Gross β activity level of fallout in the environment around Qinshan Nuclear Power Plant

YE Ji-Da, CHEN Bin, WU Zong-Mei

(Zhejiang Province Environmental Radiation Monitoring Center, Hangzhou 310012)

Abstract This paper presents the measurement results of gross β activities in fallout samples collected from the environment around Qinshan Nuclear Power Plant (NPP) during 1993-2002. The gross β activity of 191 samples collected at five monitoring spots were (0.11～3.64) Bq • m^{-2} • d^{-1}, with an average of (0.91±0.49) Bq • m^{-2} • d^{-1}. This value was lower than (1.02±0.35) Bq•m^{-2}•d^{-1} , the average of the samples collected at the reference spot in Hangzhou. It indicated that no obvious rise in the gross β activity level of fallout was observed in ambience of Qinshan NPP.

Keywords Qinshan NPP, Radioactivity monitoring, Fallout, Gross β activity

CLC numbers X591, X837

1 Introduction

According to the relevant policy, laws and regulations of environmental protection, the environment around Qinshan Nuclear Power Plant (NPP) has been placed under surveillance of Zhejiang Province Environmental Radiation Monitoring Center since the Qinshan NPP was put into operation in December 1991. The main monitoring items include measuring the environmental radiation dose rate and the content of radionuclides in various media, and measuring the fission product and active product discharged from the nuclear power plant's funnel to the environment, which is achieved by collecting aerosol and fallout samples and measuring the gross β activity. Comparing the level of gross β activity measured at present with the background level before the NPP operation, one can assess whether the environment was polluted by the NPP operation or not. The radioactivity level monitoring of the fallout is one of the most important monitoring items. In the following we will present the measurement results of gross β activity in the fallout samples collected from five monitoring spots nearby Qinshan NPP during 1993~2002.

2 Monitoring spots and collection of the sample

Five monitoring spots nearby Qinshan NPP, i.e. Wuyuan town, Qinlian village, Qinshan town, Zhongjiaqiao village and Tongfeng village, were selected for collecting fallout samples. Their distance from Qinshan NPP is about 5 km, except that of Wuyuan town (about 10 km). See Fig.1. A white enameled vessel, ϕ500 mm×400 mm, was put on a housetop for the sample collection at each monitoring spot. The volume of the vessel is so large that the accident of rain overflow has never happened up to now because the collection is made by stages in rainy season. The fallout sample has been collected once a quarter. The collectors, i.e. enameled vessels, are periodically checked for the toppling, turning-over or leaking, and corrected in time if such things happen. In case we found the fallout sample suffer loss, the sample would be discarded. After about 90 days (one quarter), the fallout samples were collected to measure the gross β activity level by low background α/β counter LB4100 (OXFORD, USA) in our laboratory.

The samples were collected and prepared in accordance with the procedure described in IAEA Technical Reports Series[1] and a guidebook on radiation

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environmental monitoring.[2]

The fallout sample, including both rain water and precipitate materials, was prepared as a sample for the gross β activity measurement by taking the following steps: dried on an electric hot plate, ashed completely in a muffle furnace at 450℃, weighted, spread on a dish and preservative agent added.

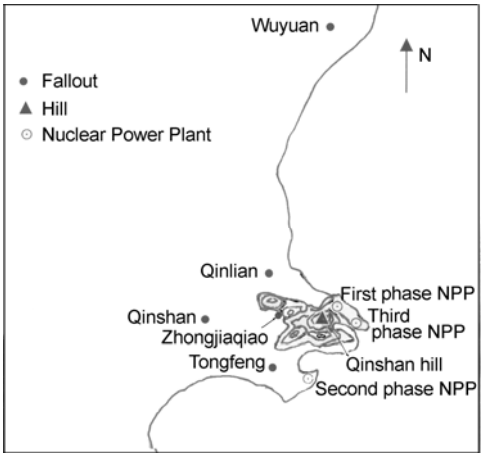

Fig.1 The distribution of monitoring points in the surroundings nearby Qinshan NPP.

