Special environmental monitoring around Tokai-mura after the accident of the Fukushima Dai-ichi Nuclear Power Station

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ABSTRACT

The nuclear accident at Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Co. (TEPCO) was caused by the Tohoku District – off the Pacific Ocean Earthquake. Various kinds of radionuclides were released from the power station right after the accident occurred and then reached our laboratories. Therefore, environmental monitoring was reinforced by observation of air absorbed dose rate, periodic collection of airborne dust, precipitation. The collected samples were used to determine radioactivity of gamma ray emitters by High pure Germanium semiconductor detector. Moreover, rainwater and humidity were collected to do the usual routine monitoring.

Radionuclides of ^{131}I, ^{134}Cs, ^{137}Cs etc. were detected in airborne samples collected after 13th of March, continuously, although these nuclides had never been found in any samples for the last ten years around our site. Then, 90Sr was also detected using chemical analysis of an airborne sample. These radionuclides such as ^{90}Sr, ^{131}I, ^{134}Cs and ^{137}Cs were determined around the accident station, too. Therefore, our monitoring detected influence of the accident into our site. In other samples such as seawater, seabed soil and etc., similar radionuclides were detected including the influence of the accident.

INTRODUCTION

After the Fukushima accident, we immediately started to measure gamma-emitters included in airborne dust and fallout sample with reinforcement of dose rate monitoring. Then, strontium-90 (^{90}Sr) and plutonium-238, 239, 240 (^{238}Pu, $^{239,240}Pu$) were analyzed using both samples.

CONCLUTIONS

In the special monitoring, it was found that air absorbed dose rate, radioactivity concentration in air borne dust and radioactivity in fallout were influenced by the radionuclides discharged from the Fukushima Dai-ichi NPS but decreased with time after the accident. Therefore, the radionuclides influencing on the environment could not be released from the NPS comparing with initial time of the accident.

In the routine monitoring, radioactivity concentration of ^{90}Sr, ^{131}I, ^{134}Cs and ^{137}Cs were raised by the amount of each radionuclide discharged from the NPS, dependent on the sample. Particularly ^{134}Cs were only detected by the accident because ^{134}Cs did not exist in the environment. Although both the ^{134}Cs and ^{137}Cs concentrations were a little high level, the ^{90}Sr concentration was low level even if the ^{90}Sr was influenced by the accident. Moreover, radioactivity ratio of ^{90}Sr to ^{137}Cs was below 0.1 as expected.

EXPERIMENTAL

(Air absorbed dose rate)

Our section controls 8 monitoring posts and 2 monitoring stations on-site NCL and 3 monitoring stations off-site the NCL. The instrument used was a 2"Φ×2" energy-compensated NaI(Tl) scintillation detector as dose rate monitor.

(Radioactivity concentration in airborne sample)

Portable Sampler (PNC-800) (see photo 1) collecting airborne and gaseous dust was set in front of Safety control building (which is on-site the laboratories) on 13th of March for the special monitoring. Filter (HE-40T, Toyo-roshi Kaisha Ltd., Japan) was used to collect airborne dust and charcoal with TEDA (tri-ethylene-diamine) (CHC-50, Toyo-roshi Kaisha Ltd., Japan) was used to collect gaseous dust such as iodine.

Photo 1
Airborne dust sampler

Photo 2
Fallout sampler

Photo 3
High-pure Germanium semiconductor detector

(Radioactivity concentration in fallout)

Large water basin (0.5 m2 in area) (see photo 2) was set on the rooftop of the safety control building for the special monitoring. As a general rule fallout from atmosphere were collected when it rained. After the collection, the sample was transferred into 2 L marinelli type vessel and set on the HP-Ge detector (see photo 3) to determine radioactivity concentration of gamma-ray emitters.

(Radioactivity concentration in usual monitoring items)

As a routine environmental monitoring around the Tokai reprocessing plant, our section determine radiation dose and radioactivity concentration in environmental samples such as leafy vegetable, milk, surface soil, seawater, marine product and etc. In the monitoring program, tritium (^{3}H), total beta radioactivity, ^{90}Sr, ^{137}Cs, $^{239,240}Pu$ are analyzed in the samples, periodically.

RESULTS AND DISCUSSION

(Air absorbed dose rate) see Figure 1

The dose rates decreased on each post and station with time after the accident. During the period, no accident was happened at our facilities handling radioactivity and at other facilities and therefore the sudden increases of dose rates were distributed on radioactivity discharged for the NPS, only.

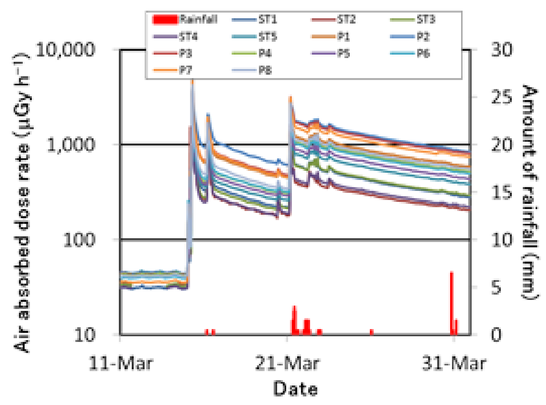

Figure 1
Transition of air absorbed dose rate measured at monitoring stations and posts with amount of rainfall.

