Measurement the Radiation Absorbed Dose Rate in Some Schools of Wasit Governorate – Iraq

Ali A. Jaber¹, Hadi D. Alattabi¹, and Shafik S. Shafik², ³
¹Department of Physics, College of Science, Wasit University, Wasit – Iraq
²University of Alayen, Thi-Qar, Iraq
³Department of Physics, College of Science, University of Baghdad, Baghdad, Iraq
²,³Corresponding author: shafeqsh76@gmail.com ; shafeq_sh@scbaghdad.edu.iq

Abstract:
In this paper, twenty four measurements for radiation absorbed dose rate (D) of selected schools in Wasit Governorate – Iraq have been investigated using Canberra dosimeter. The annual radiation effective dose rate (Eff.D) has been calculated for all investigated schools. The results showed a significant fluctuation for all measurements of indoor and outdoor absorbed dose rates (D_in and D_out) and the overall average values were 0.14 µSv/h and 0.134 µSv/h for D_in and D_out, receptively. Furthermore, the maximum value of Eff.D was 1.275 mSv/y and the minimum value was 0.294 mSv/y while the overall average value was 0.819 mSv/y.

Keywords: Absorbed Dose Rate; Natural Radiation; Annual Radiation Effective Dose; Wasit-Iraq

1. Introduction
All substances that make up our world and even the human body contain certain amounts of natural radioactivity as well as cosmic rays, which can affect human health [1]. School students are among the most important segments of society that must be continuously monitored.

By virtue of its existence, humans are exposed to multiple sources of radiation, the most important of which are natural radiation, including radionuclides ²³⁸U, ²³²Th, and ⁴⁰K, which are found in the Earth’s crust since their creation, due to their long half-lives [2]. Natural sources of radiation include cosmic rays that come from the sun and planets, including gamma rays and neutrons. ²³⁸U, ²³²Th, and ⁴⁰K are three long-lived naturally occurring radionuclides present in the earth crust. They generally enter human body through the food chain and also through the inhalation of the suspended dust in the air [3]. When inhaled or ingested these elements accumulate in critical organs and deliver radiation doses. Other sources of radiation are abnormal sources, including nuclear facilities that put radioactive materials into the atmosphere and the environment as well as exploration and extraction of uranium [4]. Other factors affecting the amount of radiation dose are the quality of construction, buildings, and heating and ventilation systems in households. Anyway, and because of its importunity, there are several national [5-9] and international studies [10-12] dells with the measurements of radiation background.
The aim of this work is to measure the rate of radiation exposure for a number of schools in Wasit province and different areas of the districts of the province and to know if there is an abnormal radiation background due to the hostilities.

2. Research Methodology

In this poster, twenty four measurements for radiation absorbed dose rate (D) of selected schools in Wasit Governorate – Iraq have been investigated using Canberra dosimeter (shown in figure 1). The dosimeter was calibrated in Iraqi Radiation Protection Center (IRPC) labs before used. The annual radiation effective dose rate (Eff.D) has been calculated for all investigated schools.

For any studied location, five measurements of D were taken and then the average value was depended. Additionally, D values have been measured at 1 m above the ground of the investigated locations. The used equations for estimation the annual radiation effective dose (Eff.D):

\[
\text{Eff. } D = \text{Eff. } D_{\text{In}} + \text{Eff. } D_{\text{Out}} \quad \ldots \ldots (1)
\]

where

\[
\text{Eff. } D_{\text{In}} = D_{\text{In}} \times T \times C_c \times OF_{\text{In}} \quad \ldots \ldots (2)
\]

\[
\text{Eff. } D_{\text{Out}} = D_{\text{Out}} \times T \times C_c \times OF_{\text{Out}} \quad \ldots \ldots (3)
\]

where \( \text{Eff. } D \) is the total annual effective absorbed dose rate in (mSv/y), \( \text{Eff. } D_{\text{In}} \) is the indoor annual effective absorbed dose rate in (mSv/y), \( \text{Eff. } D_{\text{Out}} \) is the outdoor annual effective absorbed dose rate in (mSv/y), \( D_{\text{In}} \) is the absorbed dose rate in indoor (µSv/h), \( D_{\text{Out}} \) is the absorbed dose rate in outdoor (µSv/h), \( T \) is a Time in hours (8760 hours for a year), \( C_c \) is a Correction coefficient, which value is 0.7, and \( OF_{\text{In/Out}} \) is occupancy factor (80% for indoor and 20% for outdoor).

