



ANALYSIS OF NUCLEAR RADIATIONS FROM COMMONLY USED ELECTRONIC GADGETS IN LAFIA, NIGERIA

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ABSTRACT

The Inspector Alert Device has been used to measure Radiations from Computer screen, Telephone handset, Petrol station and Television screen. Findings revealed that the gadgets emit radiations with different intensities at different hours of the day. The Computer screen emitted radiations as high as, 0.13msv in the morning, 0.23msv in the afternoon and 0.15msv in the evening. Telephone handset emits radiation as high as 0.18msv in the afternoon, 0.12msv in the evening, and 0.08msv in the morning hours. Petrol station recorded high radiation of 0.30msv in the afternoon, 0.25msv in the evening and 0.19msv in the morning. Television screen recorded high radiation of 0.30msv in the afternoon, 0.29msv in the evening, and 0.24msv in the morning hours. However the impact of radiation is very high in the afternoon, moderate in the evening and lowest in the morning hours. The values obtained were carefully analyzed, however the effects of radiation is insignificant when compared to the maximum recommended value by the International Standard Regulatory body. Although, radiation intensity decreases with increase in distance from its source but it is generally recommended that it is safer to use such gadgets in the morning hours when impacts of radiations are minimal. However, the cumulative effects of nuclear radiations on human body may have long term effects on health which may result to cancer, tumor and other related illness.

INTRODUCTION

Many of the earth's elements like the rest universe are radioactive (Vattenfall, 2010). Man has therefore always been exposed to radiations from different sources in the environment. The largest proportion of human radiation exposure originates from the natural occurrence in many homes and other buildings. (Vattenfall, 2010). In addition, exposure is caused by cosmic radiations. All radiations are carriers of energy. To know which radiation interacts with matter, e.g. living tissue, some of the energy is transferred to the atoms and molecules of that matter. If the radiation has enough energy it may strip electron from atoms. This is called ionization and it is therefore referred to as ionizing radiation. Radiation is also emitted in nuclear reactions such as those occurring in the sun. Ionizing radiation can also be produced in X-ray tube or atomic particle accelerators, due to their high energy content, radioactive substances are unstable and therefore seek lower energy that is more stable. When a radioactive atom decays and emits its surplus energy, it is transformed into another isotope of the same or a different element that in turn also may be radioactive. This process continues until a stable isotope has been formed. Radon and its short-lived decay products in dwelling's represent the main sources of public exposure to natural radiation dose contribution. The effective dose for member of the public must not exceed 1 msv/year. The limit for the lens of the eye is 15msv/year (Vattenfall, 2010), the skin 50 msv/year. The party responsible for radiation protection is required to plan the technical rating and operation of nuclear plants such that the followed limit values are not exceeded by radioactive emissions with exhaust air or waste water. The dose limit shall be observed at the most unfavorable point of effect, taking account of all relevant load parts the dietary and life style habit of reference person in to any possible prior contamination by other plant and facilities.

REGULATORY DOSE LIMIT

As a simple high level radiation exposure (i.e. that is greater than 10.000 nGy (100 msv) delivered to the whole body over short period of time may have potential health risk. (ICRP,2007). To protect the public and radiation workers and environment from the potential effects of chronic low level exposure (i.e. less than 10000nGy (100 msv), the current radiation safety practice is to prudently assume similar adverse effects and possible with low level protracted exposure to radiation exposure are conservatively calculated to be proportional to those with high level

exposure. These calculated roles are compared to others known as occupational and environmental hazards, appropriate safety standard and policies have been established (ICRP, 2007) by International and National protection organizations to control and limit potential harmful radiation effects, both public and occupational regulatory dose limits, set by Federal Government (EPA, NRP, 2007) resolved on agreement to limit cancer risk. Other radiation dose limit is applied to limit other potential biological effects with workers skin and lens of the eyes.

Annual radiation dose limit	Agency
Radiation worker 5000	
Mrem =500msv	NRA occupational exposed
General public 100 mrem 1msv	NRC, member of the public
General public 25mrem =0.25msv	NRC, D&Dal pathways
General public 10mrem =01mev	EPA, air path way
General public 4mrem = 0.04mev	EPA ,drinking water path ways

Annual regulatory limits of agencies (ICRP, 2007).

