B33

NIRS-RSD-44

RADIOACTIVITY SURVEY DATA in Japan

NUMBER 44

March. 1978

National Institute of Radiological Sciences

Chiba, Japan

ADDITION

1) Strontium-90 and Cesium-137 in Fresh Water (P.36, Table 15)

Sampling Location	Date	pH	^{90}Sr(pCi/l)	^{137}Cs(pCi/l)
Fukushima, FUKUSHIMA	Dec. 1976	–	0.14±0.007	0.01±0.003
Suwa-lake, NAGANO	Dec. 1976	9.3	0.04±0.002	0.01±0.003

2) Strontium-90 and Cesium-137 in Fresh Water Fish (P.37, Table 16)

Sampling Location	Date	Ash(%)	Component		^{90}Sr(pCi/l)		^{137}Cs(pCi/l)	
			Ca(%)	K(%)	pCi/kg	S.U.	pCi/kg	C.U.
Carassius carassius								
Uji, KYOTO	Mar.1977	4.25	31.8	5.02	88 ±1.7	6.6±0.12	1.9±0.28	0.9±0.13
Cyprinus carpio								
Fukushima, FUKUSHIMA	Aug.1976	3.30	28.2	6.62	51 ±1.5	5.5±0.16	8.5±0.45	3.9±0.21
Hypomesus olidus								
Suwa-lake, NAGANO	Dec.1976	2.61	24.1	9.52	6.1±0.45	1.0±0.07	5.3±0.33	2.1±0.13

ERRATA

1) P.34 Figure 13
Kitame ——> Kitami

2) P.36 Table 15
Akita(Goegawa), AKITA June, 1974 ——> June 1975

3) P.37 Table 16

^{90}Sr(pCi/l)		^{137}Cs(pCi/l)	
pCi/kg	S.V.	pCi/kg	C.V.

↓

^{90}Sr(pCi/l)		^{137}Cs(pCi/l)	
pCi/kg	S.U.	pCi/kg	C.U.

Radioactivity Survey Data in Japan

Number 44

March 1978

CONTENTS

Science and Technology Agency
National Institute of Radiological Sciences

Environmental Data

(1) External Exposure due to Natural Radiation (KINKI)

(National Institute of Radiological Sciences)

A field survey of exposure rates due to natural radiation has been conducted throughout the Kinki district of Japan during both September and October 1973.

The situation of the Kinki district in Japan is shown in Figure 1. Distribution of observed locations in the district is indicated in Figure 2. In each location, measurements of exposures at one to fifteen sites, one of where contained 5 stations at least, were made. A total of 143 sites were measured.

Observations were made using a spherical ionization chamber and several scintillation surveymeters. The spherical plastic ionization chamber of which inner diameter and wall thickness are 200 mm and 3 mm (acrylate) respectively has adequate sensitivity for field survey. The chamber was used as a standard of apparatus, but it is difficult to use the apparatus in all locations only by the apparatus, so that a surveymeter with a NaI(T1) 1"ϕ x 1" scintillater was used for regular measurements. Two types of surveymeters, the one with a 2"ϕ x 2" NaI(T1) scintillator and the other with a 3"ϕ x 3" NaI(T1) scintillator, were used as auxiliary devices. Both the chamber and the surveymeter were used in 20 sites and their readings were compared for drawing a relationship between them.

Practically the direct reading of the surveymeter were reduced into the corresponding value of the plastic chamber through the relationship of linear proportion. Systematic error at calibration (^{60}Co) and reading error (rodoh) of the plastic chamber were within ± 6% (maximum over all error) and within ± 3.5% (standard error for 6μ R/hr) respectively. Reading error of the surveymeter is about ± 3% (standard error for 6μ R/hr).

Measurements in open bare field were made at one meter above the ground and outdoor gamma-rays exposure rates (μR/hr) were due to cosmic rays as well as terrestrial radiation, as it may be considered that the contribution of fallout due to artificial origin was very small.

Gamma-ray exposure rates due to natural radiations in each location are shown in Table 1, and population exposure due to natural radiations in each prefecture of the Kinki district is shown in Table 2.

Table 1. Gamma-ray Exposure Rates due to Natural Radiations in each Location of the Kinki District – September & October 1973
by S. Abe, S. Hongo, T. Ido, I. Suyama, Y. Inoue and K. Fujimoto
(National Institute of Radiological Sciences)

Prefecture	Location *		Exposure Rate (μR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus **
MIE	1	Kuwana	9.4	1	5	B,C
	2	Yokkaichi	9.5	2	11	B,C
	3	Suzuka	11.5	1	5	B,C
	4	Kameyama	9.5	1	7	B,C
	5	Tsu	9.5	2	12	B,C
	6	Matsuzaka	8.6	1	5	A,B,C
	7	Ueno	10.6	1	5	B,C
	8	Nabari	10.3	1	5	B,C
	9	Toba	6.4	1	5	B,C
	10	Ise	9.6	1	6	B,C

Prefecture	Location *		Exposure Rate (μR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus **
	11	Shima	10.9	1	6	B,C
	12	Nanto	11.7	2	10	B,C
	13	Iinan	9.9	1	5	A,B,C
	14	Ouchiyama	11.8	1	5	B,C
	15	Iitaka	10.0	1	6	B,C
	16	Owase	10.8	1	6	A,B,C
	17	Kumano	11.7	1	5	A,B,C
SHIGA	18	Kinomoto	12.4	1	6	B,C
	19	Hikone	9.0	1	6	B,C
	20	Imazu	15.0	1	6	B,C
	21	Omihachiman	10.3	1	5	B,C
	22	Shiga	15.5	1	6	B,C
	23	Kosei	11.3	1	6	B,C
	24	Otsu	10.1	2	11	B,C
KYOTO	25	Maizuru	8.1	3	16	A,B,C
	26	Miyazu	11.0	1	5	A,B,C
	27	Miyama	8.7	1	6	B,C
	28	Wachi	10.0	1	5	B,C
	29	Fukuchiyama	7.9	1	5	B,C
	30	Kyoto	10.0	9	49	A,B,C
	31	Uji	7.8	1	6	B,C
	32	Nagaokakyo	10.8	1	6	B,C
	33	Kameoka	11.2	1	5	B,C
OSAKA	34	Tanabe	9.4	1	5	B,C
	35	Takatsuki	9.5	1	5	A,B,C
	36	Hirakata	11.8	1	5	B,C
	37	Shijonawate	12.0	1	5	B,C
	38	Kadoma	12.5	1	5	B,C
	39	Settsu	14.4	1	5	B,C
	40	Ikeda	10.4	1	5	B,C
	41	Toyonaka	9.2	2	10	B,C
	42	Higashiosaka	10.6	2	12	B,C
	43	Osaka	10.7	15	49	B,C
	44	Yao	9.9	2	13	B,C
	45	Kashihara	9.5	1	5	B,C

Prefecture	Location *		Exposure Rate (μR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus **
	46	Matsubara	8.7	1	5	B,C
	47	Sakai	8.9	2	11	B,C
	48	Tondabayashi	9.2	1	6	B,C
	49	Kishiwada	9.8	1	5	B,C
	50	Izumisano	9.9	1	5	B,C
	51	Misaki	10.8	1	12	B,C
HYOGO	52	Toyooka	11.9	1	5	A,B,C
	53	Kasumi	8.9	1	6	A,B,C
	54	Wadayama	12.6	1	7	B,C
	55	Ikuno	12.5	1	5	B,C
	56	Haga	8.1	1	6	B,C
	57	Yokawa	10.6	1	6	B,C
	58	Nishiwaki	9.3	1	5	A,B,C
	59	Fukuzaki	10.1	1	6	B,C
	60	Yamazaki	10.1	1	6	B,C
	61	Tatsuno	9.9	1	6	B,C
	62	Sayo	7.7	1	6	B,C
	63	Takarazuka	12.4	1	5	A,B,C
	64	Amagasaki	10.2	3	15	B,C
	65	Nishinomiya	11.0	3	15	B,C
	66	Kobe	11.1	9	45	A,B,C
	67	Akashi	10.2	2	12	B,C
	68	Ono	9.0	1	5	B,C
	69	Kakogawa	8.9	2	13	B,C
	70	Himeji	11.2	3	18	B,C
	71	Aioi	11.4	2	10	A,B,C
	72	Ako	10.5	1	5	B,C
NARA	73	Nara	9.3	2	10	A,B,C
	74	Sakurai	13.2	1	5	A,B,C
	75	Yamatotakada	7.0	1	5	B,C
	76	Yoshino	8.2	1	5	B,C
	77	Gojo	8.9	1	5	B,C
	78	Kawakami	8.0	1	5	B,C
	79	Kamikitayama	11.1	1	5	B,C
	80	Nishiyoshino	9.8	2	10	B,C
	81	Oto	10.0	1	5	B,C

Prefecture	Location *		Exposure Rate (µR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus **
WAKAYAMA	82	Hongu	11.5	1	5	A,B,C
	83	Koyaguchi	8.9	1	5	B,C
	84	Misato	9.8	1	5	B,C
	85	Wakayama	9.3	2	10	A,B,C
	86	Kainan	11.9	1	6	B,C
	87	Hirokawa	9.3	1	5	B,C
	88	Gobo	10.1	1	5	B,C
	89	Tanabe	8.9	1	5	B,C
	90	Shingu	12.1	1	5	B,C
	91	Kushimoto	11.7	1	5	B,C

* C.f. Fig. 2

** A = Sphencal Ionization Chamber

B = Surveymeter with $2''\phi \times 2''$ NaI(Tℓ) Scintillator

C = Surveymeter with $1''\phi \times 1''$ NaI(Tℓ) Scintillator

Table 2. Population Exposure due to Natural Radiations in Each Prefecture of the Kinki District by S. Abe, S. Hongo, T. Ido, I. Suyama, Y. Inoue and K. Fujimoto
(National Institute of Radiological Sciences)

Prefecture	Exposure Rate ± Standard Deviation (µR/hr)	Population* (x 1,000)	Number of Sites
MIE	10.1 ± 1.4	1,626	20
SHIGA	11.9 ± 2.5	986	8
KYOTO	9.4 ± 1.3	2,425	20
OSAKA	10.5 ± 1.5	8,279	35
HYOGO	10.4 ± 1.4	4,992	38
NARA	9.5 ± 1.8	1,077	11
WAKAYAMA	10.4 ± 1.3	1,072	11
KINKI	10.3 ± 1.6	20,457	143

