Physical Sciences
ISSN: 1308 7304
Article ID: 3A0098

Status : Research Article
Received: 18.09.2022
Accepted: 25.10.2023

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DOI	http://dx.doi.org/10.12739/NWSA.2023.18.4.3A0098
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MEASUREMENT OF BACKGROUND GAMMA RADIATION

ABSTRACT

The results of measurements of the level of radiation in places of residence are presented in this work. Based on the measurements obtained, diagrams of the state of the radiation background were constructed, based on which it can be concluded that the natural radiation background is within the normal range. The natural background does not depend on external factors: pressure, humidity, or temperature, but during measurements, external conditions affect the operation of the dosimeter and, consequently, their indications. As a result of the research, the radiation gamma background of the studied area will be determined and a radiation gamma background map will be created. The map will include a populated area, gamma-background in open space, gamma-background in the building, conducted measurements, etc. As a result of the research, the level of protection of the population living in the given area and the awareness of the current radiation situation will increase. In the future, it will be useful to study the radiation gamma background in other places, model the radiation pollution of the determined activity, and create an online map of the radiation background.

Keywords: Dose, Radiation Background, Gamma Radiation, Dosimeter, Frequency Distribution

1. INTRODUCTION

Radiation is ionizing emitting that causes irreparable damage to the surrounding environment and living organisms. Radiation affects the body indiscriminately. Radiation from many sources is omnipresent on the earth's surface, consequently, man is continuously irradiated. The basic difference between ionizing (nuclear) radiation and other common types of radiation in the environment such as heat is that it possesses sufficient energy to cause ionization. Every day, people receive a minimal dose of radiation, so they do not realize that radiation has a devastating effect on their health and the health of future generations. Part of the public due to incompetence completely ignores the expected danger. Therefore, it is necessary to inform the population about the types of radiation, and sources of radiation. In the water of which cells are largely composed, ionization can lead to molecular changes and to the formation of chemical species of a type that are damaging to the chromosome material.

Ionizing radiation injury is dependent on several factors including, the nature (alpha (α), betta (β), and gamma (γ)) and energy of the radiation, the dose, time of exposure, homogeneity of dose and shielding. When the dose and dose rate are within the accepted level, the effect of radiation is small, and most time no effect is noticed, although the effects of low-level radiation are not yet completely understood (ICRP, 1990). The human body is permanently irradiated from two ionizing radiation sources: External and Internal. External radiation sources can

How to Cite:
Gamishidze, Z., (2023). Measurement of background gamma radiation. Physical Sciences, 18(4):17-23, DOI: 10.12739/NWSA.2023.18.4.3A0098.

either be natural (cosmic, earth) or artificial (e.g. radiation generators), both of equal risk to man. Inside the body, the K-40 is, by its nature present throughout human life. In the case that anyhow (ingestion, inhalation, etc.), other radionuclides (such as radon in air) enter the body, the body becomes internally contaminated. During the last 50-60 years, the environment has been heavily polluted with radioactive substances, which has increased the radiation background. From the point of view of radiation assessment, it is advisable to measure gamma radiation, since it has a greater penetrating power than other types of radiation.

The research aims to study the radiation gamma background in the surrounding environment, to show what radiation is, what properties it has, and how we can measure and analyze the radiation background around us. In addition, radiation control is necessary because, in today's world, increased concentrations of radiation can exist in places where it is least expected. In addition, besides, the modern system of radiation protection is the most complete compared to the system of protection against other technogenic risk factors.

2. RESEARCH SIGNIFICANCE

Nuclear technologies are gaining more and more space in medicine and industry. However, the progress was accompanied by a rather large negative consequence, which dramatically increased the radiation background of the environment. Radiation background refers to radioactivity in the environment, such as cosmic rays, and radiation coming from the earth's surface (mainly in the form of gamma-quanta). Of all energy pollution in modern conditions, radioactive and acoustic pollution have the greatest negative impact on humans. The problem of radiation is very relevant, since the eradication of radioactive radiation, especially after the recent and expected possible nuclear catastrophe, has greatly changed the idea of the impact of these radiations on humans and the environment, and this issue will be relevant for many years to come. The population is deprived of information about the degree of pollution of air, water, land, and food in places of residence, and in zones of environmental emergency. The expansion of the use of the atom for peaceful purposes, with insufficient safety of radiation contamination of the environment, leads to a threat to the survival of mankind on Earth due to radiation contamination.

