimate the levels of radiological dose and annual effective dose equivalent in the soil samples collected from different locations in coastline at Rakhine Division. The three soil samples were collected from different sites of coastline such as Ngapali beach, Pearl island beach and White sand Island beach as shown in Figure (2).

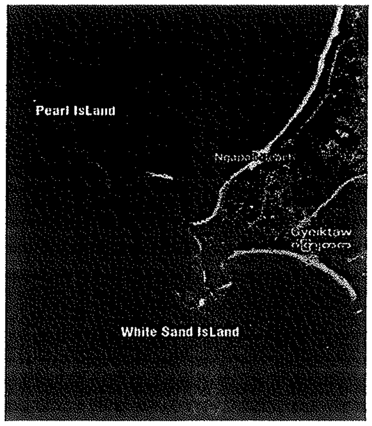

Figure 2.The map of the study area

3.1. Sample Preparation

The soil samples were collected during three feet from the beach and the invested area are to be clean places. The amount of soil samples were collected about 500g and it has been prepared for dry with normal at room temperature. The collected soil samples were measured for radon concentration by RAD7 method.

3.2. Radon Concentration Measurement

The radon concentration in soil samples were performed with of RAD7 electronic radon monitor (Department of Medical Research, Lower Myanmar).When the RAD7 is configured to perform a standard radon measurement, it will detect both radon and thoron, but the thoron readings will be unreliable because most of the thoron will have decayed before it ever reached the RAD7's measurement chamber. This is because a standard radon measurement typically involves a larger drying unit and a lower average airflow rate than is stipulated for thoron measurements.

When the RAD7 is configured for measuring radon, a full- sized laboratory drying unit is typically used. Each cycle begins with five minutes of continuous pump activity and then the pump typically operates for one minute in five for the remainder of the cycle. Grab protocol was used in the course of the sampling which enables soil gas to be extracted from the soil for five minutes into electrostatic hemispheric bowl of the equipment. The instrument will wait another five minutes and then count for four five minutes cycles. At the end of the half hours period, the RAD7 will print out a summary of the measurement, including an average radon concentration in the soil samples from four five minutes cycles. Figure (3) shows the RAD7 electronic radon monitor.

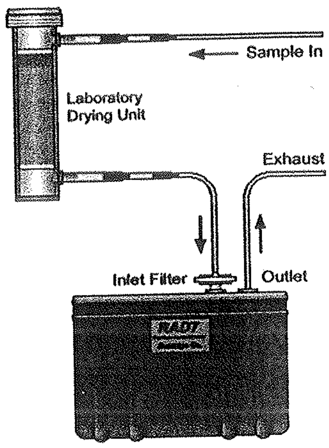

Figure 3.The RAD7 electronic radon monitor

3.3. Calculation of Equivalent Dose Rate

It well known that there is correlational statistics regarding radon concentrations between soil and indoor. Using the soil radon concentration contributing to an indoor radon activity factor, many radiation hazards indices due to radon such as effective dose equivalent (E_p), annual effective dose (H_E), the dissolved in soft tissue ($D_{soft\ tissue}$) and dose rate due to the radiation in the lung (D_{lung}) can be calculated by using Equation (1), (2), (3) and (4).

3.3.1. Dose Equivalent and Annual Effective Dose

The effective dose equivalent can be calculated using Equation (1).

$$E_p\,(WLM/y) = (\frac{1}{3700})\ \frac{t \times n \times F \times C_{Rn}}{170} \qquad (1)$$

Where, WLM/y(working level month per year) is the unit of dose equivalent, t is 8760 hours, n is the occupancy factor of time spending indoor (0.8), F is the equilibrium factor between radon and its decay products (0.4), 1/3700 is the conversation factor and 170 is the number of hours per month.

The annual effective dose can be calculated by Equation (2).

$$H_E\,(mSvy^{-1}) = C_{Rn} \times F \times t \times D \qquad (2)$$

Where, D is the dose conversion factor (9 $nSvy^{-1}$per Bqm^{-3}) and the other factors are expressed the above.