![Figure (1): Canberra dosimeter](image-url)
3. Results and Discussions

Table (1) illustrates the overall results. The maximum, minimum, and overall average values of measured $D_{\text{In}}$ ($\mu$Sv/h) are 0.230, 0.075, and 0.140, that measured in Imam Ali Preparatory school for boys in the center of Kut, and Al - Zahra Girls School in Sheikh Saad, respectively. While for $D_{\text{Out}}$ ($\mu$Sv/h), the maximum value is 0.215 that measured in Al-Ahrar middle school in Al-Ahrar area, the minimum value is 0.050 that registered in Al-Rabab Secondary School for Girls in Al Kut Center, and the overall average value is 0.134. However, some measurements of $D_{\text{In}}$ and $D_{\text{Out}}$ have values higher than the registered range of IRPC [13], which are 0.118 $\mu$Sv/h to 0.178 $\mu$Sv/h, and this can be attributed to bad ventilation in the classrooms of these schools. The results are plotted as histogram in figure (2).

The calculated results of the annual radiation effective dose (Eff.D) in (mSv/y) have been showed in table (1). The maximum value is 1.312 in Al-Ahrar middle school in Al-Ahrar area, the minimum value is 0.294 in Al-Rabab Secondary School for Girls in Al Kut Center, and the overall average value is 0.819. Nevertheless, some results of Eff.D have high values than the allowed international limit that is 1 mSv/y [14].

| Codes | The names and locations of the schools | $D_{\text{In}}$ ($\mu$Sv/h) | $D_{\text{Out}}$ ($\mu$Sv/h) | Eff.D (mSv/y) |
|-------|---------------------------------------|-----------------------------|-----------------------------|--------------|
| L1    | Alfikr Al-Arabiya Primary School in Sheikh Saad | 0.130 | 0.115 | 0.699 |
| L2    | Alfikr Al-Arabiya secondary School in Sheikh Saad | 0.175 | 0.130 | 0.773 |
| L3    | Sheikh Saad Primary School for Boys | 0.160 | 0.060 | 0.356 |
| L4    | Al - Zahra Girls School in Sheikh Saad | 0.075 | 0.185 | 1.141 |
| L5    | Sheikh Saad preparatory school for boys in Sheikh Saad district | 0.130 | 0.075 | 0.454 |
| L6    | Fidaa Secondary for Girls | 0.165 | 0.145 | 0.883 |
| L7    | Aleizat Preparatory school for boys in the center of Kut | 0.085 | 0.105 | 0.638 |
| L8    | Al-Rabab Secondary School for Girls in Al Kut Center | 0.075 | 0.050 | 0.294 |
| L9    | Farabi primary school in Numaniya district | 0.135 | 0.135 | 0.834 |
| L10   | Al-Shahid Jamal medium school for boys in Numaniya district | 0.135 | 0.110 | 0.662 |
| L11   | Ahad Elementary Mixed School in Al-Zubaidiya district | 0.135 | 0.185 | 1.128 |
| L12   | School of Kairouan in Al-Zubaidiya district | 0.185 | 0.175 | 1.067 |
| L13   | Sharhan Elementary Mixed School in Al-Zubaidiya district | 0.190 | 0.210 | 1.275 |
| L14   | Al-Ghadeer School in Al-Zubaidiya district | 0.205 | 0.190 | 1.153 |
| L15   | Sadrin Primary School in Al-Numaniya District | 0.090 | 0.100 | 0.625 |
| L16   | Preparatory Al-Shahid Qasim Shabar for boys in Numaniya district | 0.090 | 0.095 | 0.589 |
| L17   | Al-Ahrar middle school in Al-Ahrar area | 0.185 | 0.215 | 1.312 |
| L18   | Badrah preparatory school for boys in Badrah district | 0.125 | 0.100 | 0.625 |
| L19 | Mesbah Al Huda Primary School for Boys in Jassan District | 0.120 | 0.135 | 0.834 |
| L20 | Jassan Middle School for Boys in Jassan District | 0.130 | 0.125 | 0.773 |
| L21 | Al-Warda Al-Bayda Primary School in Badrah - Kut Road | 0.120 | 0.090 | 0.564 |
| L22 | Al Kut Commercial Preparatory School for Boys in Al Kut Center | 0.140 | 0.180 | 1.116 |
| L23 | Al Kut Preparatory School for Boys in Al Kut Center | 0.145 | 0.135 | 0.834 |
| L24 | Imam Ali Preparatory school for boys in the center of Kut | 0.230 | 0.170 | 1.030 |
| The Overall Average | **0.140** | **0.134** | **0.819** |