RADON

Radon is a chemical element with symbol Rn an atomic number of 86. It is radioactive, colorless gas, nearly 50% of the global effective dose to the population. (UNSCEAR, 1993). The natural radioactive noble gas radon (^{222}Rn) is present in air out door and all buildings including the work places. It is thus inescapable source of radiation exposure both at home and at work (ICRP 2007). Soil is considered the main sources of indoor radon concentration, although building materials (especially quartz cement etc.) can make significant contribution to the level of natural radioactivity in close space such as stores and badly ventilated dwellings. Radon gas can diffuse easily out of the soil into the air or houses, it can get trapped in poorly ventilated space and its concentrated ions can build up higher levels. Inhalation of alpha particle from radon (^{222}Rn) and its progeny inside houses, a worldwide problem and significant risk factor for lung cancer.(ICRP 2007). It has been estimated that an increase in radon concentration of $100\text{Bq}/\text{m}^3$ is associated with approximated of 16% increase in change of developing lung cancer. (ICRP, 2007).

Interactive report of the absorbed dose to the living varies from 5 to $71\text{nGy}/(\text{Bqh}/\text{m}^3)$ was used for calculating the range of the internal effective dose equivalent rate for the population, in calculating the effective dose equivalent rate, the radon concentration measured (back ground radiation level) in these offices are multiplied with the equilibrium factor ($F=0.2$).

It's of great importance to access the exposure to radon (^{222}Rn) and its progeny in our homes, offices, filling station, and commercial mask for communication.

RADIATION DOSE

Radiation dose could be seen when ionizing radiation penetrate the human body or an object, if deposits energy, the energy absorbed from radiation is called a dose. Radiation dose are quantities that descended in three ways, absorbed, equivalent and effective.

ABSORBED DOSE

The above dose D is the quotient from the average energy transferred to the matter in a volume element by ionizing radiation and mass of matter in this volume element.

$$D = \frac{d\varepsilon}{dm}$$

Where D = absorbed dose.
 $d\varepsilon$ = difference in energy.
 m = mass of mater.

The unit of the absorbed dose is joule divide by kilogram ($J.kg^{-1}$) and its special name is gray (GY) the former unit name was (symbolized) I GY = 100rd:

$$1rd = \frac{1}{100} GY$$

RD = red.

EQUIVALENT DOSE

When radiation is absorbed in living mater, biological effects may be observed. However equal absorbed dose will not necessarily produce equal biological effects, it depends on the type of radiation (e.g. alpha, beta, gamma etc.) and the tissue or organ receiving the radiation for example, 1 GY or alpha radiation is more harmful to tissue than 1 GY of beta radiation.

A radiation weighting factor (WR) is used to equate different types of radiation with different biological effectiveness. This weighted absorbed quantity is called the equivalent dose.

EFFECTIVE DOSE

Different tissue and organ have different radiation sensitivities. For example bone marrows are much more radiosensitive than muscles or nerve tissues (Lu, 2016). To obtain an indication of how much exposure can be effective in overall health. The equivalent dose can be multiplied by a factor related to the risk for a particular tissue or organ.

TISSUES	WEIGHTING FACTOR
Gonad	0.2
Bone marrow	0.12
Colon	0.12
Lung	0.12
Stomach	0.05
Bladder	0.05
Breast	0.05
Liver	0.05
Esophagus	0.05
Skin	0.10
Bone surface	0.01

(Lu, 2016)

Health is wealth; radiation has always been present all among us. Infact, life is involved in a world containing significant level of ionizing radiation. It comes from space, and even within our bodies. The dose due to natural background radiation varies depending on the location and habitat. It is believed that we are exposed to radiations from natural source all the time. This radiation energy can damage the living tissues and lead to lung cancer (ICRP, 2007) in the course of one's life time.

The aim of this work was to investigate radiation dose, its effect and control of nuclear radiation in Lafia metropolis of Nasarawa state of Nigeria. The objectives included, measuring the radiation dose caused by electronic gadgets as the largest contribution to public radiation exposure, computing the average quantity of radiation dose level in the investigated place and analyses compare the result with that of the International Atomic Energy Agency (IAEA, 2007) radiation exposure limits, investigating whether there is an external radiation dose in different place provided and ensure in conjunction with (ICRP, 2010) the better service delivered in the radiation protection in order to have cancer less environment and to create interest and public awareness about radiation dose hazard in places of work, community and the country at large.

