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# Evaluation of environmental monitoring at the Ghana research reactor-1 centre

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**ABSTRACT**

Regular environmental monitoring has being going on ever since the operation of the Ghana Research Reactor-1 (GHARR-1) to ensure both the safety of the workers in that they are not exposed to any harmful radiations and that equipment's that are used are in good condition. The objective of this work is to know if the right procedures are being followed to ensure that the minimum radiation dose is not being exceeded as well as not exposing the public to any controlled sources. Moreover over the years there have been encroachers on the Ghana Atomic Energy Commission (GAEC) land and this work therefore seek to know the possible effects these radiations have on those people. From the results obtained 2008 had a range of (0.03-3.10)µSv/h, (0.04-2.71)µSv/h for 2009, (0.07-2.81)µSv/h for 2010 and 2011 also had a range of (0.05-5.64)µSv/h. Comparing to the recommend value (For the public the limit is 1 mSv in a year, or in special circumstances up to 5 mSv in a single year provided that the average dose over five consecutive years does not exceed 1 mSv per year), this shows that the radiations recorded are within the recommended value indicating that the right procedures are being followed. Suffice to say this more work has to be done to ensure that there is a sustainability in following procedures and that the encroachers too must be warned off to avoid any consequences in case there is unavoidable accidents in the near future



## Introduction

Environmental monitoring is the measurement of external dose rates due to sources in the environment or of radionuclide concentrations in environmental media. Ionizing radiations cannot be seen, felt or sensed by the human body in any way but excessive exposure to them may have adverse health effects. Radiation measuring instruments are needed in order to detect the presence of such radiations and avoid excessive exposure. The use of appropriate and efficient instruments enables exposures to be controlled and the doses received to be kept as low as reasonably achievable (ALARA). (IAEA, 2004 PRTM-1 (Rev.1))

The type and extent of radiation monitoring required depends on the radiological conditions in the area of work concerned and the radiation conditions associated with the work. Such a program requires comprehensive internal radiation monitoring among other monitoring methods (i.e., individual dosimetry for external dose, contamination of skin and clothes, workplace monitoring, including determination of radiation levels, airborne contamination, and surface contamination). The radiation measurement is a time-integrated dose, i.e., the dose summed over a period of time, usually about 3 months. The dose is subsequently stated as an estimate of the effective dose equivalent to the whole body in mSv for the reporting period. Dosimeters used for personnel monitoring have dose measurement limit of 0.1 - 0.2 mSv (10-20 mrem) (Grover et al, 2002).

### *Background radiation*

Natural background radiation comes from five primary sources: cosmic radiation, solar radiation, external terrestrial sources, radiation in the human body and radon. The background rate for radiation varies considerably with location, being as low as 1.5 mSv/a (1.5 mSv per year) in some areas and over 100 mSv/a in others (Leon et al, 1950). In fact, low doses and low dose rates led to increased longevity rather than the decreased lifespan seen at higher doses and dose rates. In addressing the apparent life lengthening at low dose rates, the US National Council on Radiation Protection and Measurement (NCRP) interpreted this effect as reflecting "a favorable response to low grade injury leading to some degree of systemic stimulation." go on to state that "…there appears to be little doubt that mean life span in some animal populations exposed to low level radiation throughout their lifetimes is longer than that of the un-irradiated control population."

In the future, the accurate examination of residents of high background radiation areas around the world might generate the needed information on this phenomenon, which is termed "radiation hormesis". Based on the presently available data, residents of high background radiation areas (sizeable population is exposed up to 20 mSv per year from natural background) do not appear to suffer adverse effects from these doses. Areas characterized with background radiation significantly higher than average can be found in Iran, Brazil, India, Australia and China. In the U.S., the population of Denver receives more than 10 mSv per year from natural background. (http://mitnse.com/2011/04/07/)

