Investigation and Evaluation of Gamma Radiation in Different Places of One University in Jilin City

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Abstract-Objective:Understand annual effective dose equivalent of Gamma Radiation in Different Places of One University of Jilin City, and then make brief analysis and evaluation. Methods: Gamma radiation in different places of one university of Jilin city was monitored with BH3103B portable X-gamma radiation dose rate meter. Results : Gamma annual effective dose equivalent was respectively 0.466,0.227,0.429 and 0.429 mSv in the office building, campus, students' dormitory and bank. Gamma annual effective dose equivalent in hospital under the environment of radiation workers and public is 0.350 mSv. Gamma dose rate of the building environment (office building, dormitory, savings banks) is higher than that of the open environment (campus). They are all below national individual standard to the public (GB 8703-88) (1mSv). Conclusion : The survey indicates that the surveyed six different places Annual effective dose equivalent does not cause harmful effects on human body.

Keywords-dose rate; Gamma Radiation; annual effective dose equivalent;environmental monitoring;Radiation Evaluation

I. INTRODUCTION

Radiation is a common phenomenon in nature, especially in medical and industrial areas. In some cases radiation harm coming from nuclear power plants leakage accident is extremely huge and a longer effect.The environment substances on earth contains radioactive nuclide, whose radiation level will not harm human health. but if exposed a very high dose irradiation or a longer period in higher radioactive level environment, people's health and life will be affected.Radioactive pollutants mainly harm human and other organisms through irradiation ray , which mainly contains alpha, beta and gamma ray. The gamma radiation is electromagnetic radiation with short wave,strong penetrating power, which need to pay special attention to external exposure protection.Therefore,monitoring and evaluation of gamma radiation level of different campus environment has health protection significance.

In our country,nuclear and radiation safety supervision work is established as the third main environmental protection system after the industrial pollution prevention and ecological environment protection,nuclear and radiation environment safety is an important part of the national environmental security.Radiation environmental protection is both environmental management and unique special radiation pollution.Radiation pollution is more concealment, which produces a wide range of influence,long cycle,difficult to control,high recovery cost ,and some latent influence. Radiation environmental monitoring is an important technical support of nuclear and radiation environment safety supervision is an important during environmental monitoring.Improvement the environmental radiation monitoring capability and technical level is an important guarantee to strengthen nuclear and radiation safety supervision, effectively prevent and properly handle unexpected nuclear and jurisdiction over the shooting accident,to safety guard the people's health and environmental rights .

II. INVESTIGATION OBJECT AND METHOD

A. Selection of monitoring points.

According to the environmental terrestrial gamma radiation dose rate measurement specification (GB/T14583-93),environmental terrestrial gamma radiation dose refers to air absorbed dose rate emitted by

gamma radiation producing the artificial radionuclides and natural radio nuclides above a certain height (usually l m) of the surrounding material in the field, road, forest, grassland, squares and buildings, the surface [1].

Taking into account teaching, learning, life place in school and the measurement convenience, four kinds of different representative place containing office building, dormitory, campus and bank savings were chosen. Considering artificial radioactive sources exposure to people in life are mostly from the hospital, so we choose the hospital attached to the school as the control, and divided into the medical environment and public environment according to the radiation medical.

B. Measuring instrument and method

BH3103B X- portable gamma dose rate instrument purchased from Beijing nuclear instrument factory [2]The main technical performance of the instrument is following: Energy response: range of change values ±15% (25KeV ~ 3MeV); cosmic ray response: ±15% (relative to the RS-111 ionization chamber); range: 1~10000 $\times 10^{-8}$Gy/h; inherent error: ≤10%; the angular response: ≤15% (^{137}Cs 0~150°relative to the maximum response value): long term stability;≤± 7%; temperature change range: ±30% （-10~+40°C）; calibration factor: 1.

According to technical specification for testing radiation environment (HJ/T612001), measuring instrument probe vertically downward 1m from the ground. Measuring point away from the wall is above 30cmin the center and the four angle of the indoor room; measuring point is above 50m from the surrounding buildings in the outdoor .

C. Quality assurance

The measuring instruments is upon inspection, calibration factor of uncertainty is less than or equal to 6.5% (95% confidence); the operating procedures was in strict accordance with relevant provisions of environmental radiation monitoring regulations.The measuring point selected in flat, open, no water, vegetation; measurement readings should not have significant difference in the range of 10 m diameter;the distance between the measured point near the tall building distance is greater than 30 m, and measuring point selected in the middle of the ground over 1 m;the measuring point was as far as possible to avoid the area C radiation environment changed significantly induced by the human activity .In order to reduce the random error, the maximum level position as measured points,and read the values in the steady state.In the presence of unstable readouts situation, if not a man-made or instrument reason, we should be added to the point of measurement time and reading.The climate conditions: ambient temperature at -10 to 40°C, relative humidity was less than 95%, the measurment was not after the heat, snow or rain were measured 4 h.