*1975 National Census

Figure 1. The Situation of the KINKI District in Japan

Prefecture
1. MIE
2. SIGA
3. KYOTO
4. OSAKA
5. HYOGO
6. NARA
7. WAKAYAMA

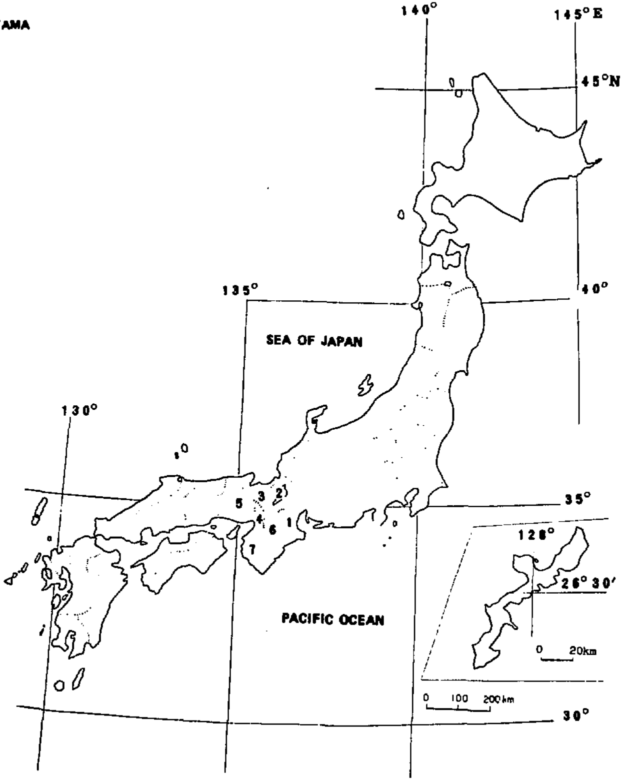
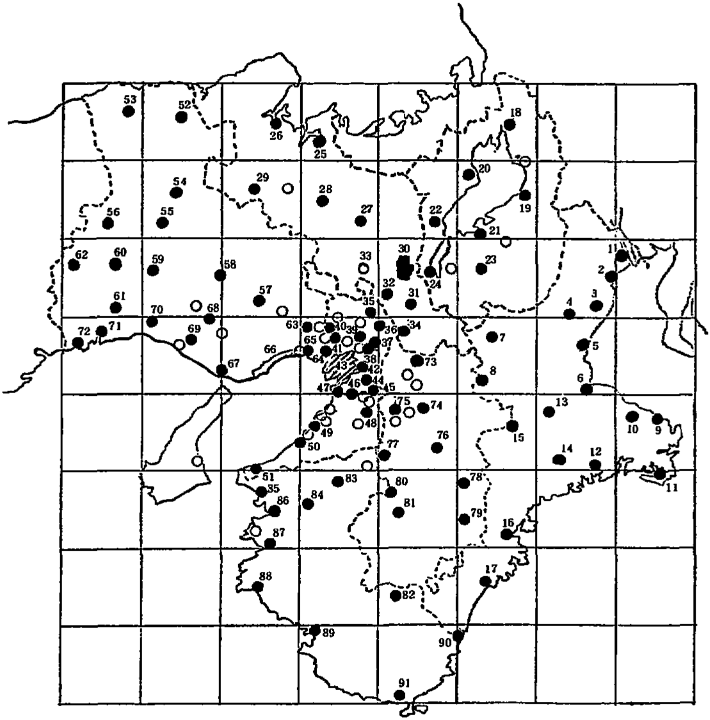


Figure 2. Distribution of Observed Locations in the KINKI District (cf. Table 2)



(2) External Exposure due to Natural Radiation Tokai. Tozan

(National Institute of Radiological Sciences)

A field survey of exposure rates due to natural radiation has been conducted throughout the Tokai. Tozan district of Japan during both September and October 1974.

The situation of the Tokai. Tozan district in Japan is shown in Figure 3. Distribution of observed locations in the district is indicated in Figure 4. In each location, measurements of exposures at one to fifteen sites, one of where contained 5 stations at least, were made. A total of 154 sites were measured.

Observations were made using a spherical ionization chamber and several scintillation surveymeters. The spherical plastic ionization chamber of which inner diameter and wall thickness are 200 mm and 3 mm (acrylate) respectively has adequate sensitivity for field survey. The chamber was used as a standard of apparatus, but it is difficult to use the apparatus in all locations only by the apparatus, so that a surveymeter with a NaI(Tl) 1"ϕ x 1" scintillator was used for regular measurements. Two types of surveymeters, the one with a 2"ϕ x 2" NaI(Tl) scintillator and the other with a 3"ϕ x 3" NaI(Tl) scintillator, were used as auxiliary devices. Both the chamber and the surveymeter were used in 22 sites and their readings were compared for drawing a relationship between them.

Practically the direct reading of the surveymeter were reduced into the corresponding value of the plastic chamber through the relationship of linear proportion. Systematic error at calibration (60Co) and reading error (radon) of the plastic chamber were within ± 6% (maximum over all error) and within ± 3.5% (standard error for 6μ R/hr) respectively. Reading error of the surveymeter is about ± 3% (standard error for 6μ R/hr).

Measurements in open bare field were made at one meter above the ground and outdoor gamma-rays exposure rates(μR/hr) were due to cosmic rays as well as terrestrial radiation, as it may be considered that the contribution of fallout due to artificial origin was very small.

Gamma-ray exposure rates due to natural radiations in each location are shown in Table 3, and population exposure due to natural radiations in each prefecture of the Tokai. Tozan district is shown in Table 4.

Table 3. Gamma-ray Exposure Rates due to Natural Radiations in each Location of the Tokai-Tozan District – – October 1974
by S. Abe, K. Fujitaka and K. Fujimoto
(National Institute of Radiological Sciences)

Prefecture	Location *		Exposure Rate (μR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus **
YAMANASHI	1	Otsuki	6.4	1	9	A,B,C
	2	Enzan	9.1	1	5	B,C
	3	Yamanashi	8.4	1	5	B,C
	4	Kofu	8.8	2	10	A,B,C
	5	Nirasaki	6.4	1	5	B,C

Prefecture	Location *		Exposure Rate (μR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus**
	6	Kamikuishiki	7.9	1	5	B,C
	7	Fujiyoshida	5.3	1	5	B,C
	8	Tsuru	6.0	1	5	B,C
NAGANO	9	Iiyama	10.3	1	5	B,C
	10	Nakano	8.4	1	5	B,C
	11	Suzaka	7.9	1	5	B,C
	12	Nagano	10.1	3	15	A,B,C
	13	Otari	10.3	1	5	B,C
	14	Koshoku	7.5	1	5	B,C
	15	Omachi	14.3	1	5	B,C
	16	Ueda	8.4	1	5	B,C
	17	Komoro	6.1	1	5	A,B,C
	18	Karuizawa	5.8	1	5	B,C
	19	Saku	6.2	1	5	B,C
	20	Wada	8.0	1	5	B,C
	21	Matsumoto	11.4	2	10	A,B,C
	22	Shiojiri	10.0	1	5	B,C
	23	Chino	10.1	1	5	B,C
	24	Suwa	7.9	1	5	B,C
	25	Okaya	10.6	1	5	B,C
	26	Minamimaki	7.3	1	5	B,C
	27	Ina	10.1	1	5	B,C
	28	Kisofukushima	12.4	1	5	A,B,C
	29	Komagane	9.2	1	5	B,C
	30	Iida	10.3	1	6	A,B,C
GIFU	31	Kamitakara	13.5	1	5	B,C
	32	Takayama	13.0	1	5	A,B,C
	33	Shokawa	13.0	1	5	B,C
	34	Osaka	13.7	1	5	B,C
	35	Shiratori	12.1	1	5	B,C
	36	Gero	14.0	1	5	B,C
	37	Hachiman	11.1	1	5	B,C
	38	Nakatsugawa	16.3	1	5	B,C
	39	Ena	13.6	1	5	B,C
	40	Mizunami	14.8	1	5	B,C

Prefecture		Location *	Exposure Rate ($\mu R/hr$)	Number of Sites *in each Location*	Number of Stations *in each Location*	Apparatus**
	41	Toki	11.[illegible]	1	5	B,C
	42	Tajimi	11.6	1	6	B,C
	43	Minokamo	12.6	1	5	B,C
	44	Mino	11.9	1	5	B,C
	45	Seki	12.8	1	5	B,C
	46	Kagamihara	10.3	1	5	B,C
	47	Gifu	10.6	4	20	A,B,C
	48	Hashima	12.2	1	5	B,C
	49	Ogaki	10.5	3	17	B,C
SHIZUOKA	50	Gotenba	5.2	1	5	B,C
	51	Fujinomiya	6.1	1	5	B,C
	52	Nakakawane	11.6	1	5	B,C
	53	Haruno	11.1	1	5	A,B,C
	54	Tenryu	10.4	1	5	B,C
	55	Kosai	9.5	1	5	B,C
	56	Hamamatsu	9.7	4	20	A,B,C
	57	Hamakita	10.0	1	5	B,C
	58	Iwata	9.9	1	5	B,C
	59	Fukuroi	9.5	1	5	B,C
	60	Kakegawa	9.6	1	5	B,C
	61	Hamaoka	9.3	1	4	B,C
	62	Omaezaki	9.7	1	6	B,C
	63	Sagara	10.2	1	5	A,B,C
	64	Shimada	10.2	1	5	B,C
	65	Fujieda	10.2	1	5	B,C
	66	Yaizu	10.8	1	5	B,C
	67	Shizuoka	9.7	4	21	B,C
	68	Shimizu	8.8	3	15	B,C
	69	Fuji	7.8	1	4	B,C
	70	Numazu	5.7	2	10	A,B,C
	71	Toi	7.4	1	5	B,C
	72	Shimoda	6.6	1	6	A,B,C
	73	Ito	5.4	1	6	B,C
	74	Atami	5.7	1	6	B,C
	75	Mishima	5.3	1	5	B,C
AICHI	76	Inabu	9.8	1	5	B,C
	77	Seto	13.1	1	5	B,C
	78	Inuyama	11.1	1	5	B,C
	79	Konan	12.6	1	5	B,C
	80	Ichinomiya	12.1	3	15	A,B,C