### *Effects of Radiation*

The effects of radiation at high doses and dose rates are reasonably well documented. A very large dose delivered to the whole body over a short time will result in the death of the exposed person within days. Much has been learned by studying the health records of the survivors of the bombing of Hiroshima and Nagasaki. We know from these that some of the health effects of exposure to radiation do not appear unless a certain quite large dose is absorbed. However, many other effects, especially cancers are readily detectable and occur more often in those with moderate doses. At lower doses and dose rates, there

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is a degree of recovery in cells and in tissues. However, at low doses of radiation, there is still considerable uncertainty about the overall effects. It is presumed that exposure to radiation, even at the levels of natural background, may involve some additional risk of cancer. However, this has yet to be established. To determine precisely the risk at low doses by epidemiology would mean observing millions of people at higher and lower dose levels. Such an analysis would be complicated by the absence of a control group which had not been exposed to any radiation. In addition, there are thousands of substances in our everyday life besides radiation that can also cause cancer, including tobacco smoke, ultraviolet light, asbestos, 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. (http://www.iaea.org/Publications/Factsheets/English/radlife.html). As an operational technique, fertile female workers should limit their occupational radiation dose to no more than 250 mrem per month, so if a pregnancy is confirmed, the total radiation dose received by the embryo/fetus during the first two months would not exceed 500 mrem fetal dose limit. Pregnant workers should then avoid, or reduce radiation exposure in the work place. (*www.ehs.umaryland.edu/.../*)

## Materials and methods

### *Instrumentation*

The instrument used for the environmental monitoring work was the thermo RADEYE g-10 gamma survey meter having a serial no.738 with a range of ±10 with CF within 1.025-0.976% which is monthly calibrated by the Radiation Protection Institute of GAEC. The instrument is held 1m above the ground to take readings. The reactor is situated at the Ghana Atomic Energy Commission, Kwabenya - Accra, Ghana.

### *Study design*

The monitoring of the radiations occurred between 2008 and 2011 on the Ghana Atomic Energy Commission site at Kwabenya - Accra, Ghana. Routine monitoring is carried out to confirm a safe working environment. Surveys are conducted at appropriate regular intervals but not to a predictable timetable. The entire area of the GAEC is divided into about 25 sub areas for the sake of monitoring. Special monitoring are undertaken when there is the need for maintenance, installation of new equipment and when a sample undergoing radiation gives a high dosage reading. This monitoring activity has gone on continuously from year to year for the sake of the safety of the personnel as well as visitors. The measurements are intended to confirm the extent of static designated areas in the workplace, to prove the adequacy of measures against external and internal hazards and to reveal any deterioration in the standard of radiation safety. Over the years, the GAEC land has been encroached upon by many private developers and businesses. Even though steps are been taken to fend off these encroachers, little results have been realized in that effort. It is however important to also safeguard the inhabitants of these lands. An average value of about 20 – 30 values were obtained for each sub area and the average value was used to assess the safety of personnel, visitors and inhabitants.

### *Location*

GAEC is located North-West of University of Ghana. It is about 24 km from the Central Accra and 6 km off the Legon-Madina road towards Kwabenya through Haatso Township. The area where the institutes, centers and most of the research facilities is 4km west of the Haatso township whiles the residential area is about 2 km west of the site towards Kwabenya. (Ghana Atomic Energy at a Glance, 2006)

