

VI. Radiation Protection and Monitoring

1. Individual Monitoring

In FY 2008, 188 workers who had been registered as radiation workers in this institute and 213 visiting workers registered in other institutions were monitored individually for external and internal radiation exposures. External exposure doses have been monitored every month with glass badges sensitive to beta-, gamma -rays, thermal and fast neutrons for staffs, students and researchers. Digital pocket dosimeters have been in use as supplement. The glass badges were used for monitoring one centimeter dose equivalent and a tissue dose equivalent at 70 μ m deep. The trend of annual collective doses were summarized in Table 1. The annual collective dose (total of 188 workers) and the average effective dose per person were 12.0 man·mSv and 0.06 mSv/y, respectively, in FY 2008. The maximum individual dose was 2.1 mSv/y. No worker was exposed to radiation beyond 20 mSv/y, a dose limit regulated by the law. According to the law and orders by the regulation authorities, necessary reports were prepared and submitted.

2. Indoor Radiation Control

The external radiation dose, the airborne radioactivity in air and the surface contamination in the controlled areas were regularly monitored by the Section of Indoor Radiation Control. The monitoring for the external radiation dose rate in the controlled areas were carried out with both fixed-position monitors and survey meters which can measure beta-, gamma-rays and neutrons during the period of the reactor operation. Ionization chambers, NaI scintillation counters and BF₃ counters are mainly used as the detectors for the fixed-position monitoring systems. The alert level for the radiation dose rate has been generally set at 20 μ Sv/h in the controlled area. The external radiation dose accumulated for a week/month was also measured with glass badges at more than 30 locations in the KUR, KUCA containment buildings and other radiation facilities such as Linac and radioactive waste management.

Fixed-position monitors for radioactive gases and/or dust are installed both in work areas and exhaust lines. The dominant radionuclide resulting from the reactor operation is ⁴¹Ar, but no radionuclides were discharged from the KUR stack due to the reactor being ceased since February 2006 for replacement of nuclear fuels. During this period, the maintenance and calibration have been continued for many equipments and facilities in FY 2008, including the monitoring posts, hand-foot-cloth monitors, dust samplers, and so on.

3. Environmental Radiation Control

The Environmental Radiation Control Section is in charge of the assessment of the external radiation dose in the vicinity of the nuclear facility and radioactivities in environmental samples. Since the reactor (KUR) did not operated in FY 2007 for the replacement of its fuel, the effective dose on the public resulting from exposure by the effluent gas from reactor was estimated as nil due to no discharge of ⁴¹Ar.

Although KUR did not operated this year, environmental monitoring and meteorological observation was continuously performed to obtain safety assurance data for the other facilities such as KUCA. Dose rates of the external radiation in the field were continuously measured by using NaI scintillation detectors set at five locations inside the KURRI area and four locations outside. The thermo-luminescence dosimeters (TLDs) are set up for measuring the radiation dose accumulated during the period of three months at locations outside the KURRI. No significant increase of the radiation level was recognized in relation to the reactor operation at any monitoring location. Temporary increases in the dose rate were attributed to events with the rainfall that entrains radon daughters. The external radiation doses for every three months at nine locations around the site are shown in Table 2.

Environmental samples including surface water, river and pond sediments, field soils, dusts and plants were collected in the vicinity of the KURRI twice a year during spring and autumn. Typical data on the environmental radioactivity are given in Table 3. The total activities in beta- and gamma-nuclides, which were measured with a low background counter using a windowless gas flow and/or a Ge(Li) detector, showed the ordinary natural radioactivity levels in any samples mentioned above. The content of ⁴⁰K in plants has a wide variation ranging from 5.3 x 10¹ to 4.1 x 10² Bq/kg-wet weight and thus, in some farm products it sometimes exceeded the maximum level reported in the past.

Liquid waste from the radioactive waste management facility or KURRI is discharged into a retention pond (named Imaiike) after treatment process. Neither the content of radionuclides beyond the regulation level was observed in the effluent water, nor radioactivity in any environmental samples exhibited tendency to increase with time.

Table 1 Number of radiation workers, collective dose, and average effective dose, per year, in FY 2003-2007.

	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Collective dose (man•mSv)	12.9	21.2	14.3	12.3	12.0
Number of registered radiation workers	204	206	198	186	188
Average effective dose (mSv)	0.06	0.10	0.07	0.07	0.06

Table 2 External doses accumulated quarterly by using thermo-luminescence detectors at nine locations around the KURRI site

Location	Period(quarter)	First	Second	Third	Fourth	Total
		(μSv/quarter)				(μSv/year)
KUR meteor. observ. tower		82	90	85	88	345
KUR south of ground		87	88	87	90	352
Bozu-Ike pond		63	91	68	67	269
KUR transformer station		90	95	91	93	369
KUR gate		80	85	83	84	332
Kumatori Wada st.		93	94	99	100	386
Izumisano Shimogawaraya st.		103	106	108	112	429
Izumisano municipal office st.		104	105	106	110	425
Izumisano Hieno st.		84	88	86	89	397

Table 3 Radioactivity concentration in environmental samples selected

Samples	Sanpling locations	Sampling date (D/M/Y)	Man-made nuclides			Natural nuclides			
			⁶⁰ Co	⁶⁵ Zn	¹³⁷ Cs	⁷ Be	⁴⁰ K	²⁰⁸ Tl	²¹⁴ Bi
Sediment (Bq/kg-dry)	Eiraku-dam	08/10/08	D.L.*	D.L.	1	D.L.	751	12	19
	Oo-ike	07/10/08	D.L.	D.L.	D.L.	D.L.	573	12	26
	Inakura-ike	07/10/08	D.L.	D.L.	1	D.L.	582	11	19
	Ameyama-gawa (Gomon)	08/10/08	D.L.	D.L.	D.L.	13	696	7	17
Soils (Bq/kg-dry)	KUR Hot Lab.	08/10/08	D.L.	D.L.	D.L.	D.L.	770	14	23
	Kumatori-Wada	07/10/08	D.L.	D.L.	5	D.L.	608	11	D.L.
	Hine shrine	07/10/08	D.L.	D.L.	D.L.	D.L.	692	14	23
	Aritoshi shrine	07/10/08	D.L.	D.L.	2	D.L.	826	34	57
Vegetables (Bq/kg-dry)	Kumatori-wada Radish (leaves)	25/11/08	D.L.	D.L.	D.L.	4.5	96.0	D.L.	0.2
	Sweet potato (root)	12/11/08	D.L.	D.L.	D.L.	D.L.	137.8	D.L.	0.2
	Sweet potato (runner)	12/11/08	D.L.	D.L.	D.L.	3.6	183.3	0.1	0.4
Rain water (Bq/l)	Meteor. observ. tower at KURRI	Sep.08 – Feb. 09	D.L.	D.L.	D.L.	D.L.	D.L.	D.L.	D.L.

* : D.L. denotes the measured values were below a detection limit.