Prefecture	Location *		Exposure Rate (μR/hr)	Number of Sites in each Location	Number of Stations in each Location	Apparatus**
	81	Bisai	12.9	1	5	B,C
	82	Komaki	12.1	1	5	B,C
	83	Iwakura	11.8	1	5	B,C
	84	Inazawa	11.8	1	5	B,C
	85	Tsushima	12.0	1	5	B,C
	86	Nagoya	10.0	24	123	A,B,C
	87	Kasugai	12.7	2	12	A,B,C
	88	Toyota	12.0	2	10	A,B,C
	89	Toyoake	9.5	1	5	B,C
	90	Tokai	11.3	1	5	B,C
	91	Chiryo	10.6	1	5	B,C
	92	Kariya	10.4	1	5	B,C
	93	Obu	10.0	1	5	B,C
	94	Chita	10.7	1	5	B,C
	95	Tokoname	10.0	1	5	A,B,C
	96	Handa	9.0	1	5	B,C
	97	Takahama	10.2	1	5	B,C
	98	Hekinan	10.7	1	5	B,C
	99	Anjo	11.4	1	5	B,C
	100	Okazaki	10.9	3	15	A,B,C
	101	Nishio	10.9	1	5	B,C
	102	Gamagori	10.0	1	5	B,C
	103	Toyohashi	9.2	3	15	A,B,C
	104	Toyokawa	10.5	1	6	B,C
	105	Shinshiro	6.9	1	5	B,C

* C.F. Fig. 4

** A = Spherical Ionization Chamber

B = Surveymeter with 2"φx2" NaI (Tl) Scintillator

C = Surveymeter with 1"φx1" NaI (Tl) Scintillator

Table 4. Population Exposure due to Natural Radiations in Each Prefecture of the Tokai-Tozan District
by S. Abe, K. Fujitaka and K. Fujimoto
(National Institute of Radiological Sciences)

Prefecture	Exposure Rate ± Standard Deviation (μR/hr)	Population * (X 1000)	Number of Sites
YAMANASHI	7.3 ± 1.4	783	9
NAGANO	9.4 ± 2.0	2,018	25
GIFU	12.2 ± 1.6	1,868	24
SHIZUOKA	8.8 ± 1.9	3,309	35
AICHI	10.6 ± 1.4	5,923	61
TOKAI · TOZAN	10.0 ± 2.1	13,901	154

* 1975 National Census

Figure 3. The Situation of the TOKAI-TOZAN District in Japan

Prefecture

1. YAMANASHI
2. NAGANO
3. GIFU
4. SHIZUOKA
5. AICHI

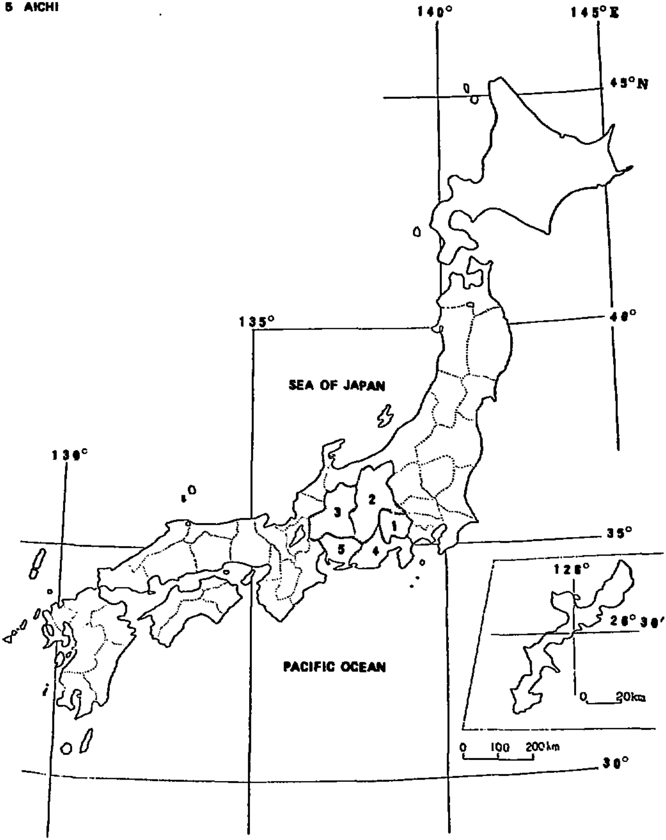
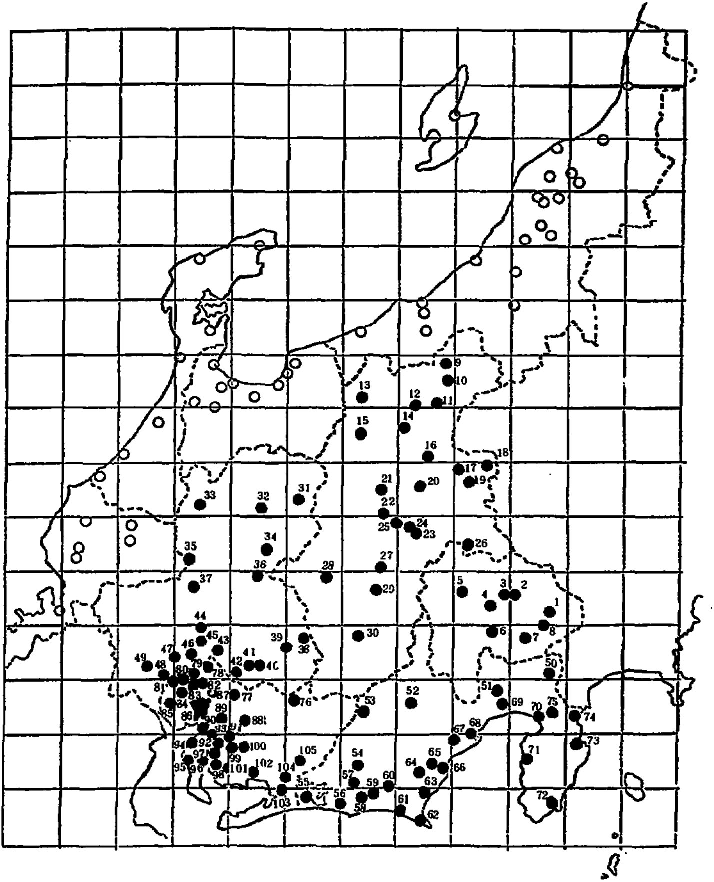


Figure 4. Distribution of Observed Locations in the TOKAI-TOZAN District (cf. Table 3)



(3) Tritium Surveillance around Nuclear Facilities in Japan by Y. Inoue and Y. Kasida.

(National Institute of Radiological Sciences)

In order to measure the tritium levels, and consequently to determine the public health significance of tritium in the environmental water around the nuclear facilities, the tritium surveillance program began in 1967 locally at Tsuruga and Mihama districts. Nowadays it has been expanded to the ten commercial nuclear power stations (Table 5) and three nuclear facilities. Their locations are presented in Figure 5.

Though the frequency of sampling were restricted once or twice a year in most cases, the times and the points were managed to fix at each station in order to follow the annual variation of tritium level, taking account of its seasonable variation. Sampling objects of water were selected basically according to following categories.

a) Land water such as rivers, reservoirs or ponds and wells around the nuclear station which are utilized as the original water of the primary cooling water or the drinking water in the station.
b) Sea water at or near the inlet or the outlet of the secondary cooling water.
c) Tap water around the station.
d) Land, sea and tap water being far from the station whose data are adoptable for the baseline to compare with those belong to above categories.

For samples whose tritium concentration is believed less than about 100 pCi/l, they were electrolytically enriched, and then counted by the liquid scintillation counter. Some of samples believed higher than 100 pCi/l were analysed without any enrichment by the low background liquid scintillation counters, Aloka LB 600 or Aloka LB 1. Aloka LSC-LB 1 is designed to use large capacity vials. Its typical counting efficiency of tritium and the background count rate were 12% and 4.5 cpm, respectively for the sample prepared by mixing with 50 ml of water and 50 ml of emulsion scintillator in a 100 ml teflon vial.

The results of each station are listed in Table from 6 to 12, respectively. The sampling points corresponding to each results are shown in Figure from 6 to 12, respectively. Certain trends obvious from the data are as follows. Tritium from the effluent was not reflected in all the land water and the tap water around the nuclear power stations and the nuclear facilities. Tritium concentration in rivers, streams, and reservoirs (pools) decreased exponentially from about 600 pCi/l in 1967 to about 150 pCi/l in 1972 at Tsuruga and Mihama, and 360 pCi/l in 1968 to 120 pCi/l in 1973 at Genkai, with the half life of about 2.5 years in both cases. After around 1972, tritium levels of river system in all districts of Japan kept nearly constant up to the end of 1975 and they were in the range from 100 to 300 pCi/l corresponding to the districts. Thereafter, it seems to start to decrease again in 1976. These tendency was also observed in the tritium concentration of the precipitation sampled monthly at Chiba, although there is a time lag between both cases. Then, only fell-out tritium seems to be reflected in all the land water around the nuclear power stations and nuclear facilities.

Sea water sampled at the intake of the station or on the seashore far from the outlet was regarded not to be influenced by the effluent from the nuclear reactors or facilities. Tritium concentration in these coastal waters decreased from 100 – 300 pCi/l in 1971 to 30 – 40 pCi/l in 1972 in Fukushima, Ibaraki and Fukui prefectures. Thereafter, its level kept almost constant in the range from 20 to 60 pCi/l in all districts which was almost the same as the concentration of tritium in offshore sea water.

Tritium concentration of tap water around the nuclear power stations was lower or same as the river.

