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## MEASUREMENTS OF RADON ISOTOPE CONCENTRATIONS IN NUCLEAR POWER STATIONS

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Radon isotope concentrations of two nuclear power stations were investigated with a passive  $^{222}\text{Rn}/^{220}\text{Rn}$  discriminative dosimeter from June 1994 to February 1995. The measurement was carried out in about 70 places inside the reactor building, turbine buildings, and radioactive waste treatment buildings of the Tokai and Tsuruga Nuclear Power Stations. One is located in the east of Japan near Tokyo, and the other is located in the west of Japan. The average concentration of radon of the place above the lower than limited detection was  $4.5 \pm 1.4 \text{ Bq m}^{-3}$  in Tokai Station and  $9.4 \pm 6.5 \text{ Bq m}^{-3}$  in Tsuruga Station, respectively. Those results showed that in nuclear power stations, which have a good ventilation system, the exposure due to radon isotope can be neglected.

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### INTRODUCTION

Radon is present everywhere. There are studies on  $^{222}\text{Rn}$  and its progeny in living environments. In recent years, studies on  $^{222}\text{Rn}$  and its progeny in workplaces have also been carried out (Hattori and Ishida 1995a; 1995b). An action level of 500-1500  $\text{Bq m}^{-3}$  has been recommended for intervention in workplaces, with a corresponding range of annual effective dose of 3-10 mSv.

This paper reports a measurement of radon isotope concentrations inside the buildings of nuclear power stations carried out from June 1994 to February 1995.

### MATERIALS AND METHODS

Figure 1 shows the schematic figure of a prototype radon discriminative dosimeter adopted for the measurement. Two pieces of polycarbonate disk, 300  $\mu\text{m}$  in thickness, 50 mm in diameter, were installed in the two hemispheric diffusion chambers as a solid state nuclear track detector (SSNTD). Main specifications of the passive  $^{222}\text{Rn}/^{220}\text{Rn}$  discriminative integrating dosimeter are summarized in Table 1, and more detailed technical

information on the dosimeter is reported by Doi et al. (1991; 1992; 1994).

Two nuclear power stations, Tokai Station and Tsuruga Station, were measured. Tokai Station is a boiling water reactor (BWR) located in the east of Japan and faces the Pacific Ocean. Tsuruga Station is in the west of Japan and faces the Japan Sea. Unit 1 is a BWR and unit 2 is a pressurized water reactor (PWR).

The measurements were carried out in places where operators stay continuously, such as the main control room and local control rooms; in places where workers work for a rather long time, such as the laundry room and radiation sample measurement rooms; and in places where workers pass through frequently, such as passages. Office buildings outside the radiation controlled areas were also measured. There were about 70 places inside the reactor building, turbine building, and radioactive waste treatment building of the two stations measured. In nearly all the measurement places, the height of the dosimeters was about 1.5 m, and the distance from the wall was more than 20 cm to avoid the high  $^{220}\text{Rn}$  concentration's influence near the wall.

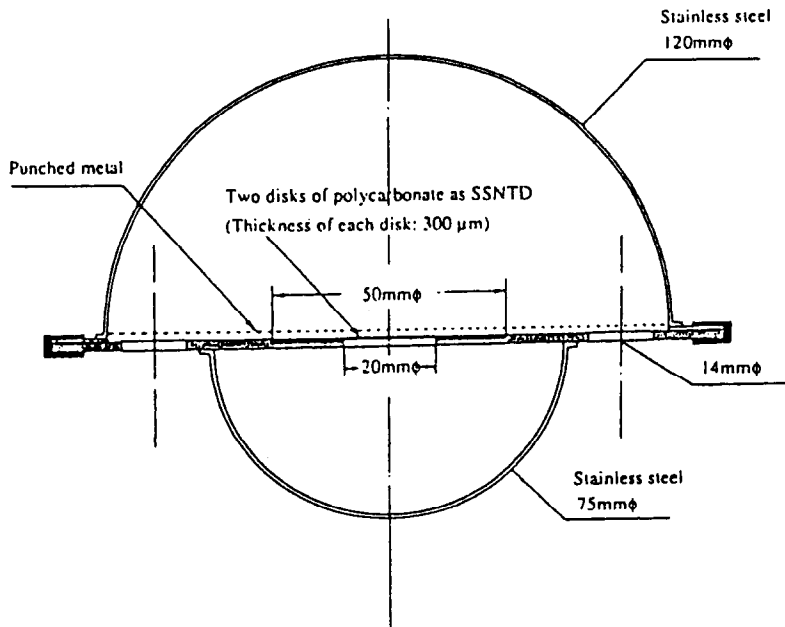


Fig. 1. Schematic diagram of the passive  $^{222}\text{Rn}/^{220}\text{Rn}$  discriminative integrating dosimeter. Two polycarbonate films are installed in the detector housing as SSNTDs.

Table 1. Specification of the passive  $^{222}\text{Rn}/^{220}\text{Rn}$  discriminative dosimeter.