**Figure 2: the relationship between absorbed dose rate (µSv/h) and the measured locations**

### 4. Conclusions

From the obtained results, one can remarkably note that some investigated schools have indoor radiation absorbed dose rate higher than the allowed limits, which can be attributed to bad ventilation in classrooms. In addition, and because most investigated schools located in agricultural land, the outdoor radiation absorbed dose rate registered high values in some other locations, which may be attributed to the nature of its soil, that are agriculture soils content high amount of fertilizer. Therefore, the annual radiation effective dose also, registered values higher than the international allowed values.
References

1. M. F. L. Annunziata, "Handbook of Radioactivity Analysis ", second edition, Elsevier Science, USA, 2003.
2. Todsadol Santawamaitre, “An Evaluation of the Level of Naturally Occurring Radioactive Materials in Soil samples along the Chao Phraya River Basin”, A thesis submitted for the Degree of Doctor of Philosophy, Department of Physics Faculty of Engineering and Physical Sciences University of Surrey, 2012.
3. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), "Report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly, Volume II: Effects", New York, (2001).
4. ICRP. 2007. Publication No. 103, The 2007 Recommendations of the International Commission on Radiological Protection. ICRP 37(2-4):1-332.
5. Shafik S. Shafik and Noor Al-Huda Irzooqi, "Measurements of radon, thoron and their progeny concentrations using twin cup dosimeter for indoor Al-Madaan city – Baghdad – Iraq", Iraqi Journal of Physics ISSN: 20704003 Year: 2016 Volume: 14 Issue: 30 Pages: 24-32.
6. Shafik S. Shafik and Basim K. Rejah, "Radon concentration measurements in sludge of oil fields in North Oil Company (N.O.C.) of Iraq", Iraqi Journal of Physics, ISSN: 20704003 Year: 2015 Volume: 13 Issue: 26 Pages: 139-145.
7. Israa K. Ahmed1, Mahdi Hadi Jasim, and Shafik S. Shafik, "Measurement of radon concentration in fly ash samples from electric power stations in Iraq in the middle and south by using nuclear track detector CR-39", Iraqi Journal of Science, 2016, Vol. 57, No.2C.
8. Kamal K. Ali, Shafik Sh. Shafik, and Husain A. Husain, " Radiological Assessment of NORM Resulting From Oil and Gas Production Processing in South Rumaila Oil Field, Southern Iraq", Iraqi Journal of Science, 2017, Vol. 58, No.2C.
9. Shafik S. Shafik, Asia H. Al-Mashhadani, and Muna A. Saeed, “Uranium Concentration in Soil of some Eastern Iraqi Regions using Nuclear Track Detector (CR-39),” Asian J. Appl. Sci. Eng., vol. 3, no. 9, pp. 61–71, 2014.
10. Alam, M.N., Chowdhury, M.I., Kamal, M., Ghose, S., Islam, M.N., Mustafa, M.N., Miah, M.M.H., Ansary, M.M., 1999. The 226Ra, 232Th and 40K activities in beach sand mineral and beach soils of Cox’s Bazar, Bangladesh. J. Environ. Radioactivity 46, 243–250.
11. Sadegh Hazrati, Abbas Naghizadeh Baghi, Hadi Sadeghi, Manouchehr Barak, Sahar Zivari and Soheila Rahimzadeh, "Investigation of natural effective gamma dose rates case study: Ardebil Province in Iran", Iranian Journal of Environmental Health Sciences & Engineering 2012, 9:1.
12. A.C. Freitas and A.S. Alencar, "Gamma dose rates and distribution of natural radionuclides in sand beaches—Ilha Grande, Southeastern Brazil", Journal of Environmental Radioactivity 75 (2004) 211–223.
13. Iraqi Radiation Protection Center (IRPC), governmental website, https://www.rpc.gov.iq/main2.htm. Last update at April 2020.

14. United Nations Sources and Effects of Ionizing Radiation (UNSCEAR), Report to the General Assembly with Scientific Annexes, vol. 1, pp. 126-127, United Nations, New York, 2000.