Table 5. Nuclear Power Plants (Stations)

Name of the Company	Abbreviation	Location: Town and Prefecture	Name of Nuclear Power Plant		Type of the Reactor	Power MWe	Date of Beginning of Operation
Tokyo Electric Power Co.	TEPCO	Ohokuma, FUKUSHIMA	Fukushima Dai-ichi				
				Unit-1	BWR	460	Mar. 26, 1971
				Unit-2	BWR	784	Jul. 18, 1974
				Unit-3	BWR	784	Mar. 27, 1976
The Japan Atomic Power Co.	JAPCO	Tokai, IBARAKI	Tokai	Unit-1	GCR	166	Jul. 25, 1966
		Myojin, FUKUI	Tsuruga	Unit-1	BWR	357	Mar. 14, 1970
Chuhu Electric Power Co.	CBEPCO	Hamaoka, SHIZUOKA	Hamaoka	Unit-1	BWR	540	Mar. 27, 1976
Kansai Electric Power Co.	KEPCO	Mihama, FUKUI	Mihama	Unit-1	PWR	340	Nov. 28, 1970
				Unit-2	PWR	500	Jul. 25, 1972
				Unit-3	PWR	826	Dec. 1976
		Ohoi, FUKUI	Ohoi	Unit-1	PWR	1175	(Jul. 1978)*
				Unit-2	PWR	1175	(Dec. 1978)*
		Takahama, FUKUI	Takahama	Unit-1	PWR	826	Nov. 14, 1974
				Unit-2	PWR	826	Nov. 14, 1975
Chugoku Electric Power Co.	CGEPCO	Kashima, SHIMANE	Shimane	Unit-1	BWR	460	Mar. 29, 1974
Shikoku Electric Power Company Inc.	SEPCO	Ikata, EHIME	Ikata	Unit-1	PWR	566	Sept. 30, 1977
Kyushu Electric Power Co.	KYEPCO	Genkai, SAGA	Genkai	Unit-1	PWR	559	Oct. 15, 1975

*( ) : Under construction.

Table 6. FUKUSHIMA PREFECTURE

Sample No.	Sampling Points around the Nuclear Power Station	Water source	Tritium Concentration, pCi/l ± 2 S.D. Jan. 13 1971	Jul. 26 1971	Sept. 21, 29, 30 1972	May 17, 18 1977
	TEPCO FUKUSHIMA DAI-I-ICHI POWER STATION					
1	Inlet of secondary cooling water	sea	121 ± 20	49 ± 3	42 ± 6	32 ± 3
2	Outlet of secondary cooling water	sea	130 ± 20	82 ± 3	34 ± 6	32 ± 4
3	Offshore sea water	sea	———	49 ± 3	———	———
4	Well No. 1	ground water	8 ± 2	13 ± 4	———	———
5	Underground water tank	ground water	———	12 ± 2	7 ± 6	———
6	Deionized water	ground water	47 ± 20	10 ± 2	7 ± 5	
7	Tap water of TEPCO	stream	———	———	———	142 ± 5
	OHOKUMA TOWN					
8	Tap at Ohokuma	stream	———	———	———	137 ± 6
9	Sakashita dam	stream	358 ± 42	———	204 ± 8	88 ± 7

Figure 5 Location of Nuclear Power Stations and Nuclear Facilities.

NUCLEAR POWER STATION

1 TEPCO FUKUSHIMA DAI-ICHI
2 JAPCO TOKAI
3 JAERI TOKAI
4 PNC TOKAI
5 JAERI OHOARAI

6 CBEPCO HAMA-OKA
7 JAPCO TSURUGA
8 KEPCO MIHAMA
9 KEPCO OHOI
10 KEPCO TAKAHAMA

11 KYEPCO GENKAI
12 SEPCO IKATA
13 CGEPCO SHIMANE

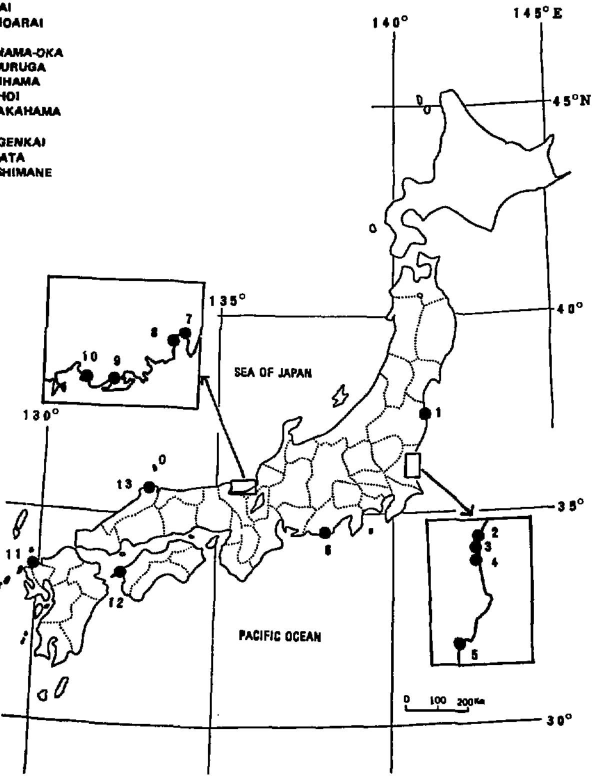


Figure 6. Sampling Points around TEPCO FUKUSHIMA DA-I-ICH Nuclear Power Station.

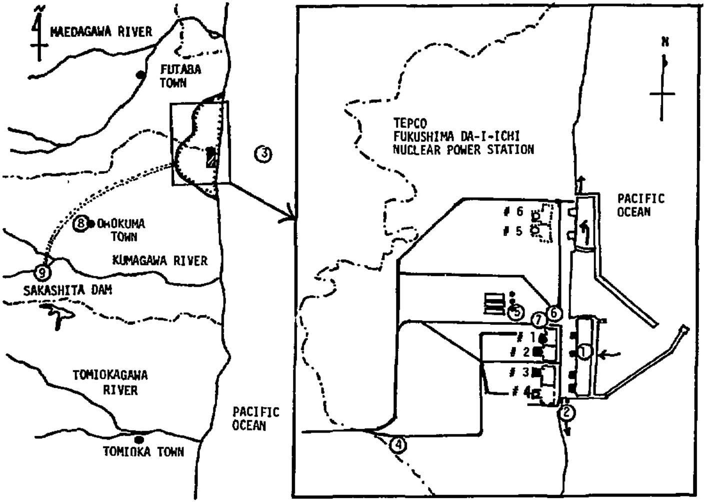
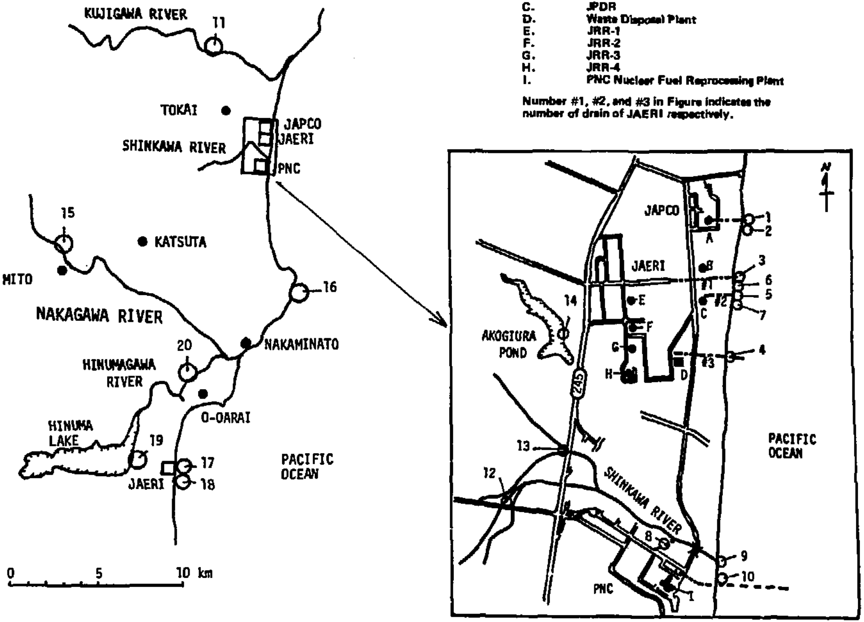


Table 7. IBARAKI PREFECTURE

Sample No.	Sampling Points around the Nuclear Facilities	Water source	Tritium Concentration, pCi/l (± 2 S.D.) Aug. 24, 1971	Dec. 8, 9. 1971	Aug. 23, 24, 1972	Dec. 14, 1972	Jul. 23, 1973	Dec. 11, 1973	Jul. 23, 1974	Dec. 16, 1974	Jul. 15, 1975	Dec. 16, 1975	Jul 19, 1976	Dec. 13, 1976
	JAPCO TOKAI POWER STATION													
1.	Outlet of secondary cooling water	sea	–	–	–	–	250 ± 15	0 ± 34*	47 ± 8	31 ± 6	58 ± 8	32 ± 4	33 ± 4	28 ± 5
2.	Seashore near outlet of secondary cooling water	sea	173 ± 5	626 ± 12	50 ± 6	27 ± 6	–	39 ± 4	46 ± 8	–	66 ± 6	–	–	–
	JAERI at TOKAI													
3.	Outlet of Drain No. 1		–	-	–	–	1389 ± 82	576 ± 46	477 ± 26	258 ± 20	352 ± 32	229 ± 20	278 ± 20	202 ± 32
4.	Outlet of Drain No. 2		–	–	–	–	1031 ± 50	201 ± 42	396 ± 20	1305 ± 112	658 ± 32	3420 ± 50	545 ± 26	615 ± 34
5.	Outlet of Drain No. 3		-	–	–	–	–	0 ± 38*	61 ± 9	0 ± 20*	84 ± 24	55 ± 20	37 ± 4	37 ± 5
6.	Seashore near the outlet of Drain No. 1 channel	sea	-	–	–	–	–	59 ± 5	64 ± 7	32 ± 4	–	–	–	–
7.	Seashore near the outlet of Drain No. 3 channel	sea	–	53 ± 7	–	97 ± 42	39 ± 3	52 ± 4	–	–	–	27 ± 5	41 ± 4	32 ± 4
	PNC at TOKAI													
8.	1st waste channel		–	-	–	–	–	170 ± 26	267 ± 26	208 ± 22	168 ± 22	188 ± 24	99 ± 22	142 ± 30
9.	The issue of Shinkawa river	stream/sea	174 ± 5	–	–	93 ± 32	199 ± 40	208 ± 60	204 ± 24	1989 ± 40	163 ± 24	223 ± 42	77 ± 28	193 ± 28
10.	Seashore at PNC	sea	–	12 ± 6	–	–	144 ± 8	69 ± 6	91 ± 6	37 ± 6	90 ± 24	59 ± 6	58 ± 6	29 ± 3
	TOKAI village													
11.	Sakakibashi Bridge: Kujigawa river	stream	387 ± 5	296 ± 14	186 ± 8	307 ± 52	293 ± 8	251 ± 34	250 ± 26	246 ± 20	191 ± 22	150 ± 26	109 ± 20	176 ± 24
12.	Kikanba: A branch of Shinkawa river	stream	419 ± 5	276 ± 14	326 ± 10	284 ± 66	254 ± 10	240 ± 54	227 ± 24	216 ± 28	132 ± 22	139 ± 20	73 ± 16	110 ± 28
13.	Miyamaebashi Bridge: Shinkawa river	stream	954 ± 10	540 ± 12	556 ± 11	872 ± 54	305 ± 28	289 ± 28	226 ± 8	389 ± 30	233 ± 24	301 ± 22	118 ± 22	106 ± 28
14.	Akogiura pond	reservoir	502 ± 6	–	187 ± 8	233 ± 56	249 ± 8	213 ± 60	223 ± 24	242 ± 20	204 ± 26	227 ± 34	166 ± 28	123 ± 26
	MITO city and NAKAMINATO city													
15.	Nakagouchi: Nakagawa river	stream	368 ± 4	242 ± 14	197 ± 7	157 ± 52	232 ± 10	204 ± 60	303 ± 36	203 ± 18	179 ± 22	191 ± 24	134 ± 18	131 ± 32
16.	Seashore at Nakaminato	sea	109 ± 3	73 ± 16	41 ± 6	27 ± 6	62 ± 8	52 ± 8	42 ± 8	27 ± 6	53 ± 6	36 ± 4	83 ± 4	18 ± 3
	JAERI at O-O-ARAI													
17.	Outlet of discharge channel		–	–	–	–	125 ± 50	1862 ± 32	–	127 ± 22	64 ± 22	2860 ± 50	88 ± 16	101 ± 4
18.	Seashore near the outlet of discharge channel	sea	149 ± 3	865 ± 14	1480 ± 15	121 ± 58	56 ± 44	741 ± 6	64 ± 6	69 ± 6	65 ± 6	607 ± 18	40 ± 4	24 ± 3
	O-O-ARAI													
19.	Kitamatsugawa: Hinuma lake	stream/sea	243 ± 4	198 ± 13	119 ± 1	127 ± 6	139 ± 8	90 ± 50	196 ± 22	–	130 ± 24	104 ± 4	93 ± 20	89 ± 6
20.	Hinumabashi Bridge: Hinumagawa river	stream/sea	280 ± 4	99 ± 12	86 ± 1	139 ± 52	130 ± 8	80 ± 52	194 ± 24	60 ± 20	136 ± 26	99 ± 4	–	46 ± 5