## Results

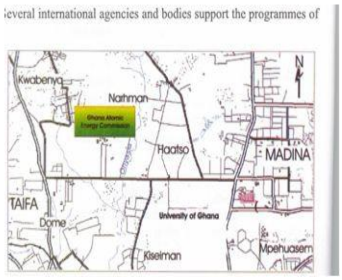


**Figure1. A map showing the location of GAEC**


**Figure2. A photograph of the instrument used (RADEYE G-10)**

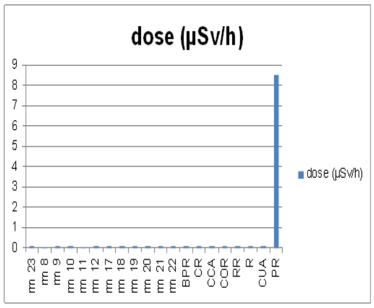


**Figure 3. A bar chart showing the average dose of 2008**

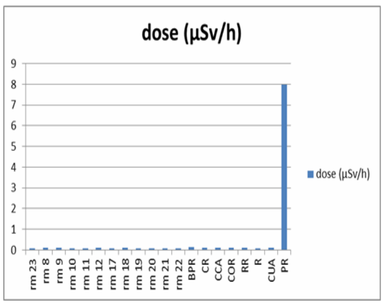


**Figure 4. A bar chart showing the average dose of 2009**

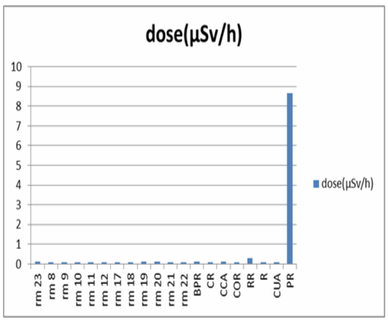


**Figure 5. A bar chart showing the average dose of 2010**

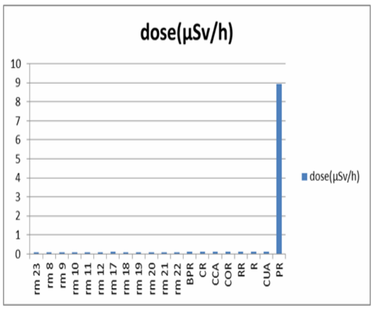


**Figure6. A bar chart showing the average dose of 2011**

## Discussions

Analyzing the results obtained from the table, 2008 had a range of (0.03-3.10)µsv/h, (0.04-2.71)µSv/h for 2009, (0.07-2.81)µSv/h for 2010 and 2011 also had a range of (0.05-5.64)µSv/h. This shows that the radiations recorded are within the recommended value ( i.e. For the public the limit is 1 mSv in a year, or in special circumstances up to 5 mSv in a single year provided that the average does over five consecutive years does not exceed 1 mSv per year )indicating that the right procedures are being followed. From the trend of results the gas purge room recorded the highest value and this is due to the fact that there is a radioactive facility underneath the room which serves as the storage for radioactive waste substances moreover, it also serves as temporary storage for radiated samples and the least values recorded differed in location. Looking at the figures, the bar charts consist of average readings of the twelve months for the various years and the results obtained for 2008 had a range of (0.07-8.55) µsv/h, (0.07- 7.98) µsv/h for 2009, (0.08- 8.65) µsv/h for 2010 and 2011 had a range of (0.08- 8.93) µsv/h. the results indicated a fluctuating value for the purge room. However 2011 results indicated rise in value for the purge room. These differences in the values for the purge room can be attributed to time as time, distance and shielding affects the dose of radiations so with time the value decreases till a new source is sent to the purge room and then a slight increase is detected. Many radiation sources are "point sources" (the radiation appears to emit from one spot some distance away). The radiation dose from these sources can be significantly reduced by applying the protective measure of "distance" as. The dose a person receives from an external radiation source is inversely proportional to the square of the distance from the source ($1/d^2$). Therefore, if the dose rate at one foot is 100 millirems/hour (10mSv/h), the dose rate at 10 feet would be $1/10^2$ of that, or 1 millirem/hour therefore although the residential area is about 2 km west of the site towards Kwabenya might be safe now, but compared to the fact that people at Chernobyl suffered radiological consequences during the 1986 accident then there is the need to extend the residential area to a further distance at least 30 km. the commission together with other state agencies has put together an emergency response team in view of the fact that occasionally the country experiences earthquakes and tremors. The team comprising of personnel from the commission, the Ghana National Fire Service, the Police Service, the Military, National Disaster Management Organization and medical personnel has been periodically carrying out simulation exercises. The reactor has other safety mechanisms to ensure that, there are no leakages, Suffice to say this more work has to be done to ensure that there is a sustainability phase such that national training program is in place and training courses linked to services, such as individual monitoring, source calibration, radiation protection equipment and maintenance to help maintain the necessary scientific expertise. The encroachers must be warned off to avoid any radiological consequences in case there is an unavoidable accident in the near future. The Land commission must be educated about the dangers they exposed people to when the sell the Ghana Atomic Land and the government should step in by putting strict measures in place such that anybody caught would be prosecuted. Specialized training too must be provided, for example, for physicians in medical handling of overexposures.