3.3.2. Dose Rate for Soft Tissue and Lung

The dissolved radon in soft tissue due to the radon concentration was determined by using Equation (3) and dose rate due to the radon concentration in the lung was Equation(4).

$$D_{soft\ tissue}\,(nGyh^{-1}) = 0.005 \times C_{Rn} \qquad (3)$$

$$D_{lung}\,(nGyh^{-1}) = 0.04 \times C_{Rn} \qquad (4)$$

Where, 0.005 and 0.04. are the dose conversion factor for soft tissue and lung.

4. RESULTS AND DISCUSSIONS

The effective dose equivalent (E_P) and the annual effective dose (H_E) were calculated for the sampling each point from the average radon concentration in Bqm^{-3} and the results were shown in Table (1) and the bar graphs were shown in Figure (4),(5) and (6). The results of radon dissolved in soft tissue and lung were listed in Table (2) and the graph for Figure (7) and (8). The radioactive level of Rn-222 for the soil samples were ranged from 0.97 Bqm^{-3} to 12.3 Bqm^{-3}. The values of E_P were varied from 0.0043 WLM/y to 0.055 WLM/y and for the values of H_E were varied from 0.388 $mSvy^{-1}$ to 0.0306 $mSvy^{-1}$.

The latter indices values are found to be slightly smaller than the level of 3-10 $mSvy^{-1}$ recommended by ICRP (International Commission on Radiological Protection). The results of the dissolved radon in soft tissue and dose rate due to radiation in the lung ($nGyh^{-1}$) from 0.0615 to 0.00485 and 0.492 to 0.0388. Looking for the whole data in all tables, these values are found to be within the safe limits that were 3-10 $mSvy^{-1}$ recommended by ICRP (International Commission on Radiological Protection).

Table 1. Effective dose equivalent and annual effective dose for soil samples

Samples Location Beach	Radon Concentration (Bqm^{-3})	Annual Effective Dose ($mSvy^{-1}$)	Effect dose Equivalent (WLM/y)
Ngapali	12.3	0.387893	0.055
Pearl Island	6.72	0.211922	0.02996
White sand Island	0.97	0.03058992	0.0043

Table 2. Radon dissolved in soft tissue and in the lung for soil samples

Samples Location Beach	Radon Concentration (Bqm^{-3})	Dose Rate in Soft Tissue ($nGyh^{-1}$)	Dose Rate in Lung ($nGyh^{-1}$)
Ngapali	12.3	0.0615	0.492
Pearl Island	6.72	0.0336	0.2688
White sand Island	0.97	0.00485	0.0388