3 Results and discussion

3.1 Distributed frequency

Fig.2 demonstrates the distributed frequency of the gross β activities of 191 fallout samples collected at the five monitoring spots around Qinshan NPP. It seems to belong to Poisson distribution. The gross β activities of the 191 samples collected at the five monitoring spots were (0.11~3.64) Bq • m^{-2} • d^{-1}, with an average of (0.91±0.49) Bq • m^{-2} • d^{-1}. This value was lower than (1.02±0.35) Bq • m^{-2} • d^{-1}, the average for samples collected at the reference spot in Hangzhou for 6 years. It is shown that no obvious rise in the gross β activity level of fallout was observed in ambience of Qinshan NPP in the period of 1993-2002.

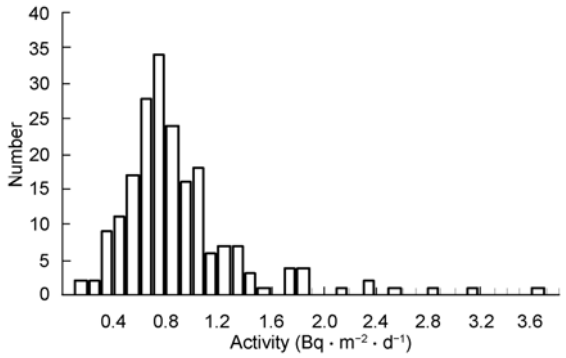

Fig.2 Distributed frequency of gross β activity of 191 fallout samples.

3.2 Annual average value

According to the statistical analysis for the measured results of gross β activity, the range of annual average value of gross β activities for the fallout samples is (0.71~1.35) Bq • m^{-2} • d^{-1} (Fig.3). It seems that there is an increasing trend of gross β activities in the ten years. The reasons remain to be further investigated. The maximum annual average value of gross β activities is 1.35 Bq • m^{-2} • d^{-1} in 1999, and the minimum is 0.71 Bq • m^{-2} • d^{-1} in 1994.

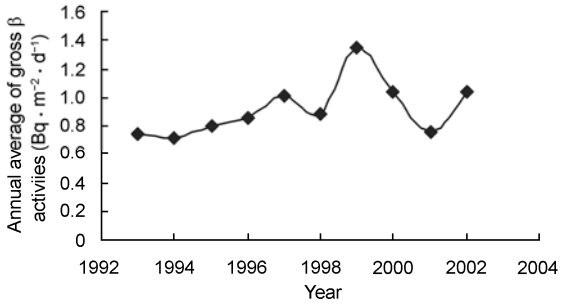

Fig.3 Annual average of gross β activities of the fallout samples collected around Qinshan NPP in ten years.

3.3 Seasonal variation

In accordance with the statistical analysis each year, the seasonal variation of gross β activities of the fallout samples collected at the five monitoring spots around Qinshan NPP in ten years is exhibited as in Fig.4. It shows that variation of the quarterly average values is wavy. The maximum annual average value of gross β activities is 2.54 Bq • m^{-2} • d^{-1} in the second quarter of 1999, and the minimum is 0.25 Bq •m^{-2} •d^{-1} in the fourth quarter of 1998.

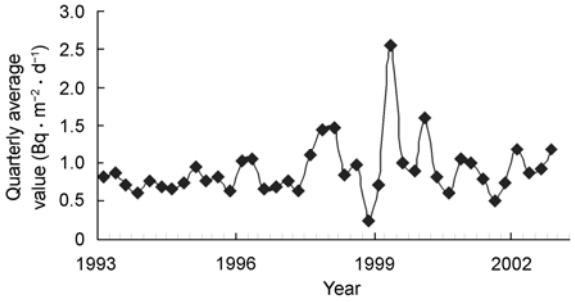

Fig.4 The seasonal variation of the gross β activities of the fallout samples collected in the ambient of Qinshan NPP in ten years.