* Values less than or equal to the two-sigma error of the counting were shown as zero.

Figu-e 7. Sampling Points around JAPCO, JAERI and PNC at TOKAI and OHO-ARAI.



Nuclear Facilities at TOKAI in Figure 7.

A. JAPCO Nuclear Power Reactor No. 1
B. JAERI NSRR
C. JPDR
D. Waste Disposal Plant
E. JRR-1
F. JRR-2
G. JRR-3
H. JRR-4
I. PNC Nuclear Fuel Reprocessing Plant

Number #1, #2, and #3 in Figure indicates the number of drain of JAERI respectively.

Table 8. FUKUI PREFECTURE

Sample No.	Sampling Points around the Nuclear Power Station	Water source	Tritium Concentration, pCi/l (± 2 S.D) 18, Oct. 1967	29, Oct. 1970	15, Dec. 1971	6, Oct. 1972	15, Oct. 1973	11, Oct. 1974	2 or 3, Apr. 1975	29, Oct, 1975	12 or 13, Oct. 1976
	JAPCO and PNC TSURUGA POWER STATION										
1.	Takamakigawa river	stream	564 ± 90	284 ± 36	197 ± 10	170 ± 10	115 ± 32	149 ± 6	–	117 ± 22	72 ± 3
2.	Inogaike pond	reservoir	563 ± 106	236 ± 32	191 ± 12	128 ± 10	95 ± 32	109 ± 6	–	96 ± 18	65 ± 4
3.	Inlet of JAPCO secondary colling water	sea	–	–	61 ± 10	41 ± 11	60 ± 6	48 ± 4	–	50 ± 6	42 ± 3
4.	Outlet of JAPCO secondary cooling water	sea	–	134 ± 38	65 ± 10	37 ± 10	45 ± 6	39 ± 4	56 ± 18	46 ± 6	27 ± 3
5.	Inlet of PNC secondary cooling water	sea	–	–	–	–	62 ± 6	40 ± 4	–	–	–
6.	Outlet of PNC secondary cooling water	sea	–	–	–	–	42 ± 7	48 ± 5	–	36 ± 5	25 ± 4
7.	Reservoir of drinking water of PNC	stream	–	–	–	–	–	–	–	111 ± 18	82 ± 3
8.	Tap of PNC	stream	–	–	–	–	–	–	–	–	101 ± 5
	KEPCO MIHAMA POWER STATION										
9.	Majogawa river	stream	–	233 ± 34	213 ± 12	128 ± 10	128 ± 32	148 ± 6	–	103 ± 22	69 ± 4
10.	Ochiaigawa river	stream	786 ± 90	236 ± 32	202 ± 12	133 ± 11	138 ± 34	124 ± 6	–	145 ± 18	89 ± 4
11.	Inlet of secondary cooling water	sea	–	–	68 ± 10	34 ± 10	50 ± 8	68 ± 5	25 ± 17	80 ± 8	32 ± 4
12.	Outlet of secondary cooling water of Reactor I and II	sea	–	195 ± 42	75 ± 10	930 ± 14	167 ± 6	51 ± 4	–	79 ± 6	43 ± 3
13.	Outlet of secondary cooling water of Reactor III	sea	–	–	–	–	–	–	–	–	29 ± 3
14.	Tap of KEPCO	stream	–	–	–	–	–	–	–	–	91 ± 4
	KEPCO TAKAHAMA POWER STATION										
15.	Sekiyagawa river	stream	–	276 ±36	–	–	–	–	–	105 ± 21	117 ± 6
16.	Tap at Otomi	ground water	–	–	– –	–	–	–	–	121 ± 5	70 ± 2
17.	Tap at Koguroi	ground water	–	–	–	–	–	–	–	154 ± 24	120 ± 30
18.	Inlet of secondary cooling water	sea	–	28 ± 2	–	–	–	–	–	40 ± 5	38 ± 4
19.	Outlet of secondary cooling water	sea	–	–	–	–	–	–	277 ± 18	50 ± 5	34 ± 3
20.	Tap of KEPCO	stream	–	–	–	–	–	–	–	–	271 ± 10
	KEPCO OHOI POWER STATION										
21.	Inlet of secondary cooling water	sea	–	–	–	–	–	–	–	–	37 ± 3
22	Outlet of secondary cooling water	sea	–	–	–	–	–	–	–	–	31 ± 4
23.	Pool of drinking water	stream	–	–	–	–	–	–	–	–	151 ± 7

Figure 8-1. Sampling Points around JAPCO and PNC TSURUGA Nuclear Power Station.

1. Takamakigawa river.
2. Inogaike pond.
3. Inlet of secondary cooling water of JAPCO
4. Outlet of secondary cooling water of JAPCO.
5. Inlet of secondary cooling water of PNC.
6. Outlet of secondary cooling water of PNC.
7. Reservoir of drinking water of PNC.
8. Tap of PNC.

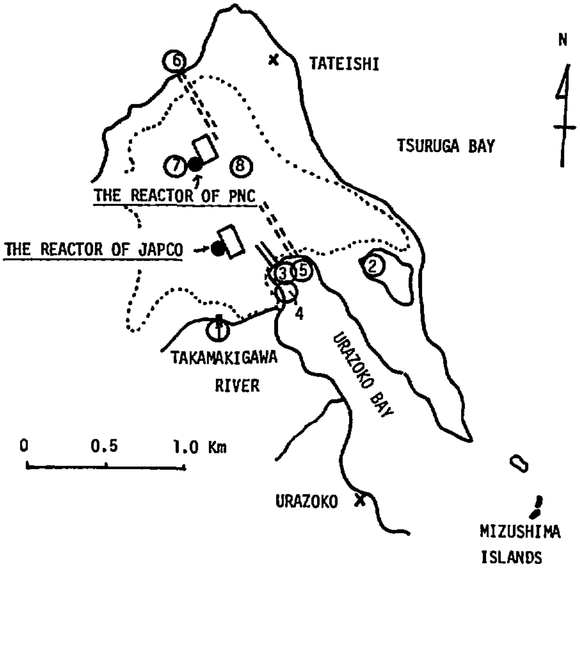


Figure 8-2. Sampling Points around KEPCO MIHAMA Nuclear Power Plant.

1. Majo gawa river.
2. Ochiai gawa river.
3. Inlet of secondary cooling water.
4. Outlet of secondary cooling water. of Reactor # 1 and # 2.
5. Outlet of secondary cooling water of Reactor # 3.

6. Tap of KEPCO.

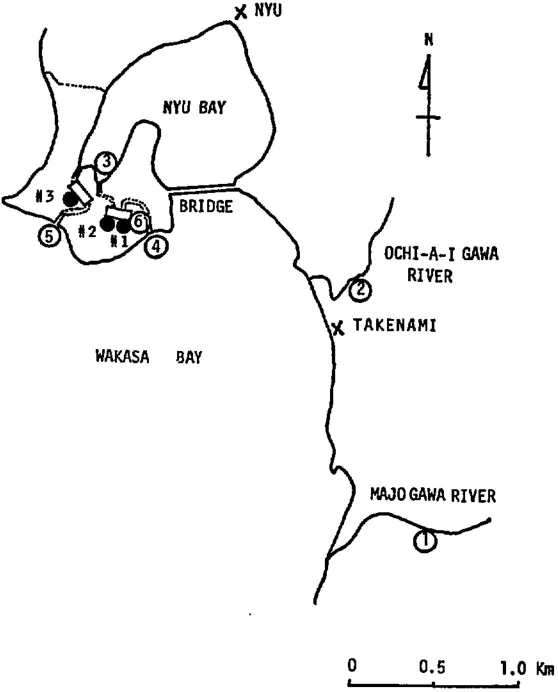


Figure 8-3. Sampling Points around KECPO TAKAHAMA Nuclear Power Plant.

1. Sekiya gawa river
2. Tap at Otomi
3. Tap at Koguroi
4. Inlet of secondary cooling water.
5. Outlet of secondary cooling water.
6. Tap of KEPCO.