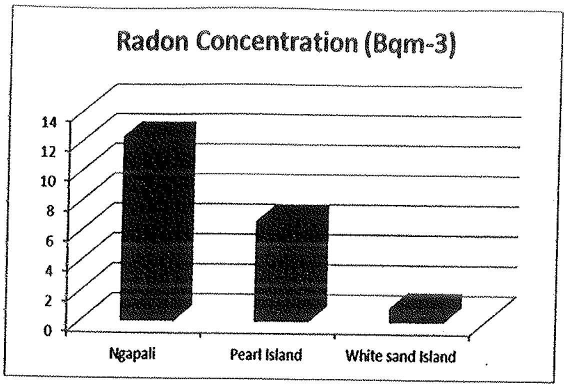

Figure 4. Radon concentrations of the soil samples from different location

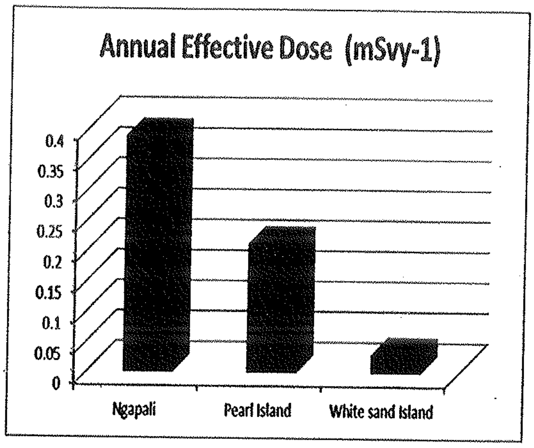

Figure 5. Annual effective dose for soil samples

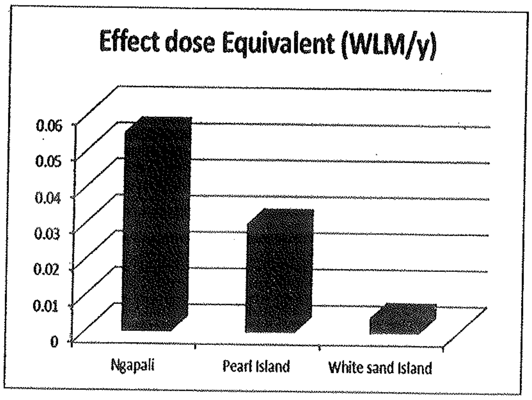

Figure6.Effective dose equivalent for soil samples

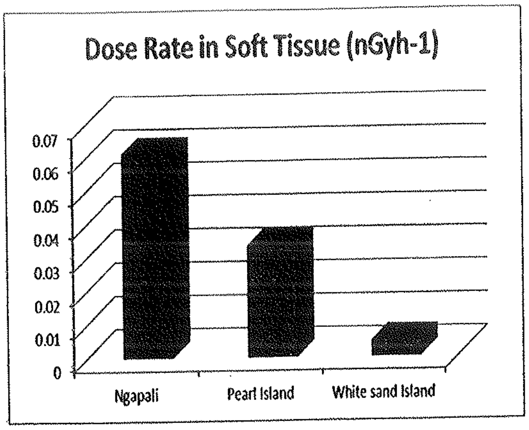

Figure 7. The graph for the dose rate in soft tissue

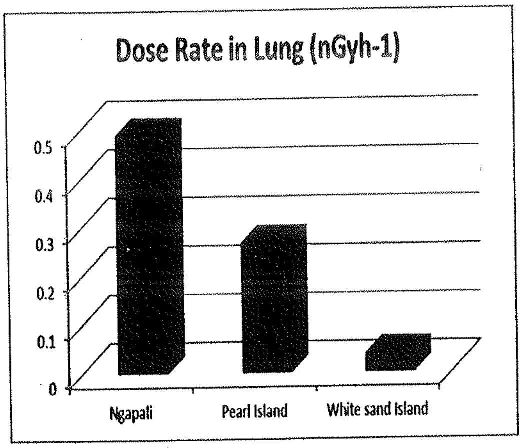

Figure 8. The graph for dose rate in lung

5. CONCLUSIONS

The radon concentrations in the soil samples were found to be less than the recommended limit. Also, the results in the present work indicated that the radon concentrations in terms of area, the annual effective dose, $D_{soft\ tissue}$ and D_{lung} due to the radiation were within the limit 3-10 $mSvy^{-1}$ recommended by ICRP (International Commission on Radiological Protection).The mean value of dose rate obtained from the soil samples is less than the permissible value 56 $nGyh^{-1}$ by the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR). The results showed that these areas could be safe from the health hazard point of view as far as the radon is concerned. Therefore, it could be concluded that the area of the study is free of risk of exposure to radon as they do not pose any hazard due to the low radon exhalation.

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7. REFERENCES

[1] C.A. McMahon. Radioactivity Monitoring of the Irish Marine Environment 2002.Radiological Protection Institute of Ireland, December 2005.

[2] Ajiboye Y. Measurement of Radon Concentration and Radioactivity in Soil Samples of Aramoko, Ekiti State, Nigeria. Department of Physics, Ekiti State University,2016.

[3] Khalid Hussain Hatif. Natural Radioactivity Level and Measurement of Soil Gas Radon, Thoron Concentrations in Hilla City. Department of Physics, University of Babylon, 2015.

[4] G.Akerblom(chairman). Naturally Occurring Radioactivity in the Nordic Countries Recommendations. Swedish Radiation Protection Institute, 2000.