

ON THE LONG TERM INDDOR RADON CONCENTRATION MEASUREMENTS IN THE BASEMENT OF JAPANESE HOSPITALS

Mika Shiotsu¹, Koichi Ikeda¹, Susumu Yosizawa², Kazukiyo Kumagai¹

¹ The Institute of Public Health, Tokyo, Japan

² Sience University of Tokyo , Tokyo, Japan

ABSTRACT

Long term indoor radon gas measurements using a passive monitor were conducted in the basement rooms of five hospitals, which are built in the Tokyo metropolitan area. The ventilation rate averaged over all hospital was 12.3 ACH. The highest radon concentration was 56.3Bq/m³. The it averaged over all hospital and all season was 20 Bq/m³. But the two hospitals of averaged were twice as high as another three. Since the total ventilation rate integrated over a day is not different much. The reason for the concentration difference is considered to be the difference in emission rate from concrete wall and soil of the each hospital. And we inquired workers about "Environmental", it do not show the direct relation between radon and environmental complaints.

INTRODUCTION

The hospital basements are not usually residential space, but sometimes used for radiology, examination, laundering and kitchen so forth. Although many people are working, there is usually no window, therefore mechanical ventilation is only way to ventilation the space. More over, as the space was surrounded by soil and thick concrete walls, extremely high indoor radon concentration is expected.

Long term indoor radon gas measurements using a passive cup monitor were now being conducted in the basement rooms of five hospitals, which are built in the Tokyo metropolitan area. Ventilation rate are also measured during the monitoring pried. We also made questionnaires concerning complaints about environmental conditions in the work place to the workers in the terms of radon health risk.

METHODS

Indoor radon concentration measurements in 5 hospital basements in the Tokyo metropolitan area was conducted from 1995 summer to 1996 spring. 35 measuring points were set passive type monitor in each hospitals. Blank times were also set in the each 5 hospitals. During the measurements is 3 month as one season.

Radon gas measuring instruments

Passive ²²²Rn cup monitor method with cellulose nitrate (CN) film (Kodak Pathe, LR115 type

2) was used for measurements. (Figure 1) Sample air enters into the monitor through a membrane filter and alpha rays emitted from radon in the monitor are detected by the CN film. We decided to put two monitors for each measuring point so that we can take average of two monitors as sensitivity of the monitors are not high enough.

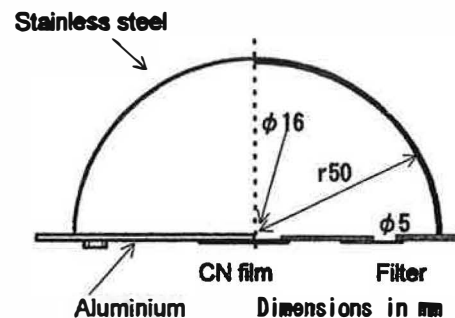


Figure1. Detail of Passive Type radon Gas Monitor

Ventilation rate measurement

We measured the ventilation rates in almost all the rooms. Ventilation rates were determined by the tracer gas decay method. We used SF_6 as a tracer which was detected by photo acoustic spectroscopy method.

Calibration

Calibration of passive monitors was conducted in August 1995 and July 1996 in Faculty of Nuclear Science, Department of Engineering Nagoya University in Japan.

Calibration of the monitor were performed by setting fifteen or sixteen cups monitors into a 247.8L stainless steel canister which was connected with 1.5L cylindrical ionization chamber containing high concentration ^{222}Rn gas. Relationship between integral radon concentration and the number of etch pits is shown in figure 2. These passive monitors were also calibrated at the intercomparison held in December 1996 in Critical Assembly in Kyoto University in Osaka.

Questionnaire

We were told from some workers who worked in these hospitals that they were having anxiety about indoor air quality, for example a feeling of stagnant air, lack of ventilation, and so on. Therefore we inquired workers about these conducting questionnaire about "Environmental complaints". The questionnaire was consisted of three items, affirmation, complaints about work place environmental and satisfaction with them.