The extent to which this investigation of radiation dose needs to be carried out is relevant with the health risk (cancer cause) which will give more attention to the quality of indoor air and quantity of ionizing radiation dose the office occupants are exposed to in Lafia metropolis.

However this research work is limited to investigation levels analyze and discuss the result related to the effects of radiation dose on matter (human) and how it can be reduced to the acceptable level in some of the area visited for this investigation was granted.

MATERIALS AND METHODS

The materials used to execute this research work are the Inspector Alert (Nuclear Radiation monitor, with inbuilt Geiger Muller counter tube) with the serial number 35440, made in U S A by 10s PECTRA (International medcom, Inc.), a scientific calculator, Personal Computer (Laptop) Pen and Paper, Fuel Dispenser Machine, Telephone hand set and Television Screen.

Inspector alert (Nuclear Radiation Monitor, with inbuilt Geiger Muller Counter tube) used to accomplish this investigation of radiation from computer screen, telephone handset, petro

filling station and television screen; within Lafia metropolis. The reason was due to the fact that the above listed device gives out radiation, and man comes into contact with this gadget due to day to day activities. Radiation from four different sources have been read and recorded using Inspector alert, after the first beep sound which indicate that the intensity of radiation entering into Inspector alert. When the device was turned on and timed on the Inspector alert is been set for the measurement, repeated readings were taken at different stages of measurement and average was obtained to ascertain accurate values. The first beep sound indicated statistical validity of the reading on Liquid Crystal display Screen (LCD) monitor. Readings were obtained in count per minute, and converted into dose rate ($\mu\text{Sv/hr}$), absorb dose rate nGy/hr and finally to effective dose which is the required dose (msv/yr). The precision after calculation were done. Note that radiation has a different unit but the one that has effect on human body is the effective dose. (msv/yr)

The following methods of computation was used.

Dose rate it measured in (CPM)

i. Count per dose (CPM)

$$100 \text{ CPM} = 1 \mu\text{Sv/hr}$$

$$\therefore 1 \text{ CPM} = 10^{-2} \mu\text{Sv/hr}$$

ii. Absorbed dose

It's usually measure in Nano Gray. NGy/hr

$$10^3 \text{ nGy/hr} = 1 \mu\text{Sv/hr}$$

iii. Effective dose is measured in millisiver per hour MSv/hr .

$$\text{ADR} \times \text{time} \times \text{C} \times \text{C} \times \text{OF}$$

Where:

ADR is the absorb dose rate

Time taken to do the job

C = Conversion Coefficient

For indoor is 0.2 while for outdoor is 0.4, and the occupational factor is constant which is given to be 0.7.

RESULTS AND DISCUSSION

Values of radiations as measured by the Inspector alert (Nuclear Radiation Monitor, with inbuilt Geiger Muller Counter tube) from the computer screen, telephone handset, petro filling station and television screen respectively have been carefully analyzed below.

RADIATION FROM COMPUTER SCREEN

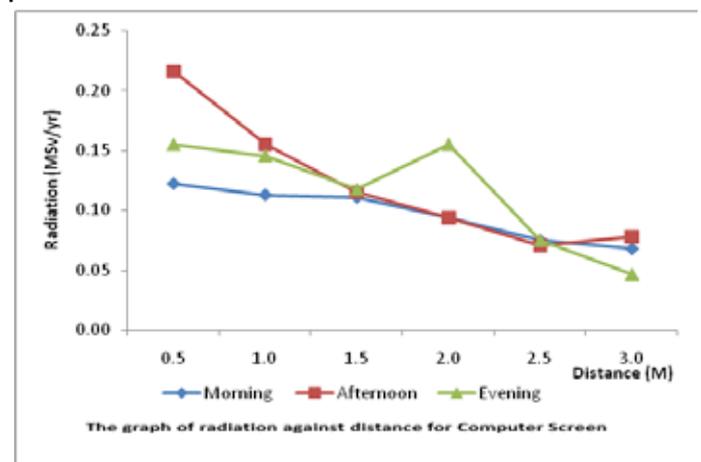


Fig. 1 Graph of Radiation against Distance.