(Radioactivity concentration in airborne sample) see Figure 2, 3

We collected radioactivity using dust filter and charcoal cartridge, separately. However, total amount of ^{131}I, ^{134}Cs and ^{137}Cs was plotted in figure 2, except for ^{129m}Te, ^{133}I, ^{136}Cs etc. which were determined on our measurements. Moreover radioactivity ratio of each nuclide to ^{137}Cs was plotted in figure 3. The change of each radioactivity concentration was, on the whole, decreased tendency. On the other hand, the ratio of ^{131}I to ^{137}Cs was fluctuated and the ratio of ^{134}Cs to ^{137}Cs was constant as shown in figure 3. The ratio tendency was supported by the difference of chemical property

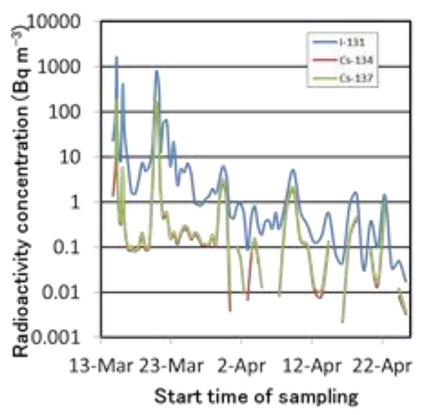

Figure 2
Transition of radioactivity concentration in airborne sample.

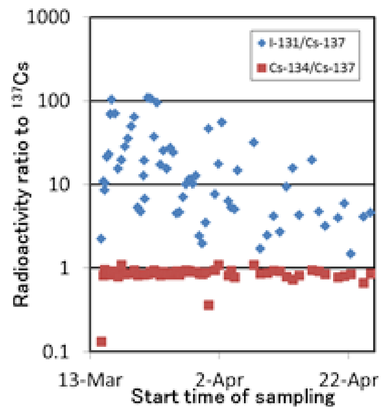

Figure 3
Transition of radioactivity concentration ratio of ^{131}I or ^{134}Cs to ^{137}Cs in airborne sample.

(Radioactivity concentration in fallout) see Figure 4

Totally, the radioactivity decreased with time after the accident but did not show any relationship with rainfall.

Comparing figure 2 with figure 4, each radioactivity was similar tendency, in other words higher radioactivity in airborne sample was higher radioactivity in fallout and the opposite tendency was observed.

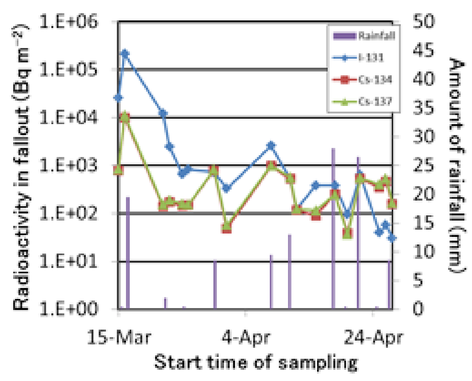

Figure 4
Transition of radioactivity in fallout..

(Radioactivity concentration in usual monitoring items) see Table 1

In all the samples, ^{137}Cs concentrations were detected higher level than the previous level before the accident and exceeded fluctuation level in the past 10 years. ^{134}Cs was also detected on similar level to the ^{137}Cs. On the other hand, ^{90}Sr concentration was exceeds the fluctuation level in airborne dust and a part of marine sample such as seaweed but was low level, relatively. Table 1 shows only radioactivity concentration of ^{137}Cs and ^{90}Sr determined in the sample with both of the concentrations exceeded fluctuation levels in the past 10 years monitoring. On the other hand, $^{239,240}Pu$ concentration was not influenced by the accident in all the samples. Although Pu caused from the accident was detected near the Fukushima Dai-ichi NPS (MEXT, 2011b), Pu could not reach the NCL.

Table 1 Radioactivity concentration of ^{137}Cs and ^{90}Sr in environmental samples with the radioactivity ratio

Sampling items	^{137}Cs	^{90}Sr	$^{90}Sr/^{137}Cs$
Airborne dust	1.0 – 910 (mBq/m^3)	0.010 – 0.36 (mBq/m^3)	(0.033 – 2.2)×10^{-2}
Seawater	0.93 – 1.1 (Bq/L)	0.024 – 0.027 (Bq/L)	(2.5 – 2.6)×10^{-2}
Seabed soil	(1.5 – 4.3)×10^2 (Bq/kg dry)	0.51 – 0.55 (Bq/kg dry)	(1.3 – 3.4)×10^{-3}
Shellfish	7.1 – 14 (Bq/kg raw)	0.025 – 0.063 (Bq/kg raw)	(1.8 – 8.8)×10^{-3}
Seaweed	5.4 – 50 (Bq/kg raw)	0.076 – 1.1 (Bq/kg raw)	(0.48 – 8.4)×10^{-2}
Coastal water	0.14 – 0.19 (Bq/L)	(4.7 – 6.0)×10^{-3} (Bq/L)	(2.7 – 4.2)×10^{-2}