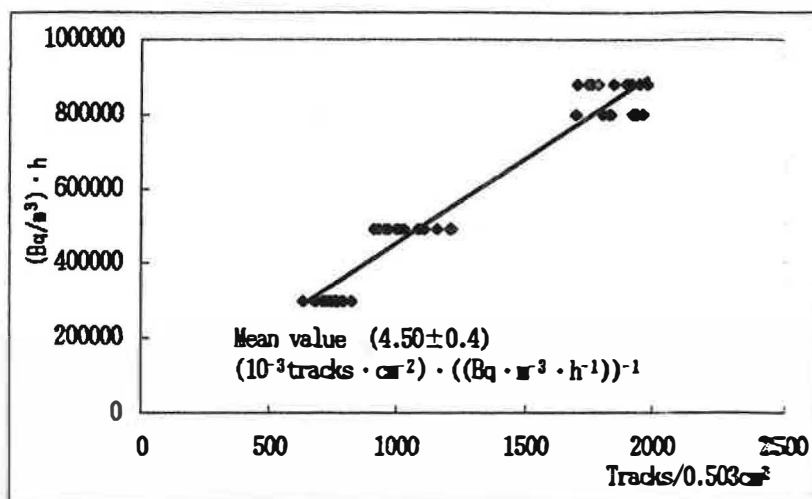


Figure 2. Calibration Curve

RESULT AND DISCUSSION

Measurement results of radon concentration obtained by summer of 1995 to spring of 1996 in Tokyo are shown in Figure 3.

The highest radon concentration, 56.3 Bq/m^3 , which is almost one third of the EPA standard, 150 Bq/m^3 , was observed in the summer season (June to September) in one of hospital A. The radon concentration was, in the other hand, almost equal to lower detection limit of the monitor.

The radon concentration averaged over all hospital and all seasons was 20 Bq/m^3 . The hospital A and B of average were 35.6 and 26.6 Bq/m^3 respectively, which were twice as high as the another three.

Figure 1 does not show seasonal change about concentration of radon gas.

It is well known fact that radon concentration is changing depending on the seasons and atmospheric pressure.

Ventilation

The result of ventilation measurements were also shown in Figure 4.

The ventilation rate averaged over all hospital was 12.3 ACH. The rates are ranging from 3.6 to 20.6 ACH. Although, we could measure ventilation rates for some rooms in this measurement in this measurement. We measured them almost all room in previous measurements¹⁾, result of which was 8.9 ACH, and was a little bit lower than present measurement. The ventilation systems were always running during the ventilation rate measurement.

From both results, these rooms of the hospitals were kept high ventilation rate so far as the ventilation systems are on.

However, there is anxiety that ventilation rates during the ventilation systems off was not high. In fact, the measurement during the systems off were considerably low, 1.0 ACH, or so,

although the number of cases is limited.

Figure 1 does not show seasonal change about concentration of radon gas.

It is well known fact that radon concentration is changing depending on the seasons and atmospheric pressure.

The reason for the concentration difference between hospital A and B, and other three is considered to be the difference in emission rate from concrete wall and soil of the each hospital. Since the total ventilation rate integrated over a day is not different much.

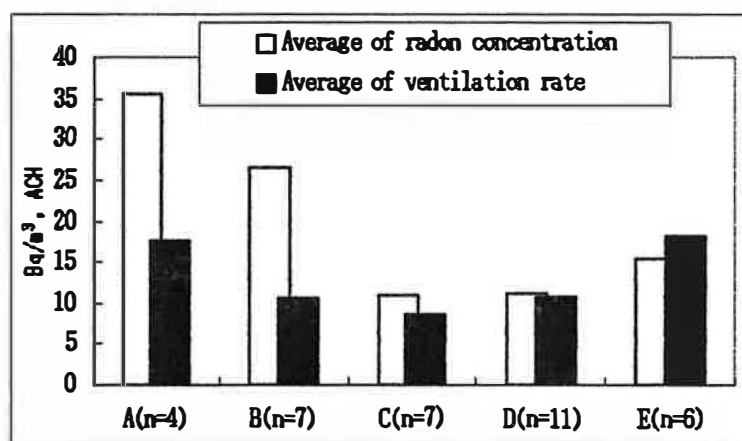


Figure 4 . Average Radon Gas Concentration and Ventilation rate

Questionnaire result

36 persons answered as shown in Table 1.

36 percent of the subjects answered that they are satisfied with number of staffs and the medical facilities with which they are working. The items pointed out by the subject as "satisfactory environmental factor". were a little bit different from items we were expected. 39 percent of the subjects were complaining of the shortage of room spaces and width of the corridor in each hospital. We think that these items are deeply related to building planning. We also did not expected them as environmental factor. 36 percent complained that the work place has no window, since they could not see outside and could not introduce outdoor air. Another 31 percent did not they were not complained of the factors related to HAVC systems, such as "Bad smell", "thermal sensation" and so forth.

But these results of questionnaire do not show the direct relation between for radon exposure and health.

