§9. Property and Behavior of Radon Progeny in the LHD Building

Yamasaki, K., Takahashi, T., Fukui, M. (Research Reactor Institute, Kyoto Univ.), Yamanishi, H.

INTRODUCTION

The inhalation of airborne radon progeny is a major path of the radiation exposure for not only general public but also workers. Since differing sized aerosol deposits at different location in the lung, the size distributions of inhaled aerosol-attached radon progeny and aerosol-unattached fraction are important in determining the lung dose. There have been very few experimental studies, because of the difficulties of their correct measurements in the environment. Therefore, we measured these quantities in the LHD building using a low pressure cascade impactor and a single wire screen technique.

EXPERIMENTAL

The LHD hall is an airtight room with large volume of about $1.2 \times 10^5 \mathrm{m}^3$ made of thick concrete wall for radiation shielding, and has recycle ventilation systems equipped with the filter chamber for air pre-treatment. The ventilation rate is about three times per hour, and the ratio of the recycle air and fresh air is about 30 : 1. So, the fresh air of the hall essentially replaces one time per ten hours. The filter is a so-called pre-filter which has a particle collecting efficiency of 86% with the gravimetric method.

Measurements were carried out under the conditions of normal ventilation and works including electric welding.

Radon gas concentration was measured continuously by a flow through scintillation cell (Pylon, AB-5) or a passive ionization chamber (Alpha Guard). Total (unattached and attached) radon progeny were sampled by a membrane filter (pore size : 0.65 μ m, low late : 1.2 $\mathrm{m}^3\mathrm{h}^{-1}$, face velocity : 26.5 cms^{-1}) and measured by alpha-spectroscopy after sampling. The unattached radon progeny were sampled by a single wire screen made of stainless steel (pore size 300 mesh, face velocity : 26.5 cms^{-1}, 50% cut-off diameter 2.2 nm, collection efficiency : 0.95, count efficiency : 0.79) and measured the same method of total radon progeny. Size distributions of the attached radon progeny were sampled with the Andersen type low pressure impactor. The activity collected on each stage was measured with a ZnS(Ag) scintillation counter. The aerosol particles number concentration and its size distribution were measured with a laser particle counter (Rion, KC-18)

RESULTS AND DISCUSSION

Measurements were carried out at 6~7, July, 2000, 3 ~6, June, 2000 and 13~16, March, 2001. Table shows the typical data on the property of radon progeny observed in the LHD hall in the courses of latter two rounds. The equilibrium equivalent radon concentration at each round is estimated to be 48 Bqm^{-3} and 45 Bqm^{-3}, respectively, from the concentrations of total radon progeny shown in table. These values are about eight times higher than the mean value of about 6 Bqm^{-3} at the dwellings in Japan. The fact that the difference between seasons in relatively small is based on the scale of the hall and ventilation system. On the other hand, the values of unattached fraction are relatively large, but within the range of 0.02~0.05 of representative values of Japan. The size distributions of the radon progeny were relatively well approximated by log normal distributions. The activity median aerodynamic diameters were, 0.20 μ m and 0.13 μ m, depending on the different size distributions of the ambient aerosol owing to the different conditions of the works in the LHD hall.

From these data, the annual dose of the workers due to radon inhalation in the LHD hall is estimated to be 0.8~1.0mSv, assuming 2000hrs of annual working time. These are about two times higher than the mean value of 0.46 mSv of the public in Japan.

Table   Typical data observed in the LHD hall

Measuring items		3-6, July, 2000			13-16, March, 2001		
		Run No.	Mean	St. dev.	Run No.	Mean	St. dev.
Total radon Progeny (Bq m^{-3})	^{218}Po	10	73.4	6.9	12	83.2	15.7
	^{214}Pb	10	48.7	3.0	12	47.9	4.2
	^{214}Bi	10	38.5	4.0	12	31.0	5.0
Unattached radon Progeny (Bq m^{-3})	^{218}Po	10	11.7	2.6	12	11.4	3.5
	^{214}Pb	10	1.5	1.2	12	1.6	0.7
	^{214}Bi	10	0.6	1.0	12	1.2	0.4
Unattached fraction	fp	10	0.048	0.013	12	0.044	0.013
Size distribution	Median d.(μ m)	6	0.20	0.02	15	0.23	0.02
	St. dev.	6	1.87	0.05	15	2.01	0.19
Aerosol concentration (cm^{-3})		10	2.1×10^3	4×10^2	24	1.4×10^3	5×10^2