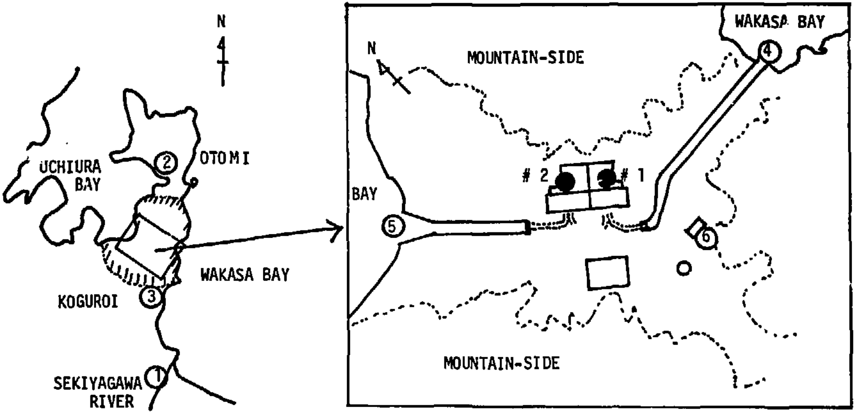


Figure 8-4. Sampling Points in the Site of KECPO OHOI Nuclear Power Plant.

1. Inlet of secondary cooling water
2. Outlet of secondary cooling water
3. Pool of drinking water

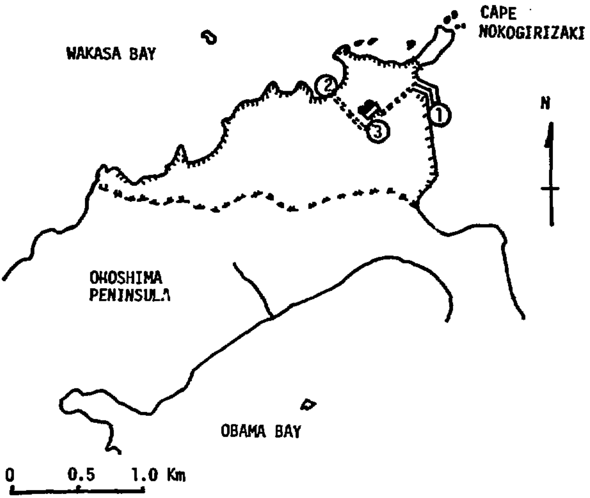


Table 9 HAMAOKA PREFECTURE

Sample No.	Sampling Points around the *Nuclear Power Station*	Water source	Tritium Concentration, pCi/l ± 2S.D. Oct., 12 or Nov., 6 1975	Apr. 7 1976
	CBEPCO *HAMAOKA NUCLEAR* POWER STATION			
1	Intake tower of secondary cooling water 600 meter from sand hill	sea	29 ± 16	27 ± 3
2	Intake reservoir of secondary cooling water	sea	30 ± 16	23 ± 3
3	Outlet of secondary cooling water	sea	34 ± 16	32 ± 3
4	Ni-inogawa river	stream	101 ± 44	86 ± 21
5	Tank for primary cooling water	stream	156 ± 32	91 ± 27
6	Tap at CBEPCO	stream	59 ± 40	37 ± 20

Figure 9. Sampling Points around CBEPCO HAMAOKA Nuclear Power Station

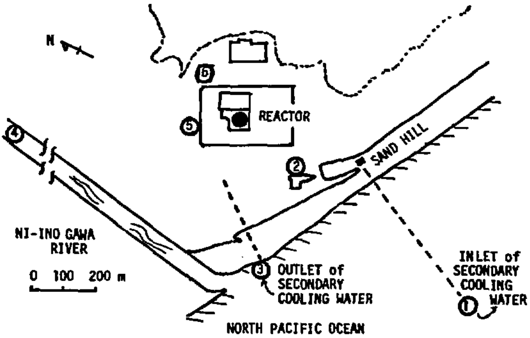


Table 10. SHIMANE PREFECTURE

Sample No.	Sampling Points around the Nuclear Power Station	Water source	Tritium Concentration, pCi / l ± 2 S. D. Oct. 9, 1972	Jun. 19, 1973	Dec. 5, 1973	Jun. 26, 1974	Oct. 9, 1974	Dec. 4, 5, 1974	Jun. 3, 1975	Dec. 4, 1975 *or* Jan. 16, 1976	Jun. 24, 1976	Dec. 21,22,28, 1976
	CGEPCO KASHIMA POWER STATION											
1	Offshore water at CGEPCO	sea	–	–	–	–	–	–	–	28 ± 3	–	28 ± 3
2	Inlet of secondary cooling water	sea	30 ± 7	30 ± 5	21 ± 6	40 ± 8	55 ± 4	19 ± 7	47 ± 7	30 ± 4	23 ± 4	12 ± 3
3	Outlet of secondary cooling water	sea	33 ± 7	25 ± 8	28 ± 7	45 ± 10	50 ± 4	18 ± 12	37 ± 5	28 ± 4	24 ± 4	18 ± 4
4	Reservoir for drinking and primary cooling water	stream	225 ± 56	161 ± 10	–	155 ± 10	148 ± 18	129 ± 16	190 ± 14	134 ± 16	154 ± 22	113 ± 30
	Southern district of CGEPCO											
5	*Public water supply of KASHIMA town*	stream	181 ± 74	138 ± 10	125 ± 20	142 ± 12	–	160 ± 18	94 ± 12	122 ± 18	139 ± 22	108 ± 4
6	Nakaumi lake at HONJYO	stream/sea	–	74 ± 8	59 ± 14	77 ± 12	–	53 ± 10	120 ± 5	68 ± 23	78 ± 26	45 ± 4
7	Shinjiko lake at AIKA	stream/sea	–	143 ± 10	134 ± 4	156 ± 10	–	137 ± 20	146 ± 6	–	–	–
8	Shinjiko lake at TAMAYU	stream/sea	–	140 ± 8	121 ± 4	154 ± 12	–	108 ± 10	164 ± 16	113 ± 20	94 ± 4	79 ± 3
9	Hi-igawa river	stream	–	190 ± 10	133 ± 42	206 ± 12	–	190 ± 12	188 ± 26	193 ± 18	137 ± 28	160 ± 28

Figure 10-1. Sampling Points in the Site of CGEPCO KASHIMA Power Station.

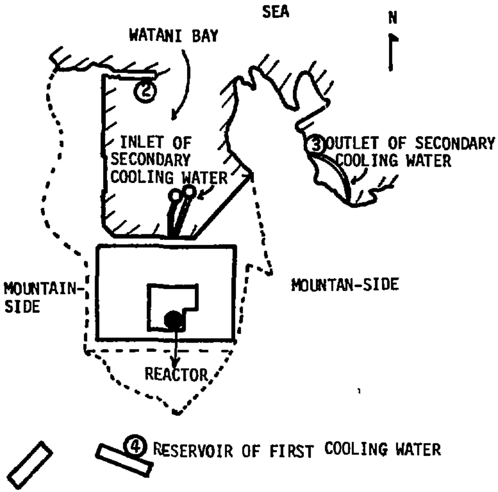


Figure 10-2. Sampling Points around CGEPCO in SHIMANE Prefecture.

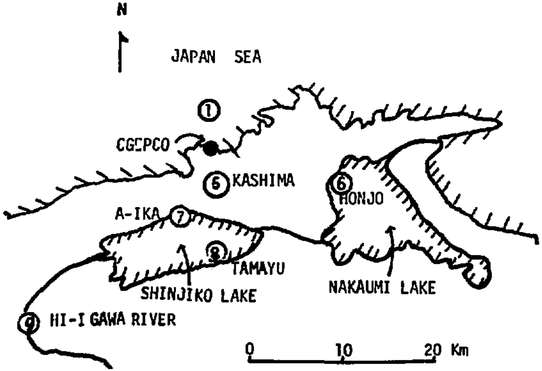


Table 11. EHIME PREFECTURE

Sample No.	Sampling Points around the Nuclear Power Station	Water source	Tritium Concentration, pCi/l ± 2 S.D. Sept., 21 1972	Oct., 11 1976
	SEPCO IKATA NUCLEAR POWER STATION			
1.	Inlet of secondary cooling water	sea	29 ± 7	24 ± 2
2.	Outlet of secondary cooling water	sea	30 ± 7	11 ± 2
3.	Desalted sea water	sea	–	32 ± 2
4.	Tap at SEPCO	stream	–	95 ± 7
	IKATA and Other Area			
5.	Tap at IKATA Town	stream	–	150 ± 7
6.	Kikigawa river	stream	219 ± 72	–

Table 12. SAGA PREFECTURE

Sample No.	Sampling Points around the Nuclear Power Station	Water source	Tritium Concentration, pCi/l ± 2 S.D. Oct. 31, 1968	Apr. 9, 1971	Jul. 20, 1973	Nov. 18-20, 1974	Oct. 20 or 25, 1975	Nov. 6, 1976
	KYEPCO GENKAI POWER STATION							
1.	Inlet of secondary cooling water	sea	–	18 ± 2	37 ± 10	40 ± 5	29 ± 4	42 ± 4
2.	Outlet of secondary cooling water	sea	–	38 ± 2	26 ± 13	6.7 ± 1.0	22 ± 4	63 ± 5
3.	Reservoir for drinking and primary cooling water (Dam of Hatsta river)	stream	–	300 ± 6	115 ± 44	98 ± 18	100 ± 18	76 ± 5
4.	Shimobatameike Pond	reservoir	363 ± 45	255 ± 6	121 ± 50	108 ± 22	111 ± 22	68 ± 6
5.	Tap of KYEPCO	stream	–	–	79 ± 40	89 ± 26	62 ± 22	78 ± 5

Figure 11. Sampling Points around SEPCO IKATA Nuclear Power Station.