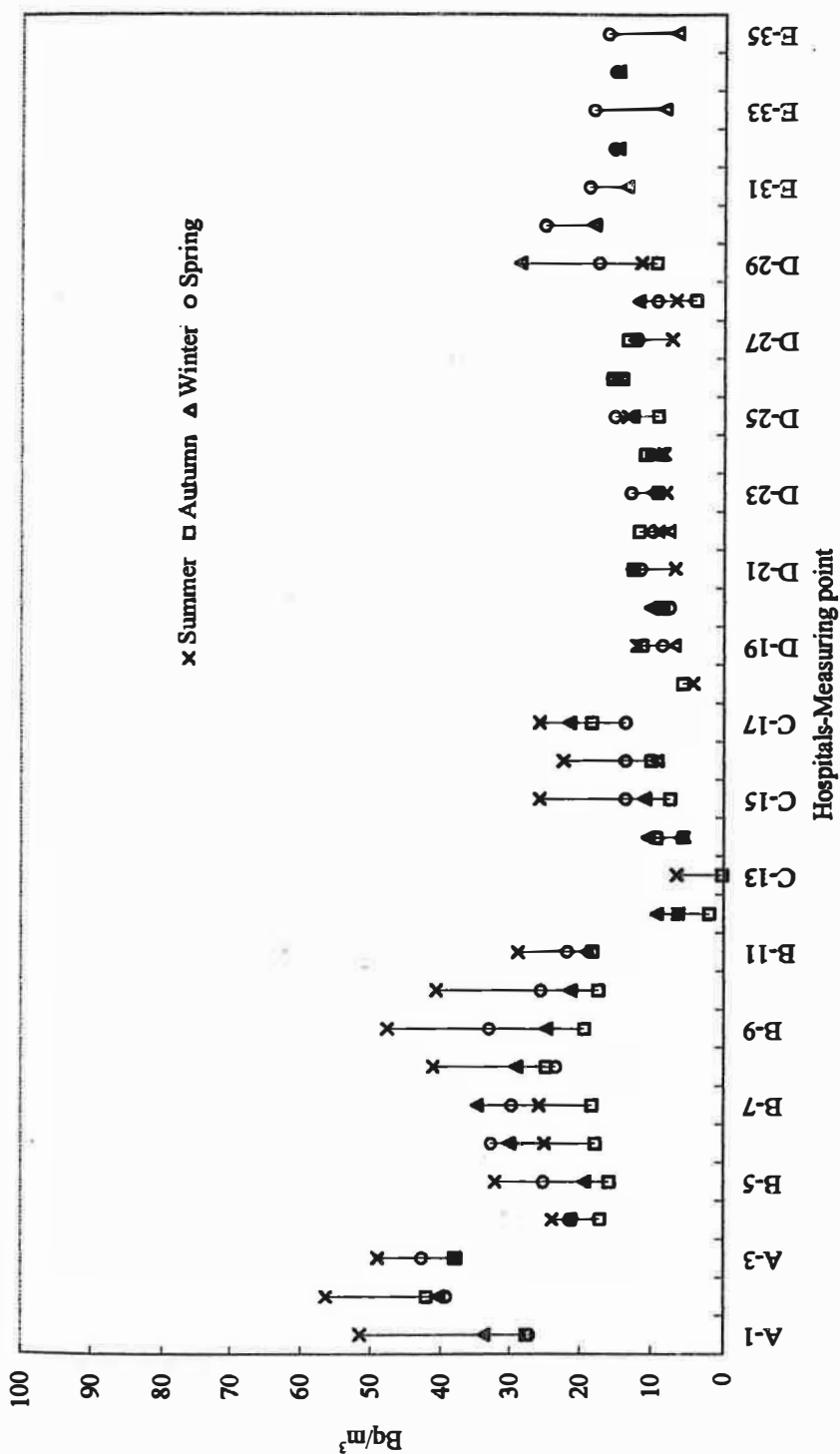


Figure 3. Seasonal Change in Radon Concentration

Table 1. Questionnaire Result

Hospitals	Answer of Workers	Number of subject							
		Satisfied with				Complaining of			
		Planninig systems	HAVC among rerationship	Human among others		Shortage of room space and width	No window	HAVC systems	Human among rerationship others
A	4	1		3		2	1	1	
B	12	4		4	5	8	3	2	1
C	9	1		2	3	2	4	5	1
D	10	2			2	2	5	3	2
E	1	0							
Total	36	8		6	13	14	13	11	5
Percentage	100	22		17	36	39	36	31	14

CONCLUSION

1. The highest radon concentration, 56.3Bq/m^3 , which is almost one third of the EPA standard, 150Bq/m^3 .
2. The hospital A and B of average were 35.6 and 26.6Bq/m^3 respectively, which were twice as high as the another three.
3. The ventilation rate averaged over all hospital was 12.3ACH .
4. Result of questionnaire do not show the direct relation between for health by radon exposure.

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