The expansion of the use of the atom for peaceful purposes, with insufficient safety of radiation contamination of the environment, leads to a threat to the survival of humanity on Earth due to radiation contamination. The damaging effect of ionizing radiation is found at all levels of organization of living objects - molecular, cellular, and in the whole organism. The impact of radiation on the body is different, but quite often it is negative. Natural and man-made radiation can bring us benefits and harm. Solar radiation is an irreplaceable source of light and heat. X-rays and lasers used in medicine produce radiation that is completely safe for most people, but even at higher doses, they can destroy human tissue. Medics believe that at low doses, radiation has a stimulating effect, training the human biological defense system. Many resorts use radon baths, where the level of radiation is slightly higher than in natural conditions. It was noticed that those who take these baths improve their working performance, the nervous system calms down, and injuries heal faster. In large doses, it often leads to the death of the body due to the destruction of tissue cells. The sensitivity of individual organs to radioactive radiation also differs.

The probability of tissue damage depends on the total dose and the size of the dosage, due to the reparative abilities. The likelihood of cancer increases in direct proportion to the radiation dose. The impact

of radiological radiation is sharply enhanced by other adverse environmental (the phenomenon of synergy). Therefore, it is necessary to monitor the radiation background of the environment and to study the natural radioactive sources in detail, to carry out systematic measurements, and to process the data, so that we can all make a small contribution to the world's global radiation research.

Highlights:

- Monitoring the radiation background of the environment
- To examine natural radioactive sources in detail
- Making systematic measurements in nature and processing data

3. EXPERIMENTAL METHOD-PROCESS

One of the best ways to protect against radiation is the analysis of the radiation background in all areas-premises, office, enterprise, and surrounding environment, and its compliance with the radiation level determined by the state sanitary norms. The radiation background is measured with special device detectors, one of the important quality-determining features of which is the efficiency of registration of various radiations. For these measurements, we used a portable, modern radiation detection and monitoring model detector of the GMQ Geiger Counter type, both for indoor/outdoor and other environment measurements. The dosimeter provides automatic recording of radiation characteristic data, and when connected to a computer, this data can be downloaded and analyzed. It also allows us to connect to the world Geiger Counter map via the Internet. On this platform, it is possible to view the data both in real-time and according to a specific period, which allows us to analyze the level of radiation and determine the regularity of changes.

4. FINDINGS AND DISCUSSION

This article presents a picture of current radiological conditions by examining external gamma radiation. We performed measurements of external gamma radiation at the given location from 1/22/2019 to date. A part of such data is presented as a sample in the form of a table (Table 1). The statistical indicators of the received data are defined, such as the range (minimum–maximum), arithmetic mean (AM), arithmetic standard deviation (SD), and median (Table 2), based on which it is also possible to determine other characteristics, such as it is Variance, Skewness, Kurtosis, Minimum, Maximum, Frequency distribution, and others.