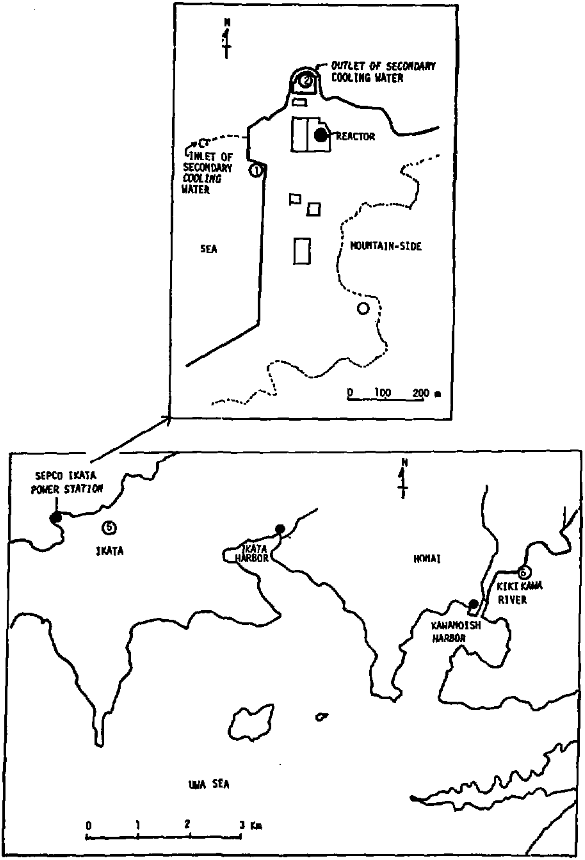
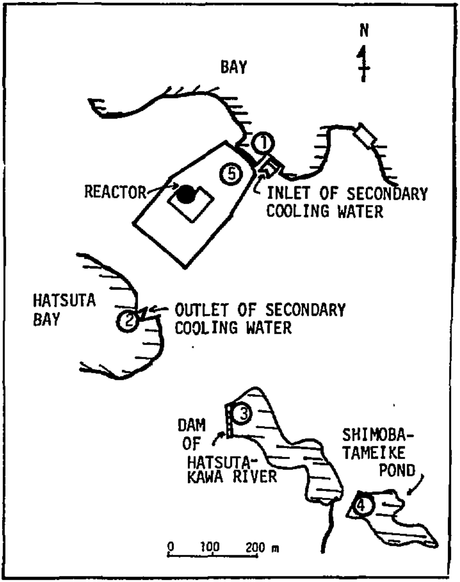


Figure 12. Sampling Points around KYEPCO GENKAI Nuclear Power Station.



(4) Concentration of Carbon-14 in Plants

(National Institute of Radiological Sciences)

The carbon-14 survey program initiated 1960 to gather data on current levels of carbon-14 in environments. The study was necessary to establish the *baseline concentration level so that future deviation* from the baseline could be evaluated. Plants essential oil and fermented alcohol were selected as sample materials. The carbon contained in these materials is fixed from atmospheric carbon dioxide by anabolism, so they well reflect the variation of carbon-14 in biosphere. The data before 1967 were presented in No. 19 (1968) and No. 25 (1969) of this publication.

Materials and counting methods

(1) Thymol; Thymol was obtained from the essential oil of *Orthodon Japonicium* Benth which was cultivated and harvested every year in the experimental field of NIRS and Chiba University. The methylation was carried out to eliminate the strong quenching action of the phenolic group of thymol. Eighteen *grams of thymol methyl ether was used as liquid* scintillator by adding 0.4% PPO and 0.01% POPOP.

(2) Menthol; Menthol was obtained from *Mentha arvensis L* which was cultivated in the east part of Hokkaido and prepared by Kitami Factory of Federation of Agricultural Cooperative Society of Hokkaido. The chemical conversion of menthol to p-cymene was carried out and used as liquid scintillator as same as above sample.

(3) Lemongrass oil; Lemongrass oil was obtained from *Cymbopogon citratus Stapf* which was cultivated in Izu Experimental Station of Medicinal Plants, National Institute of Hygienic Sciences located Minami-Izu, Shizuoka Pref. The p-cymene derived from Lemongrass oil was used as liquid scintillator.

(4) Alcohol; All samples of fermented alcohol were obtained from the Alcohol Factories of Ministry of Trade and Industry. Raw materials of alcohol were (a) sweet potatos cultivated in several prefectures in Japan (shown in Fig. 13)., (b) "high test" molasses and blackstrap molasses imported from several countries of Asia, South America and South Africa, (c) crude alcohol imported from U.S.A., Argentina and Brazil. Mixed solvent of 10 ml sample *alcohol and 10 ml toluene or p-xylene containing* 0.8% PPO and 0.1% dimethyl POPOP was used as liquid scintillator.

The results obtained are shown in Table 13. and Table 14. Annual variation of carbon-14 concentration are illustrated also in Figure 14..

Table 13. ^{14}C Concentration in Alcohol

Year of Harvest	Seweet Potato		Molasses		Crude Alcohol	
	Prefecture in Japan	dpm/g carbon	Foreign Country	dpm/g carbon	Foreign Country	dpm/g carbon
1968	IBARAKI	17.8±0.3	FORMOSA	19.9±0.4		
	KUMAMOTO	18.9±0.3	BRAZIL	18.8±0.3		
	KAGOSHIMA	17.9±0.3	"	18.2±0.3		
	EHIME	18.8±0.3	SOUTH AFRICA	18.6±0.3		
			"	18.5±0.3		
			"	18.7±0.3		
			"	18.0±0.3		
			"	18.4±0.3		
			"	18.2±0.3		
			AUSTRALIA	17.5±0.3		

Year of Harvest	Sweet Potato		Molasses		Crude Alcohol	
	Prefecture in Japan	dpm/g carbon	Foreign Country	dpm/g carbon	Foreign Country	dpm/g carbon
1969	IBARAKI	18.4±0.3	FORMOSA	19.1±0.3		
	KUMAMOTO	18.0±0.2	"	18.0±0.3		
	KAGOSHIMA	18.2±0.3	"	18.8±0.3		
	EHIME	18.1±0.2	BRAZIL	18.2±0.3		
			SOUTH AFRICA	15.6±0.3		
			"	16.6±0.3		
			"	17.5±0.3		
			"	17.8±0.3		
			"	17.7±0.3		
			"	17.9±0.3		
			"	19.9±0.3		
1970	IBARAKI	19.7±0.3	PHILIPPINES	20.5±0.3		
	KUMAMOTO	19.7±0.3	"	21.2±0.3		
	KAGOSHIMA	19.8±0.4	AUSTRALIA	21.4±0.3		
			"	20.2±0.3		
			BRAZIL	20.9±0.3		
			"	20.5±0.3		
			SOUTH AFRICA	20.2±0.3		
1971	IBARAKI	19.8±0.3	FORMOSA	20.6±0.3		
			AUSTRALIA	20.2±0.3		
			"	20.6±0.3		
			"	20.3±0.3		
			"	21.0±0.3		
			INDONESIA	21.4±0.3		
			"	21.3±0.3		
			"	21.2±0.3		
			"	22.6±0.3		
1972	IBARAKI	18.3±0.2	INDONESIA	19.4±0.2		
	KUMAMOTO	19.1±0.2	AUSTRALIA	19.6±0.2		
	KAGOSHIMA	18.7±0.2	PHILIPPINES	19.2±0.2		
			CUBA	20.1±0.2		
1973	IBARAKI	19.4±0.2	PHILIPPINES	19.7±0.2	AGRENTINA	19.0±0.2
	KAGOSHIMA	17.8±0.2	INDONESIA	20.2±0.2	"	22.2±0.2
			ARGENTINA	19.7±0.2	"	18.9±0.2
					"	18.8±0.2
					"	19.5±0.2
					U.S.A.	14.8*±0.1
					"	15.6±0.1
1974	KAGOSHIMA	18.6±0.2	INDONESIA	17.6±0.2	ARGENTINA	18.0±0.2
	"	16.8±0.2	"	18.0±0.2	"	17.7±0.2
			ARGENTINA	18.0±0.2	"	18.6±0.2
			THAILAND	17.5±0.2	BRAZIL	16.6±0.2
					U.S.A	17.7±0.2

Year of Harvest	Sewest Potato		Molasses		Crude Alcohol	
	Prefecture in Japan	dpm/g carbon	Foreign Country	dpm/g carbon	Foreign Country	dpm/g carbon
1975	KUMAMOTO	17.9±0.3	THAILAND	18.9±0.4	RAKISTAN	19.3±0.4
	KAGOSHIMA	18.4±0.3	"	18.6±0.4	PHILIPPINES	18.9±0.4
			"	19.2±0.4	U.S.A	17.6±0.4
			AUSTRALIA	18.1±0.3	"	15.4*±0.4
1976	KAGOSHIMA	17.7±0.2	PHILIPPINES	18.4±0.2	PHILIPPINES	18.1±0.2
					"	17.9±0.2
					INDIA	18.1±0.2
					INDONESIA	18.5±0.2
					"	17.1±0.2
					CHINA	18.3±0.2
					ARGENTINA	18.6±0.2
					AUSTRALIA	17.7±0.2
					U.S.A	14.7*±0.2

* raw material is waste sulfite liquor of pulp

Table 14. ^{14}C Concentration of Essential Oil (1968 to 1975)

Year of Harvest	Thymol dpm/g carbon	Menthol dpm/g carbon	Lemongrass dpm/g carbon
1968	19.4*±0.4	20.0±0.4	19.7±0.4
1969	18.7*±0.2	19.6±0.2	–
1970	18.1**±0.1	19.8±0.1	19.1±0.2
1971	17.4*±0.1	19.0±0.2	19.5±0.2
"	17.6**±0.2	–	–
1972	16.6**±0.2	19.2±0.2	19.1±0.2
1973	–	–	–
1974	18.7**±0.1	–	–
1975	18.3**±0.1	–	–

