§1. Correlation of Cosmic Ray Dose in Concrete Buildings between Neutron Component and Ionizing Component

Yamanishi, H.

According to the UNSCEAR 1993 report, information on the shielding effect of ordinary buildings on neutrons in cosmic rays is limited. There are not enough data on the dose distribution due to cosmic rays in buildings. This is partly because the dose rate is too small to attract attention, and partly because measuring it is difficult. However, from the point of view of understanding the natural background, measurement data are required. On the other hand, the intensity of background neutron is interested in the field of induced radioactivity due to environmental neutron component.

A proportional counter filled with helium-3 gas at about 10 atm was used for neutron measurements in this study. The counter had a diameter of 2.7 cm and a length of 56 cm. In order to obtain rough value of the neutron energy at the measuring point, four types of cylindrical polyethylene moderator were prepared. Each thickness of the moderator was 0, 2.5, 5 and 10 cm, respectively. A counter surrounded with a thin moderator has high sensitivity for low-energy neutrons. On the other hand, a counter surrounded with a thick moderator has high sensitivity for relatively high-energy neutrons.

At some measurement points, the count rates due to neutrons were compared with dose rates that were measured by means of a Rem-counter (model TPS 451S, Aloka Co. LTD) in dose integrating mode. The measured dose rate outdoors was 3.9 nSv/h, which agreed with the result 4.4 nSv/h calculated from the equation in the UNSCEAR 1993 report. The count rates measured with the 10-cm-thick moderator have a good correlation with the dose rates measured by a Rem-counter. By using this relationship, the neutron dose rates were derived from the count rates measured with a 10-cm-thick moderator.

The intensity of the cosmic ray ionizing component was measured with a spherical 3-inch-diameter NaI(Tl) detector.

The measurements were conducted at the site of the National Institute for Fusion Science (NIFS). The NIFS site is located in Toki-shi, Gifu-prefecture, Japan, lat. 35° 19' N, long. 137° 10' E, 250 m above sea level. Almost all measurements in this study were conducted in research staff building II at the NIFS site, in order to obtain the dose distribution in a concrete building. This building is a seven-story concrete building, 30 m long north-south, 15 m long east-west, and the thickness of the floor is 0.165 m. The height from floor to ceiling is 3 m in ordinary rooms and in the corridor. There is a five-story building to the south of the building. These two buildings are connected via a 6 m corridor.

Figure 1 shows the east-west distribution of the measured value on the 3rd floor in research staff building II. The measured dose distribution of the ionizing component was as follows. The maximum value was obtained at a point near the window. The minimum value was measured at a distant point from the window. The count rates due to neutron component decreased substantially in the range of 5 m from the window. On the other hand, the count distribution due to the neutron component has almost the same variation as the ionizing component. The ratio of dose rates due to the ionizing component and neutron component on the floor ranged from 0.54 to 0.67, and from 0.20 to 0.46, respectively, against the outdoor dose rate at the NIFS site.

The ratios of the dose rate at each point to that outdoors were calculated for the ionizing component and the neutron component, and these values were plotted in Fig. 2. The decrease of the neutron dose rate was larger than that of the ionizing component. There is a correlation in the range more than 0.3 for the ionizing component, and more than 0.08 for the neutron component. The equation of the relationship is also shown in Fig. 2. Using this equation, the dose rate due to the neutron component in a concrete building can be estimated from the measured value of the dose rate due to the ionizing component.

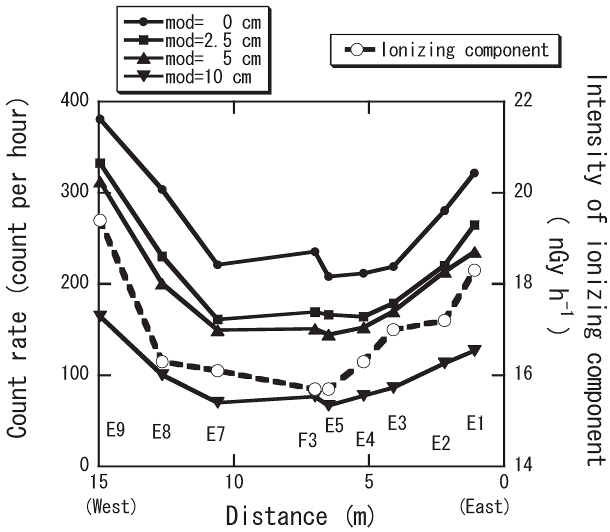

Fig. 1

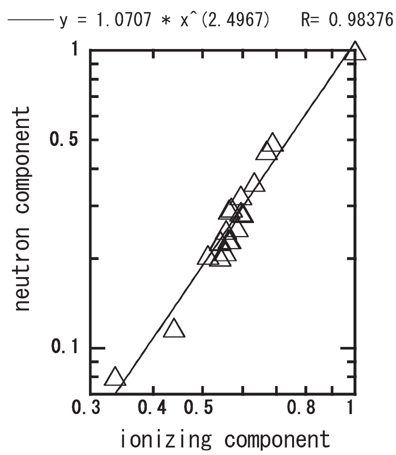

Fig. 2