Sample point should be accurate, also should make original records (the original records include weather conditions, temperature, humidity, air pressure, the sample surface features).The sampling record, sample registration table and field test records should be complete. Sampling person should timely carefully fill in sampling record form and signature.Record card must have others review and signature. Keep the sample card writing clear,and not be altered.

D. Statistical methods

Statistical analysis was performed using SPSS 15 statistical software. Groups were compared using Z test and were considered to be statistically significant at $p<0.05$.

III. RESULTS

A. Monitoring complete point and repeated points

Real time measurement method is adopted in this data collection, namely the dose rate instrument directly measured instantaneous value of gamma air absorbed dose rate of the monitoring point.The instrument height was1 m (breathing zone height) and measuring probe vertically downward [3], measuring time was 10 s, 3 cycles, 5 groups data each physical points . After the measurement is completed, no less than 15% measurement area repeated observations in order to know the reliability and accuracy of observation data(seen Table 1).

TABLE1. Monitoring complete observation point and repeated points

Detecting region	Observation point	Repeated points	Samples number
Office building	8	1	45
Campus	14	2	80
Domitory	8	1	45
Banks savings	2	1	15
Hospital(medical environment)	13	2	75
Hospital(public environment)	10	2	60
Total	55	9	320

B. The measured results of the gamma radiation level of different places

According to the environmental terrestrial gamma radiation dose rate measurement specification (GB/T14583-93), gamma radiation dose rate need to deduct measurement instrument response to cosmic ray.In this paper,this instrument response value of cosmic rays is 3.9×10^{-8}Gy/h[4].

The calculation formula of environmental terrestrial gamma radiation air absorbed dose rate at observation point :

$$D\gamma=(D_0-D_G)\cdot q \qquad (1)$$

$D\gamma$ stand for the environmental terrestrial gamma radiation air absorbed dose rate;

D_0 is the actual level of the measuring point value;

D_G is the response of the instrument to the cosmic ray ,Gy/h;

q is thecorrection factor, taking 1 (provided by science technology and industry for national defense ionizing radiation metrology station verification certificate).

The calculation formula of effective dose equivalent gamma radiation on residents is:

$$He=D\gamma \cdot K \cdot t \quad (2)$$

He is the effective dose equivalent, Sv;

Dγstand for environmental terrestrial gamma radiation gamma air absorbed dose rate, Gy/h;

K is the ratio of effective dose equivalent rate dose to air absorption, according to"environmental terrestrial gamma radiation dose rate measurement specification" (GB/T 14583-93), using 0.7 SvGy-1.

t is the residence time of environment, adopting 8760 h(1 a years).

According to formula (1) and (2),through the measurement and calculation,the gamma radiation level of kinds of different places were seen in table 2.

TABLE2. The measured results of gamma radiation level of different places

Detecting region	N	Data category	Measurement result/ (10^{-8}Gy·h^{-1})	Conversion results/ (10^{-8}Gy·h^{-1})	Effective dose eqivalent/ mSv
Office building	45	Average Maximum Minimum	11.5 12.7 9.2	7.6 8.8 5.3	0.466 0.540 0.325
Campus	80	Average Maximum Minimum	7.6 9.4 5.8	3.7 5.5 1.9	0.227 0.337 0.117
Domitory	45	Average Maximum Minimum	10.9 12.5 9.5	7.0 8.6 5.6	0.429 0.527 0.343
Banks savings	15	Average Maximum Minimum	10.9 11.5 10.0	7.0 7.6 6.1	0.429 0.466 0.374
Hospital (medical environment)	75	Average Maximum Minimum	9.6 14.2 7.6	5.7 10.3 3.7	0.350 0.632 0.227
Hospital (public environment)	60	Average Maximum Minimum	9.6 11.6 6.6	5.7 7.7 2.7	0.350 0.472 0.166

C. *Gamma radiation level Comparison between building environment and open environment*

The above six kinds places divided into the building environment (office building, dormitory, savings banks) and open environment(Campus).Hospital is a special medical environment, medical radiation is more, so hospital was not be compared. Two groups were compared using Z test and the results were shown in Table 3.There was the difference in Gamma dose rate of building environment and open environment , and Gamma dose rate of the building environment is higher than that of the open environment($p<0.05$).

TABLE 3 Gamma radiation level of building and open environment.