The graph above shows the plot of radiation against distance. It was observed that the impact of radiation are higher in the morning, afternoon and evening at a distance 0.5m from the computer screen. However, the value of measured radiation continued to reduce at greater distance away from the computer screen except for evening value which suddenly jumped up to 0.16MSv at a distance of 2.0m away from the computer screen which is higher than the value obtained in themorning and afternoon, otherwise it could have been conveniently concluded that radiation is inversely proportional to distance from the computer screen.

RADIATION FROM TELEPHONE HANDSET

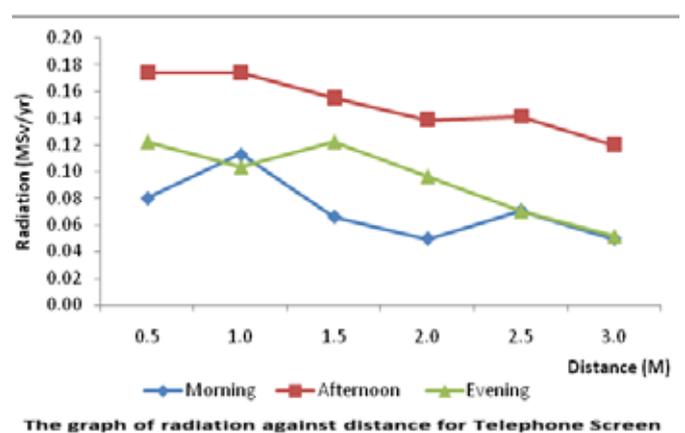


Fig. 2: Graph of Radiation against Distance

It was observed that the impact of radiation is higher for telephone handset at a distance of 0.5m in the afternoon, 0.08 and 0.12MSv in the morning and evening respectively. However, the effect continues to reduce at a greater distance away from the telephone handset. Except for evening hours at a distance of

0.15m, it rises above $0.12MSv$. Otherwise it would have been at a greater distance from the telephone handset although the value obtained for afternoon hour was still high.

RADIATION FROM PETRO FILLING STATIONS

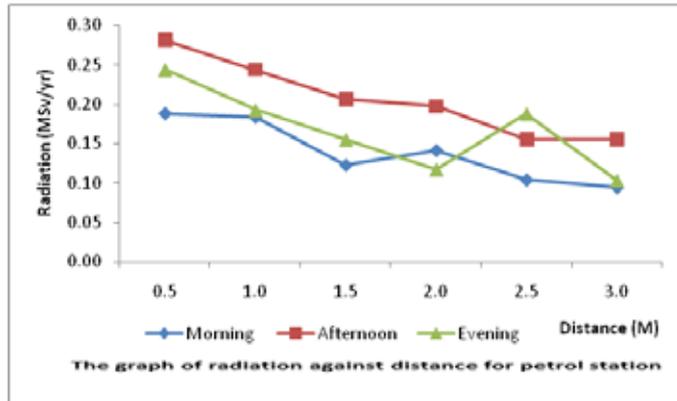


Fig. 3: Graph of Radiation against Distance

It was observed that at a distance of 0.5m away from the petrol filling station, the impact of radiations for morning, afternoon and evening are $0.19MSv$, $0.30MSv$, and $0.25MSv$ respectively. The values are higher in the afternoon, lower in the evening and lowest in the morning hours. However, the impact of radiation continue to reduce at a greater distance away from the petrol filling station until a distance of 2.0m in the evening and rise up at a distance of 2.5m while the one for morning hours is still less and the values for that of afternoon continue to reduce at a greater distance.