The average value of gross β activities in four quarters from 1993 to 2002 are 1.03, 1.00, 0.78 and 0.81 Bq • m^{-2} • d^{-1}, respectively (Fig.5). According to

the 10 year's statistical analysis, the gross β activities in the first half year is (1.01±0.48) Bq • m^{-2} • d^{-1}, 26% higher than that of the second half year (p>0.05). It may be attributed to "spring leaking" phenomenon, i.e. a lot of rain water in spring and seldom raining in winter.

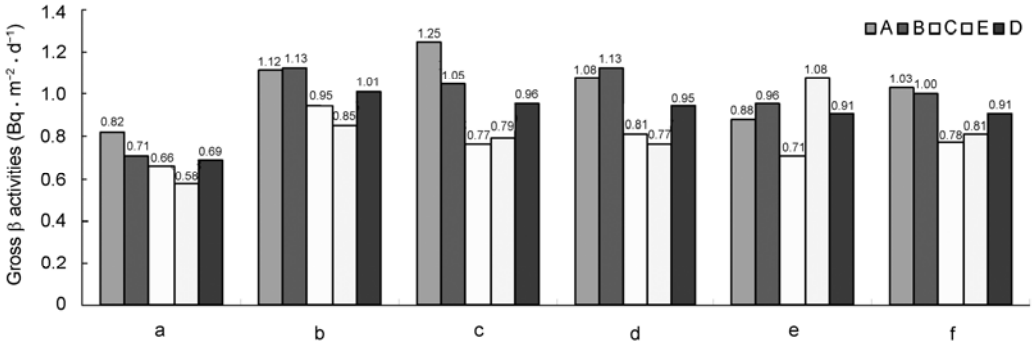

Fig.5 The gross β activities of the fallout samples collected at five monitoring spots.

The A, B, C, E and D indicate the gross β activities in the first, second, third, fourth quarter and their average in ten years, respectively. The a, b, c, d, e and f indicate the monitoring spot at Wuyuan town, Qinlian village, Qinshan town, Zhongjiaqiao village, Tongfeng village and the average of gross β activities of these monitoring spots in ten years, respectively.

3.4 Average value of each monitoring spot in ten years

According to the statistical data from various monitoring spots, the average value of gross β activities of the fallout samples collected at five monitoring spots, i.e. Wuyuan town, Qinlian village, Qinshan town, Zhongjiaqiao village and Tongfeng village in ten years, are (0.70±0.29), (1.02±0.45), (0.96±0.51), (0.95±0.56) and (0.91±0.54) Bq•m^{-2}•d^{-1}, respectively. The maximum of gross β activities appeared in the monitoring spot of Qinlian village on the leeward (in the west) of Qinshan NPP, with a distance of about 1 km from Qinshan NPP, and this is a maximum rushing down spot of fallout in summer. The minimum of gross β activities appeared in Wuyuan town on the windward (in the north) of Qinshan NPP, with a distance of about 10 km from Qinshan NPP. Because the monitoring spot of Wuyuan town is far from the highway and Qinshan NPP, the gross β activities of the fallout samples collected at the monitoring spot is obviously different from that of samples collected at each of four other monitoring spots (p>0.05).

4 Conclusions

1) The average value of gross β activities of 191 fallout samples collected in surroundings nearby Qinshan NPP is (0.91±0.49) Bq • m^{-2} • d^{-1}, lower than that of samples collected in Hangzhou. It shows that gross β activities of the fallout in surroundings nearby Qinshan NPP do not obviously rise.

2) There seems to be a slow rising trend of gross β activities nearby Qinshan NPP in past ten years, which may be related to the fact that the number of neighbouring quarries has been increased year after year.

3) The average value of gross β activities of fallout samples collected in the first half year is higher than that in the second half year in ten years, which may be attributed to the seasonal variation of precipitation.

4) The average value of gross β activities of fallout samples from the monitoring spot of Wuyuan town is obviously lower than those from other four monitoring spots because the Wuyuan monitoring spot is far from the highway and Qinshan NPP.

References

1 IAEA. Measurement of radionuclides in food and the environment, Technical reports No.295, Vienna. 1989.

2 Zhejiang Province Radiation Environmental Monitoring Center, A guidebook on radiation environment monitoring (a restricted publication, in Chinese), 2000.