	N	Average	Standard deviation	Variance	Z value	P value
Building environment	180	11.14	0.83	0.69	[illegible]	<0.01
Open environment	80	7.60	0.95	0.90		

IV. RESULTS ANALYSIS AND EVALUATION

At present,radiation environmental problem has become one of the focus of the public attention. Environmental radiation monitoring objective is to grasp conditions and trends of the radiation environmental quality,to master the latest,situation and development trend of radiation source, and to provide technical support for a radiation environmental management. Measurement of ionizing radiation environment monitoring includes two aspects, namely the measurement of environmental administer ground direct measurement and analysis of environmental samples.Direct measurement of ambient radiation field is gamma radiation absorbed dose rate emitting radionuclides in the environment.

A. *Office buildings*

Selected office building is the school faculty office building. Its gamma radiation level reflect the general level of the teachers office environment gamma radioactivity. The minimum value of Office environment gamma effective dose equivalent is 0.325mSv; the maximum value is 0.540mSv.Gamma radiation level is larger in the corridor, probably because the material around the ground and wall is marble, and the light is dark; while gamma radiation level is lower in the windowsill of the office, probably because the office ground material is ceramic tile, light is bright, and a better ventilation [5-7].

In general，gamma radioactive radiation average level of the regional environmental was the highest , but was in the environment background fluctuation range, less than the national standard of the public person 1mSv.In order to provide a more comfortable, comfortable, healthy living environment to the teacher office, we should strengthen the office building material radioactivity monitoring and management.

B. *Campus*

The monitoring campus selected the student main activity place, including the old playground, plastic playground, lawn, landscaped plaza. Theirs gamma radiation level reflect the general gamma radioactivity level of students in outdoor environment. The minimum value is 0.117mSv; the maximum value is 0.337 mSv, is 2.88 times the minimum value. According to the surface material and the surrounding environment, detection level is larger in waterscape Plaza, because the material around the ground is marble, while monitoring level is lower in plastic playground and centraland grass, probably because the plastic play ground material is plastic, it is open, the light and ventilation is good. The grassland is more open, the ground is the soil, green plants have certain absorption. In general, the regional environmental gamma radiation level in campus was the lowest , far less than the national standard of the public person 1mSv .

C. *Student dormitory*

Student dormitory is the main activities of students. Its level of gamma radioactivity was similar to the teacher office. Gamma radiation level is larger in the corridor and is lower in the windowsil. Gamma radioactive radiation average level of the regional environmental was in the environment background fluctuation range, less than the national standard of the public person.

D. *Bank savings*

The minimum value of savings bank gamma effective dose equivalent is 0.374mSv; the maximum value is 0.466 mSv, is 1.25 times the minimum value. detection level is larger in doorway, the reason was that the light is dark, the door is a revolving door, poor ventilation, no central air conditioning while monitoring level is lower rest seat area in the customer, may be because here the light is bright, central air conditioning ventilation is good. Gamma radioactive radiation average level of bank was less than the national standard of the public person.

E. *Affiliated Hospital*

In the environment of the hospital, the minimum gamma ray value to medical workers was 0.227mSv; the maximum value was 0.632 mSv, while the minimum value to public was 0.166mSv; the maximum value was 0.472 mSv. The overall radiology mean level of medical hospital environment was equal to that of public environment, but the minimum value is lower and maximum value is higher than that of the public environment, which illustrated the hospital adapted the construction planning to the special environment of radiology, including wood layer of floor, plastic wall, the use of shielding wall for gamma ray, shielding glass wall and so on[8,9,10].These could reduced gamma radiation level medical in researchers radiology environment.

In general ,gamma radiation level of average value in the affiliated hospital environmental is low, far less than the national standard to the public person 1mSv.Annual effective dose equivalent of radiological medical researchers is equal to mean annual effective dose equivalent of value and public, which illustrated that hospital has better done in radiation protection, avoided marble natural radiation larger in the choice of building materials. The hospital is an area gathered in more people. health is our common purpose, we need to strengthen the monitoring, to provide a more comfortable healthy hospital environment to the public.

F. *building environment and open environment*

The comparison results of the building environment and open environment can be seen that gamma radiation level of building environment was higher than that of the open environment. The ground of building environment is made of marble and tile; open environment was in the open air, ground material was forsoil. Therefore, in order to reduce the indoor radiation, the selection building materials should avoid marble or other materials containing natural radiation, wood is ideal material, meantime, the indoor should often open and ventilate

V. CONCLUSIONS

In this study, analysis shows that gamma radiation gamma radiation level in office buildings, dormitory buildings, banks and other indoor environment is higher than that of the open environment of campus. But on the whole, radioactive radiation level is not high, average annual effective dose equivalent is only up to 0.466 mSv, compared with the state of the public individual standard value 1 mSv, of 50% limited dose equivalent, belongs to low level .On the whole, the regional annual effective dose equivalent does not cause harmful effects on human body.

ACKNOWLEDGMENT

This work was financially supported by the Science and Technological Project of Jilin Province in China (No.201205038).

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