* : Experimental field of Chiba University
** : Experimental field of NIRS

Figure 13. Sampling Location of Raw Materials

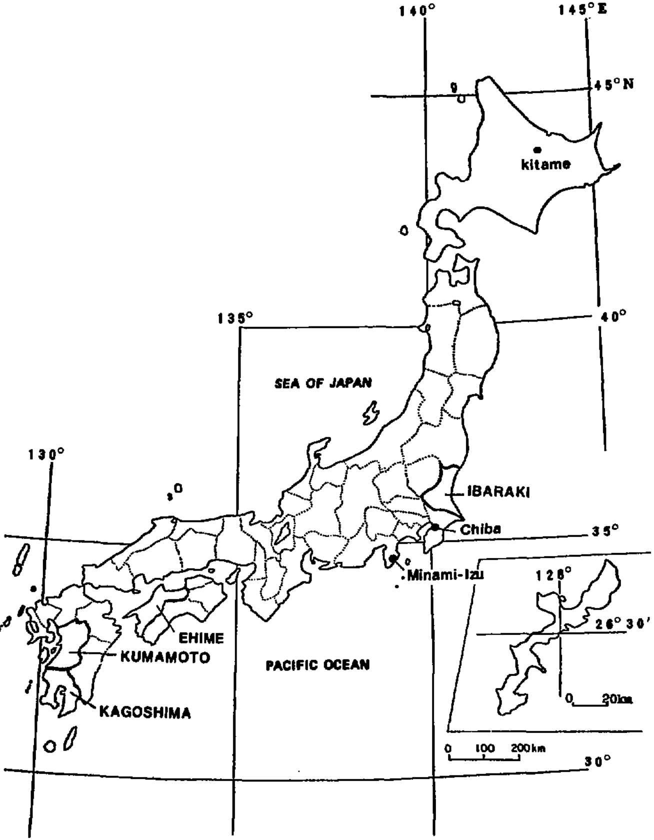
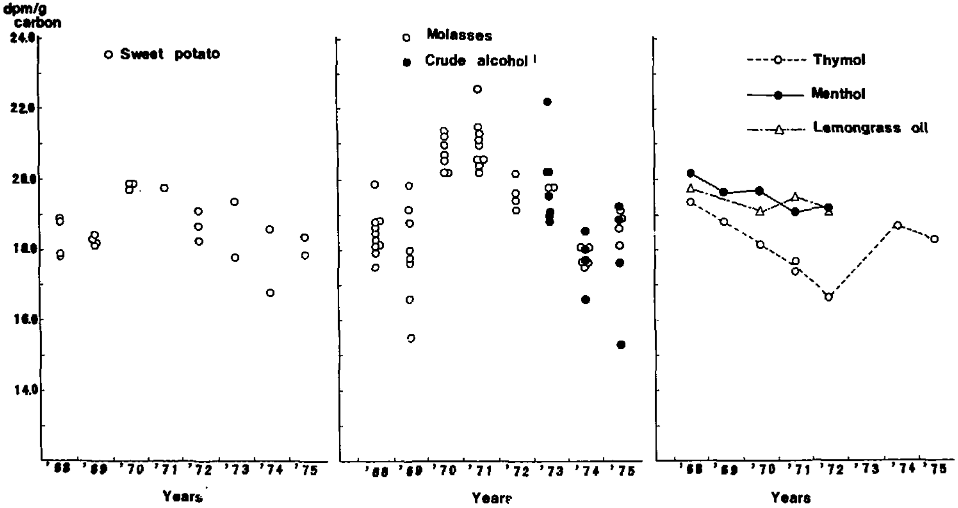


Figure 14. ^{14}C Concentration in Plants (1968 ~ 1975)



(5) Strontium-90 and Cesium-137 in Fresh Water

(Japan Chemical Analysis Center)

Japan Chemical Analysis Center has analysed the strontium-90 and Cesium-137 contents in fresh water from 7 prefectures in Japan by the commission of Science and Technology Agency of Japanese Government.

The method described in "Radioactivity Survey Data in Japan No. 43 (NIRS-RSD-43, 1977) was applied to the analysis of these two radionuclides in samples.

Results obtained during the period 1974 to 1976 are given in Table 15. And sampling locations are shown in Figure 15.

Table 15. ^{90}Sr and ^{137}Cs in Fresh water – April, 1974 to March, 1977 –
(Japan Chemical Analysis Center)

Sampling Location	Date	pH	^{90}Sr (pCi/l)			^{137}Cs (pCi/l)		
Sapporo (Barato-lake), HOKKAIDO	July 1974	–	0.061	±	0.003	0.085	±	0.006
Akita (Soegawa), AKITA	Aug. 1974	6.8	0.023	±	0.01	0.17	±	0.01
Fukushima (Iizaka), FUKUSHIMA	Aug. 1974	7.0	0.32	±	0.01	0.024	±	0.004
Kasumigaura, IBARAKI	June 1974	7.6	0.56	±	0.01	0.16	±	0.01
Niigata (Toyano), NIIGATA	July 1974	7.3	0.58	±	0.01	0.093	±	0.006
Sapporo (Barato-lake), HOKKAIDO	Sept. 1975	7.5	0.18	±	0.005	0.041	±	0.004
Akita (Soegawa), AKITA	June 1974	6.8	0.19	±	0.006	0.024	±	0.004
Fukushima (Iizaka), FUKUSHIMA	Oct. 1975	–	0.10	±	0.004	0.02	±	0.004
Kasumigaura, IBARAKI	May 1975	8.2	0.53	±	0.009	0.13	±	0.008
Niigata (Toyano), NIIGATA	Nov. 1975	7.25	0.42	±	0.007	0.05	±	0.005
Biwako (Oumimaiko), SHIGA	Oct. 1975	7.88	0.37	±	0.007	0.015	±	0.003
Shobara (Kawatemachi), HIROSHIMA	Nov. 1975	7.2	0.09	±	0.004	0.010	±	0.003
Kasumigaura, IBARAKI	June 1976	7.9	0.29	±	0.006	0.06	±	0.005
Sapporo (Barato-lake), HOKKAIDO	Oct. 1976	7.1	0.15	±	0.006	0.06	±	0.005
Akita (Soegawa), AKITA	Aug. 1976		0.15	±	0.007	0.02	±	0.004
Niigata (Toyano), NIIGATA	Nov. 1976	7.52	0.32	±	0.010	0.05	±	0.004
Biwako (Oumimaiko), SHIGA	Oct. 1976	7.38	0.27	±	0.009	0.003	±	0.003
Shobara (Kawatemachi), HIROSHIMA	Nov. 1976	7.0	0.07	±	0.005	0.01	±	0.003

(6) Strontium-90 and Cesium-137 in Fresh Water Fish.

(Japan Chemical Analysis Center)

Japan Chemical Analysis Center has analysed the strontium-90 and Cesium-137 contents in fresh water fish obtained from 7 prefectures in Japan by the commission of Science and Technology Agency of Japanese Government.

The method described in "Radioactivity Survey Data in Japan No. 43 (NIRS-RSD-43, 1977) was applied to the analysis of these two radionuclides in samples.

Results obtained during the period 1974 to 1976 are given in Table 16. And sampling locations are shown in Figure 15.

Table 16. ^{90}Sr and ^{137}Cs in Fresh-water fish
– April, 1974 to March, 1977 –
(Japan Chemical Analysis Center)

Sampling Location	Date	Ash (%)	Component (% by weight)		^{90}Sr (pCi/l)		^{137}Cs(pCi/l)	
			Ca (%)	K (%)	pCi/kg	S.V.	pCi/kg	C.V.
Carassius carassius								
Sapporo (Barato-lake), HOKKAIDO	July, 1974	4.87	30.8	5.80	260 ± 0	17 ± 1	25 ± 1	9.0 ± 0.4
Mikata-lake, FUKUI	July, 1974	5.39	31.0	4.20	120 ± 0	7.2 ± 0.1	18 ± 1	7.9 ± 0.4
Sapporo (Barato-lake), HOKKAIDO	Sept. 1975	4.00	29.6	6.90	71 ± 0.9	6.0 ± 0.08	8.0 ± 0.54	2.9 ± 0.20
Niigata (Toyano), NIIGATA	Nov. 1975	4.96	31.2	5.43	130 ± 1	8.4 ± 0.09	13 ± 0.6	4.5 ± 0.22
Mikata-lake, FUKUI	Dec. 1975	1.77	19.1	16.9	17 ± 0.5	5.0 ± 0.15	17 ± 0.7	5.5 ± 0.22
Biwako (Oumimaiko), SHIGA	Jan. 1976	4.16	30.0	6.22	110 ± 1	9.2 ± 0.10	10 ± 0.5	3.9 ± 0.21
Niigata (Toyano), NIIGATA	Nov. 1976	4.72	30.5	6.22	120 ± 5	8.4 ± 0.34	9.5 ± 1.4	3.2 ± 0.47
Mikata-lake, FUKUI	Dec. 1976	4.30	30.9	7.05	74 ± 3.0	5.6 ± 0.23	14 ± 1.4	4.6 ± 0.45
Cyprinus carpio								
Kasumigaura, IBARAKI	Apr. 1974	2.80	32.1	4.97	96 ± 1	11 ± 0	16 ± 1	11 ± 0
Shobara (Kawatemachi), HIROSHIMA	June 1974	2.19	25.2	9.40	25 ± 1	4.5 ± 0.1	19 ± 1	9.3 ± 0.4
Fukushima (Iizaka), FUKUSHIMA	Aug. 1974	2.29	27.3	9.64	51 ± 1	8.2 ± 0.1	12 ± 1	5.3 ± 0.2
Akita (Soegawa), AKITA	Nov. 1974	3.75	17.2	6.10	130 ± 0	21 ± 1	80 ± 0.6	3.5 ± 0.3
Fukushima (Iizaka), FUKUSHIMA	May, 1975	2.71	26.1	9.2	84 ± 1.0	12 ± 0.1	11 ± 0.6	4.3 ± 0.22
Akita (Soegawa), AKITA	June, 1975	2.75	26.1	9.2	110 ± 1	15 ± 0.2	12 ± 0.6	4.7 ± 0.20
Shobara (Kawatemachi), HIROSHIMA	Nov. 1975	0.96	3.06	32.7	21 ± 0.34	7 ± 1.2	17 ± 1.0	5.5 ± 0.30
Akita (Soegawa), AKITA	Aug. 1975	3.53	21.5	6.94	110 ± 1	15 ± 0.2	16 ± 0.7	6.7 ± 0.29
Sapporo (Barato-lake), HOKKAIDO	Oct. 1976	3.58	29.7	6.31	110 ± 2	10 ± 0.2	2.8 ± 0.33	1.2 ± 0.15
Shobara (Kawatemachi), HIROSHIMA	Nov. 1976	1.05	2.61	32.2	23 ± 1.9	8.5 ± 0.9	12 ± 0.5	3.4 ± 0.15
Carassius carrasius cuvieri								
Niigata (Toyano), NIIGATA	June 1974	5.03	30.6	4.70	190 ± 0	12 ± 1	16 ± 1	6.9 ± 0.3

Figure 15. ^{90}Sr and ^{137}Cs in Fresh-Water
^{90}Sr and ^{137}Cs in Fresh-Water Fish
(Japan Chemical Analysis Center)

1. Sapporo (Barato-lake), HOKKAIDO
2. Akita (Soegawa), AKITA
3. Fukushima (Iizaka), FUKUSHIMA
4. Kasumigaura, IBARAKI
5. Niigata (Toyano), NIIGATA
6. Biwako (Oumimaiko), SHIGA
7. Shobara (Kawatemachi), HIROSHIMA
8. Mikata-lake, FUKUI