RADIATION FROM TELEVISION SCREEN

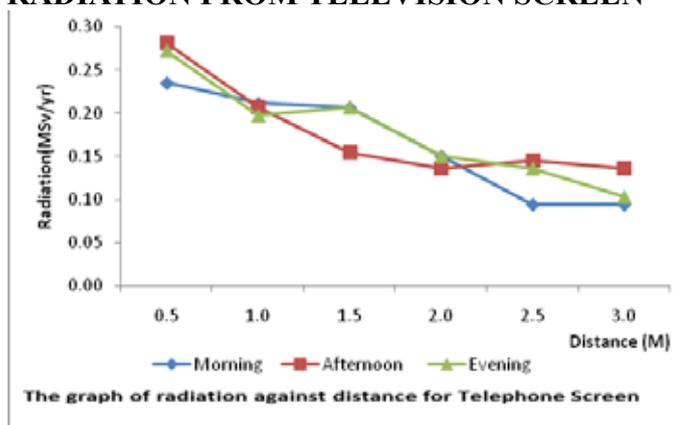


Fig. 4: Graph of Radiation against Distance

From Fig 4 above, it has been observed that the impact of radiation is very high for both afternoon and evening hours, the morning hours which is $0.30MSv$ and $0.24MSv/yr$ at a distance of 0.5 m but at a distance of 1.0 m away from the screen there is a decrease before it rises up again at a distance 1.5m.

Furthermore, at a distance of 2.0m and 2.5m away from the television screen the impact of radiation continued to reduce at a greater distance for morning and evening hours except for afternoon which jump up to $0.156 MSv/yr$. Otherwise, it would have been concluded that radiation decreases with increase in distance from source.

COMPARISON OF RESPONSE TO RADIATION BY THE FOUR GADGETS AT DIFFERENT HOURS OF THE DAY

Further attempts were made to compare the intensity of radiation obtained from the four different gadgets namely: (i) Computer screen, (ii) Telephone handset, (iii) Petrol filling station and (iv) Television screen at morning, afternoon and evening hours of the day with a view to determining the best hours of operation for the gadgets with a view to operating them with minimum risk of radiation exposure.

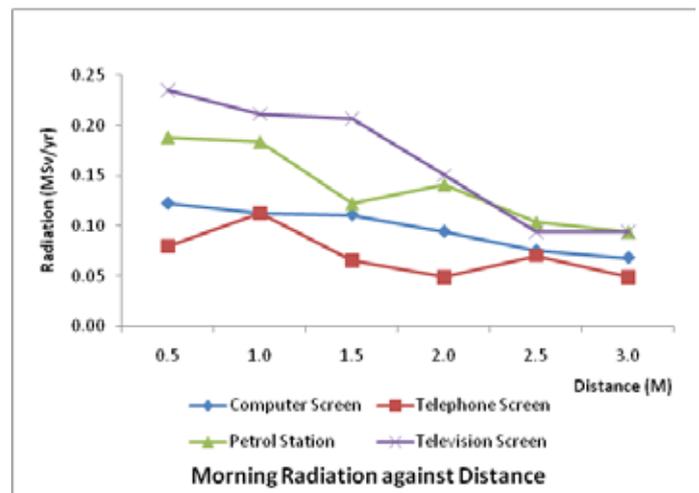


Fig 5 Comparison of Radiation for Morning Hours

From Fig 5, it was observed that at a distance of 0.5m away from the screen. Computer recorded a value of $0.13MSv$, $0.08MSv$ for telephone handset and $0.19MSv$ and $0.25MSv$, for Petro filling station and Television screen. However the impact of radiation continue to drop for Computer screen at a greater distance while the value for Telephone hand set suddenly rises and then drops before it primarily reduced with increase in distance even below that of Computer screen. Petro station records a value of $0.13MSv$ at a distance of 1.5m and Television screen recorded $0.24MSv$ at the same distance of 1.5 m which is higher than that of Computer, Telephone and Petro station for morning hours otherwise it would have been concluded that impact of radiation for the four gadgets decreases with an increase in distance.

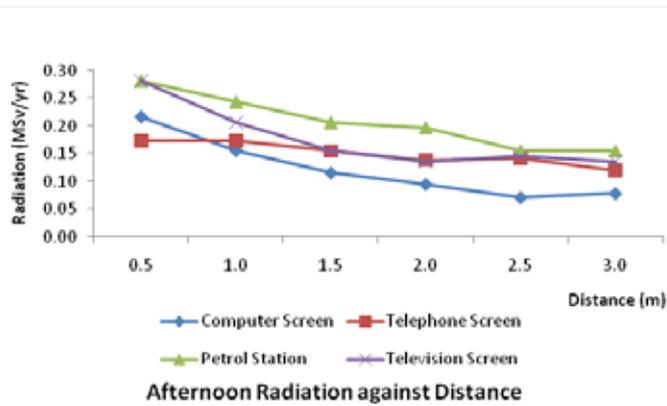


Fig. 6: Comparison of Radiation for Afternoon hours.