Table 1. External gamma measurement results

Date (GMT-7:00)	uSv/h	CPM	ACPM	Latitude	Longitude
10:22:06 PM	0.09	18	16.4	41.75391	42.81982
6/24/2021 22:17	0.115	23	17.9	41.75391	42.81982
6/24/2021 22:11	0.105	21	20.7	41.75391	42.81982
6/24/2021 22:06	0.135	27	20.2	41.75391	42.81982
6/24/2021 22:01	0.085	17	21.1	41.75391	42.81982
6/24/2021 21:56	0.11	22	21.1	41.75391	42.81982
6/24/2021 21:51	0.06	12	21.2	41.75391	42.81982
6/24/2021 21:46	0.13	26	21.2	41.75391	42.81982
6/24/2021 21:41	0.095	19	20.3	41.75391	42.81982
6/24/2021 21:36	0.11	22	20.8	41.75391	42.81982
6/24/2021 21:30	0.12	24	20.6	41.75391	42.81982
6/24/2021 21:25	0.11	22	22.6	41.75391	42.81982
6/24/2021 21:20	0.12	24	24.3	41.75391	42.81982
6/24/2021 21:15	0.11	22	22.7	41.75391	42.81982
6/24/2021 21:10	0.125	25	21.2	41.75391	42.81982
6/24/2021 21:05	0.1	20	21.1	41.75391	42.81982
6/24/2021 21:00	0.055	11	22.2	41.75391	42.81982
6/24/2021 20:55	0.135	27	23.1	41.75391	42.81982
6/24/2021 20:50	0.16	32	21.8	41.75391	42.81982
6/24/2021 20:45	0.085	17	21.4	41.75391	42.81982
6/24/2021 20:40	0.105	21	22.4	41.75391	42.81982
6/24/2021 20:35	0.09	18	19.5	41.75391	42.81982
6/24/2021 20:29	0.08	16	18.4	41.75391	42.81982
6/24/2021 20:24	0.105	21	19.5	41.75391	42.81982
6/24/2021 20:19	0.115	23	20.1	41.75391	42.81982
6/24/2021 20:14	0.115	23	20	41.75391	42.81982
6/24/2021 20:09	0.07	14	19.9	41.75391	42.81982
6/24/2021 20:04	0.08	16	20.6	41.75391	42.81982
6/24/2021 19:59	0.12	24	20.6	41.75391	42.81982
6/24/2021 19:54	0.075	15	21.8	41.75391	42.81982
6/24/2021 19:49	0.115	23	20.6	41.75391	42.81982
6/24/2021 19:44	0.115	23	19.6	41.75391	42.81982
6/24/2021 19:39	0.11	22	20.4	41.75391	42.81982
6/24/2021 19:33	0.115	23	21.4	41.75391	42.81982
6/24/2021 19:28	0.125	25	19.9	41.75391	42.81982
6/24/2021 19:23	0.105	21	20.9	41.75391	42.81982
6/24/2021 19:18	0.14	28	22.6	41.75391	42.81982
6/24/2021 19:13	0.11	22	20.5	41.75391	42.81982
6/24/2021 19:08	0.07	14	19.9	41.75391	42.81982

Table 2. Statistical data of measurement results

	Mean (AM), uSv/h	Median, uSv/h	Std. Deviation (SD), uSv/h
01.2019	0.096	0.095	0.021
04.2019	0.096	0.095	0.022
07.2019	0.01	0.09	0.021
10.2019	0.090	0.09	0.021
01.2020	0.093	0.095	0.021
04.2020	0.096	0.095	0.023
07.2020	0.026	0.025	0.011
10.2020	0.094	0.095	0.021
01.2021	0.097	0.095	0.022
04.2021	0.093	0.095	0.022
07.2021	0.015	0.015	0.010
10.2021	0.095	0.095	0.021
01.2022	0.094	0.095	0.021
04.2022	0.096	0.095	0.022
07.2019	0.090	0.09	0.023

The basic statistics show that the arithmetic mean values at different times are slightly different in some cases, but mostly close to each other, and as it turned out somehow only in summer when the ambient temperature is high, it is not possible to determine the background of gamma radiation (Figure 1).