Specification	$^{222}\text{Rn}$	$^{220}\text{Rn}$
Calibration factor	$0.0395 \pm 0.053$	$0.0127 \pm 0.0022$
Tracks $\text{cm}^{-2}/(\text{Bq m}^{-3} \text{ d})$	(75-mm hemisphere)	(120-mm hemisphere)
Lower limit of detection (60-d exposure)	$2.9 \text{ Bq m}^{-3}$	$9.0 \text{ Bq m}^{-3}$
Upper limit of detection (60-d exposure)	$250 \text{ Bq m}^{-3}$	$790 \text{ Bq m}^{-3}$

The exposure time of the dosimeter was 60-90 d, and measurements were performed three times during the period of June 1994 to February 1995.

## RESULTS AND DISCUSSIONS

The measured  $^{222}\text{Rn}$  concentrations ranged from  $3.4 \text{ Bq m}^{-3}$  to  $41.5 \text{ Bq m}^{-3}$  in both the stations and the average concentration of radon of the place above the lower limit of detection during the investigation period was  $4.5 \pm 1.4 \text{ Bq m}^{-3}$  in Tokai Station and  $9.4 \pm 6.5 \text{ Bq m}^{-3}$  in Tsuruga Station, respectively. This result suggested that the  $^{222}\text{Rn}$  concentration inside the buildings was the same or lower than that of outdoor air. There is a ventilation system in every building and the air inside the buildings is ventilated throughout the year in the two stations. This was thought to be the reason for the low  $^{222}\text{Rn}$  concentrations.

The difference in radon concentrations between the two stations could be the result of the difference in radon concentrations outside the buildings of the two districts where the two power stations are located, the difference in ventilation rates of the buildings of the two stations, or the difference in the uranium contents of the building materials of the two stations.

There are radioactive waste storage buildings with no ventilation in the power stations. The  $^{222}\text{Rn}$  concentrations of these buildings were also measured. The result of the measurement was 20 to  $160 \text{ Bq m}^{-3}$ , higher than other places because of no ventilation, but still lower than the action level recommended by ICRP 65.

The  $^{220}\text{Rn}$  concentrations in 54% of the measured places were lower than the lower limit of detection of the dosimeter ( $9 \text{ Bq m}^{-3}$ ) in Tokai Station, and in 30% of the places in Tsuruga Station. The average concen-

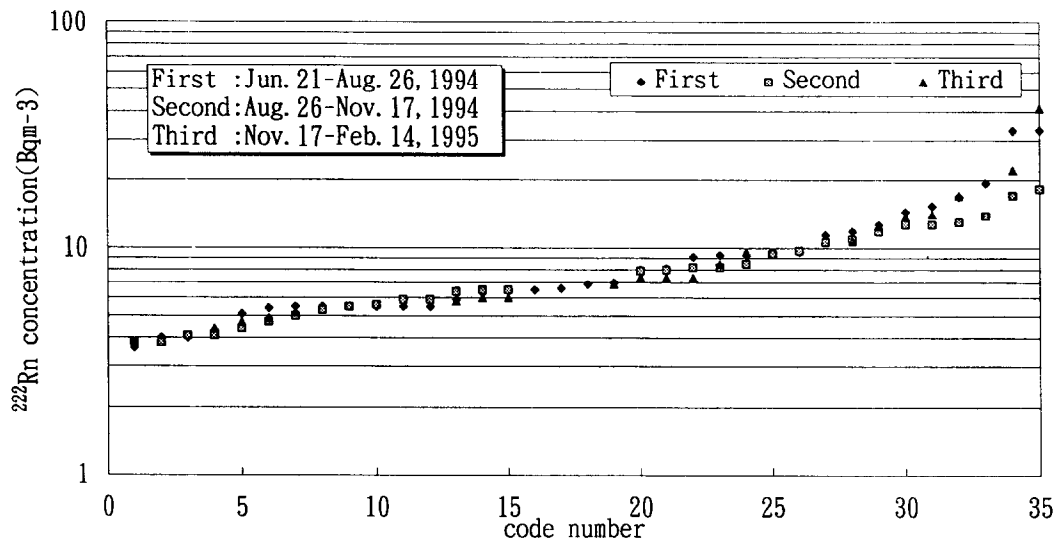


Fig. 2. Distribution of  $^{222}\text{Rn}$  concentrations in Tsuruga station.

tration of  $^{220}\text{Rn}$  in the places above the lower limit of detection was  $24.2 \pm 37.2 \text{ Bq m}^{-3}$  in Tsuruga Station.

The period of the measurement was from June 1994 to February 1995. The distributions of radon concentrations in different seasons in Tsuruga Station are shown in Fig. 2. There was no seasonal variation observed. The good ventilation makes radon concentration low, so no variation can be observed.

## CONCLUSION

Throughout the measurement, radon isotope concentrations of the nuclear power stations were low enough so that radiation exposure due to the inhalation of radon progeny can be neglected.

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