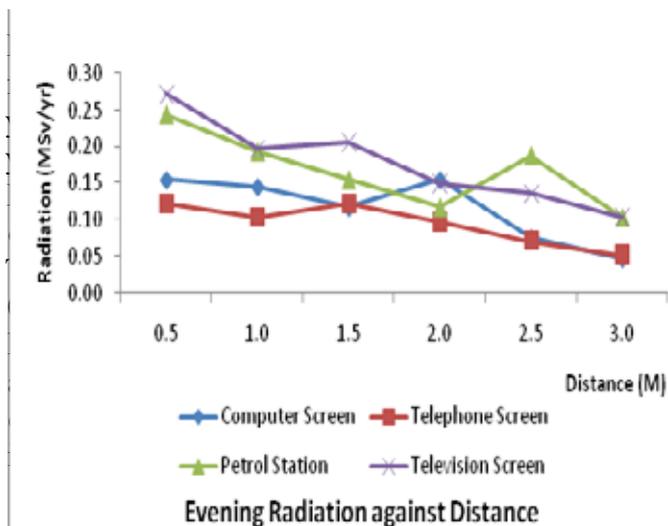


Fig. 7: Comparison of Radiation for Evening hours

It has been carefully observed that at a distance of 0.5m the effect of radiation is high with a value of $0.15MSv$, $0.13MSv$ for Telephone handset and $0.25MSv$ for Petro station and $0.27MSv$ all at same distance of 0.5m. However, the impact of radiation continues to decrease with an increase in distance. Meanwhile computer screen recorded a value of $0.5MSv$, Telephone and Petro station $0.5MSv$ and $0.165MSv$ all at a distance of 1.5m except for Television screen which rises with a value of $0.24MSv$. But at a distance of 2.5m away from the screen the values for Computer screen, Telephone handset fall below $0.1MSv$ while Petro station and Television screen rise up with values of 0.16 and $0.22MSv$ respectively. Otherwise, it would have been concluded that the impact of radiation continued to decrease with increase in distance for all the four gadgets.

CONCLUSION

Inspection alert (Nuclear Radiation monitor, with an inbuilt Geiger Muller Counter tube) was used to measure radiation from four different machines and gadgets often used by man in everyday activities. The gadgets considered are: computer screen, telephone

handset, petro filling station and television screen, it is confirmed that these items emit radiations of different intensities at different hours of the day. This implies that we are exposed to radiations, due to constant use of those gadgets although the radiation effect is very minimal or insignificant when compared with the recommended minimum dose by the International Council for Radiation Protection Standard which states that for any radiation to have an adverse effect on human health. It must exceed $1.20MSv/yr$ (ICRP,2007) from analysis made by this work radiation values obtained are far less than $1.0MSv/yr$ which may be considered as insignificant effect, but constant exposure over a long period of time may have accumulative effect on the health of people that are exposed to such radiations.

From the above analysis it is observed that computer screen has its lowest radiation effect in the morning hours, high in the afternoon and moderate in the evening hours; telephone handset recorded low radiation in the morning, highest in the afternoon and moderate in the evening hours. However, petro filling station radiation impact of radiation is lower in morning, higher in the afternoon and moderate in the evening. While Television screen has a low radiation in the morning, higher in the afternoon and lower in the evening hours, radiation has longtime cumulative effects on people at the receiving end at a distance, however the effect is very low.

It is true that man works to earn his living. It is recommended for people working with computer to utilize the morning hours and should keep computer screen a few distance away from the eyes, while for people making use of mobile devices (telephone handset) are advised to make most calls in the morning and evening (otherwise) due to the high radiation effect on the body in the afternoon hours; also the mobile devices should not be placed close to the body when it is not in use.

However, people who want to buy fuel should try and do that within the morning hours, and for the fuel pump attendees in afternoon and evening shifts, should be allowed a period of vacation for a period to be advised by medical experts or radiologists. In addition, all Petro station attendants should visit radiologist for advice from time to time.

Lastly, household should try to watch television in the morning and evening hours to avoid exposure to high radiations in the afternoon, the Television set should be placed a few distance away from the human eyes to avoid constant exposure to radiation at close range.

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