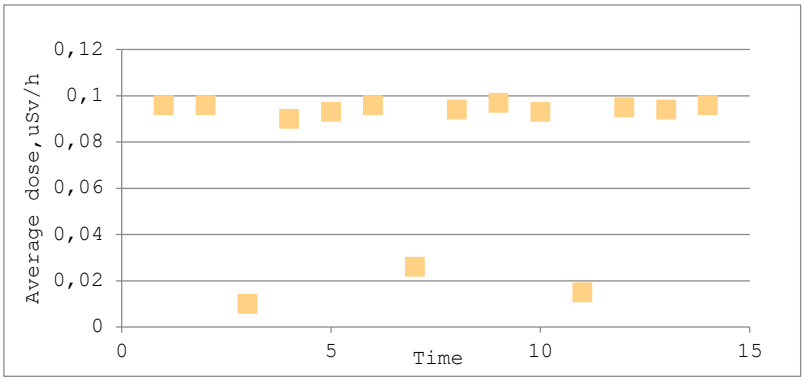

Figure 1. Summer average gamma radiation background measurements

Based on the obtained measurements, diagrams of the state of the radiation background gamma are constructed. In the diagram (Figure 2), the change of radiation gamma background dose is presented as a function of time, during some conditionally selected period. In these cases, for about one day. As can be seen from the graphs, there are changes in the dose value over time, but the average dose during this time is constant and, as we mentioned, only in some cases has deviations from the average values, which may be related to the natural changes of the gamma background in this case. The data in the figure are taken corresponding to different times of the year and seasons.

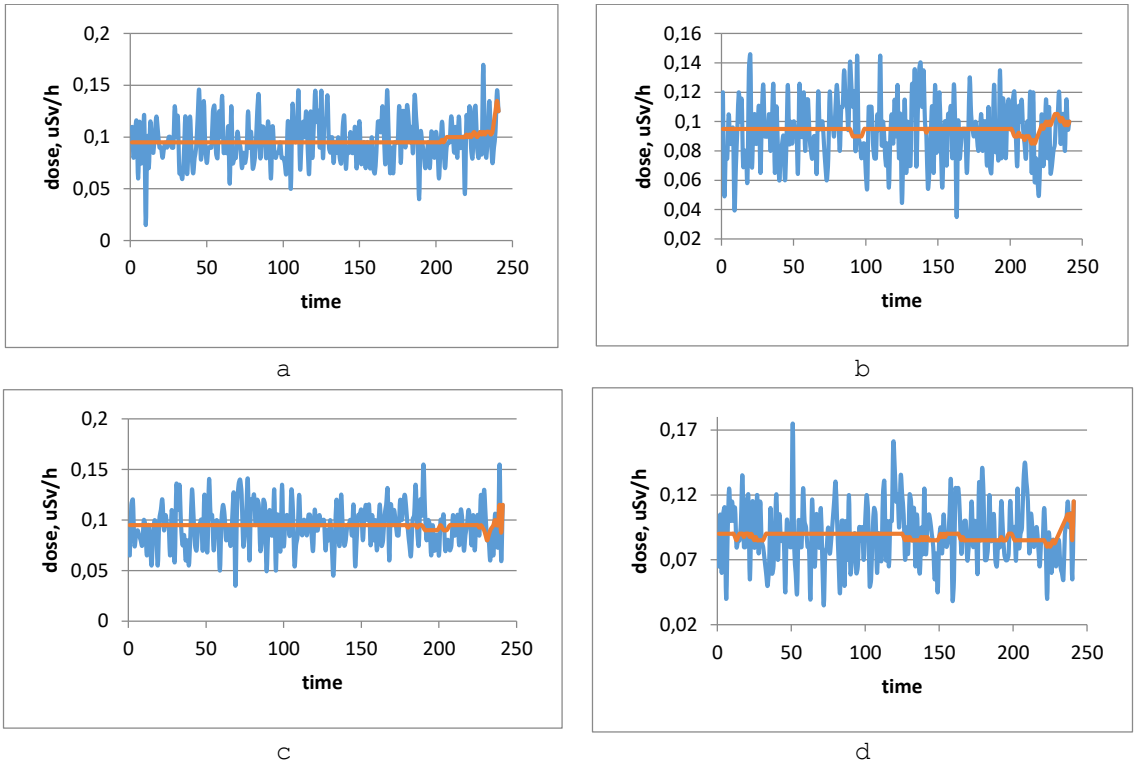

Figure 2. State diagrams of radiation background gamma measurements

In the figure (Figure 3) the curve of normal distribution of external gamma radiation is given-frequency distribution of doses. As can be seen from the graph, the normal distribution is symmetrical about the mean, which means that data close to the mean occur more often than data far from the mean. However, in reality, data points may not be perfectly symmetric. Kurtosis is a measure of the peakedness of the

probability distribution of a real-valued random variable. It characterizes the relative peakedness or flatness of a distribution compared with the normal distribution. Positive Kurtosis indicates a relatively peaked distribution. Negative Kurtosis indicates a relatively flat distribution. Higher Kurtosis means more of the variance is the result of infrequent extreme deviations, as opposed to frequent modestly sized deviations.