## Conclusion

The probabilistic nature of low-dose radiation health effects makes it impossible to derive a clear distinction between 'safe' and 'dangerous' level of radiation. This also creates difficulties in explaining the control of radiation risks. The results obtained were within the range of background radiations indicating safety of personnel, visitors and inhabitants. Nevertheless strict measures should be taken to fend off the encroachers on the GAEC land for their own safety in the future. As it is now, many scientists shy away from political activities. Their involvement in these activities will help to explain and spread the message about nuclear science. There is the need to encourage more scientists to enter into politics as they would be in a better position to ensure that certain policies are in place that would ensure the safety of the people.

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**Table 1 Giving an example of the environmental monitoring of 2008-2011**

| Location | Dose (µsv/h) 10th Nov,2008 | Dose (µsv/h) 30th June, 2009 | Dose (µsv/h) 30th July, 2010 | Dose (µsv/h) 6th Oct, 2011 |
|---|---|---|---|---|
| Room 23 | 0.10 | 0.09 | 0.13 | 0.08 |
| Room 8 | 0.06 | 0.10 | 0.07 | 0.08 |
| Room 9 | 0.05 | 0.10 | 0.10 | 0.07 |
| Room 10 | 0.09 | 0.10 | 0.08 | 0.05 |
| Room 11 | 0.03 | 0.06 | 0.10 | 0.06 |
| Room 12 | 0.10 | 0.12 | 0.10 | 0.11 |
| Room 17 | 0.09 | 0.06 | 0.11 | 0.10 |
| Room 18 | 0.12 | 0.06 | 0.09 | 0.08 |
| Room 19 | 0.08 | 0.04 | 0.12 | 0.07 |
| Room 20 | 0.12 | 0.07 | 0.18 | 0.07 |
| Room 21 | 0.10 | 0.15 | 0.07 | 0.09 |
| Room 22 | 0.07 | 0.11 | 0.08 | 0.11 |
| Counting room(COR) | 0.10 | 0.08 | 0.13 | 0.10 |
| Control room (CR) | 0.09 | 0.12 | 0.09 | 0.12 |
| Purge room | 3.10 | 2.71 | 2.81 | 0.07 |
| Reception (R) | 0.13 | 0.13 | 0.10 | 0.07 |
| Back of RSO | | 0.11 | 0.16 | 0.07 |
| Front of compression room | 0.10 | 0.11 | 0.15 | 0.11 |
| Corridor of uncontrolled area (CUA) | 0.09 | 0.06 | 0.10 | 0.08 |
| Rabbit room (RR) | 0.11 | 0.10 | 0.65 | 5.64 |
| Corridor of controlled area (CCA) | 0.09 | 0.15 | 0.15 | 0.07 |
| Reactor hall | 0.12 | 0.12 | 0.13 | 0.09 |
| Back of offices | 0.11 | 0.09 | 0.13 | 0.11 |
| Back of purification room (BPR) | 0.10 | 0.10 | 1.23 | 0.09 |
| Under mango tree | 0.11 | 0.10 | 0.18 | 0.12 |

*range of radiation (0.03-3.10)µSv/h for 2008, *range of radiation (0.04-2.71)µSv/h for 2009
*range of radiation (0.07-2.81)µSv/h for 2010, *range of radiation (0.05-5.64)µSv/h for 2011