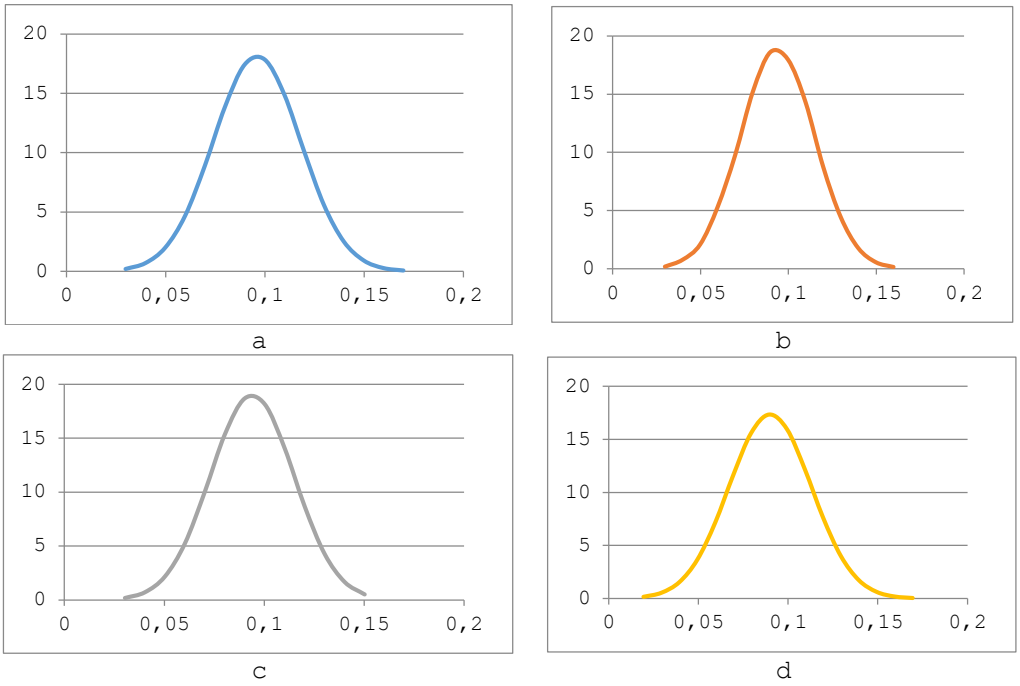

Figure 3. Normal Distribution Curves

5. CONCLUSION AND SUGGESTIONS

The results of measurements of the level of radiation in places of residence are presented in this work. Based on the measurements obtained, diagrams of the state of the radiation background were constructed, based on which it can be concluded that the natural radiation background is within the normal range. The natural background does not depend on external factors: pressure, humidity, or temperature, but during measurements, external conditions affect the operation of the dosimeter and, consequently, their indications. As a result of the research, the radiation gamma background of the studied area will be determined and a radiation gamma background map will be created. The map will include a populated area, gamma-background in open space, gamma-background in the building, conducted measurements, etc. As a result of the research, the level of protection of the population living in the given area and the awareness of the current radiation situation will increase. In the future, it will be useful to study the radiation gamma background in other places, model the radiation pollution of the determined activity, and create an online map of the radiation background.

NOTICE

This paper was presented as an oral presentation at the 6th International Science Symposium in Bulgaria-Sofia, on 1-2 September 2023.

CONFLICT OF INTEREST

The author has no conflicts of interest to be disclosed.

FINANCIAL DISCLOSURE

The author declare that this study has received no financial support.

DECLARATION OF ETHICAL STANDARDS

The author of this article declare that the materials and methods used in this study do not require an ethical committee.

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