PNCT N8530 87-06

Environmental Monitoring at Tokai Works, PNC

December, 1 9 8 7

Tokai Works

Power Reactor and Nuclear Fuel Development Corporation

Ⓐ

PNCT N8530 87-06
December, 1987

Environmental Monitoring at Tokai Works, PNC

Osamu Narita

Junichiro Ishida

Tomohiro Asano

ABSTRACT

Safety is the most important in the processes of developing nuclear fuel cycle technology. Especially, the public safety around the nuclear facilities is the top priority. We should design, construct and operate the nuclear facilities in conformity to the principle of "defence in depth" to keep the public safety and health.

Effluent monitoring is performed to assess effectiveness of safety design and adequacy of plant operation. In addition, environmental monitoring is carried out to confirm the public and environmental safety. This report summarizes the activities of the Environmental Protection Section at Tokai Works.

Environmental Protection Section

Health and Safety Division

CONTENTS

1. Introduction

To proceed effectively with nuclear power generation, the establishment of a nuclear fuel cycle appropriate to the domestic demand is a fundamental requirement. To achieve this, the establishment of an optimal fuel cycle, suitable to each stage of the energy supply system, is an important task. Power Reactor and Nuclear Fuel Development Corporation (PNC) was established in 1967 for the purpose of developing the heavy water reactor (Advanced Thermal Reactor : ATR), the fast breeder reactor (FBR), as well as for developing of nuclear fuel. Locations of PNC facilities are shown in Fig. 1-1.

Among the tasks of PNC, Tokai Works has been in charge of the comprehensive development of nuclear fuel technology such as spent fuel reprocessing, waste management, FBR fuel recycling, MOX fuel fabrication, uranium enrichment and its related R & D.

Safety is a top priority in the development of such technologies. Public safety, especially, must be guaranteed through the concept of defence in depth. Of the facilities at Tokai Works, the reprocessing plant is the one that handles much amount of radioactive materials. Accordingly, it becomes aware of how important such a facility is with respect to the environmental safety.

The reprocessing plant was completed in 1974 and brought into hot operation in 1977. Thereafter the plant has reprocessed approximately 350 metric tons of spent fuel from domestic BWR and PWR power plants and our ATR up to early 1987.

On the history of the plant, environmental protection problems have been disscussed. "Safety First" is the most important principle for public protection. In such point of view, effluent monitoring is performed to assess the effectiveness of safety design and adequacy of plant operation. In addition, enviromental monitoring is carried out to confirm public and environmental

safety.

This report summarizes the effluent and environmental monitoring, environmental research and development of dose assessment models performed in the Environmental Protection Section.

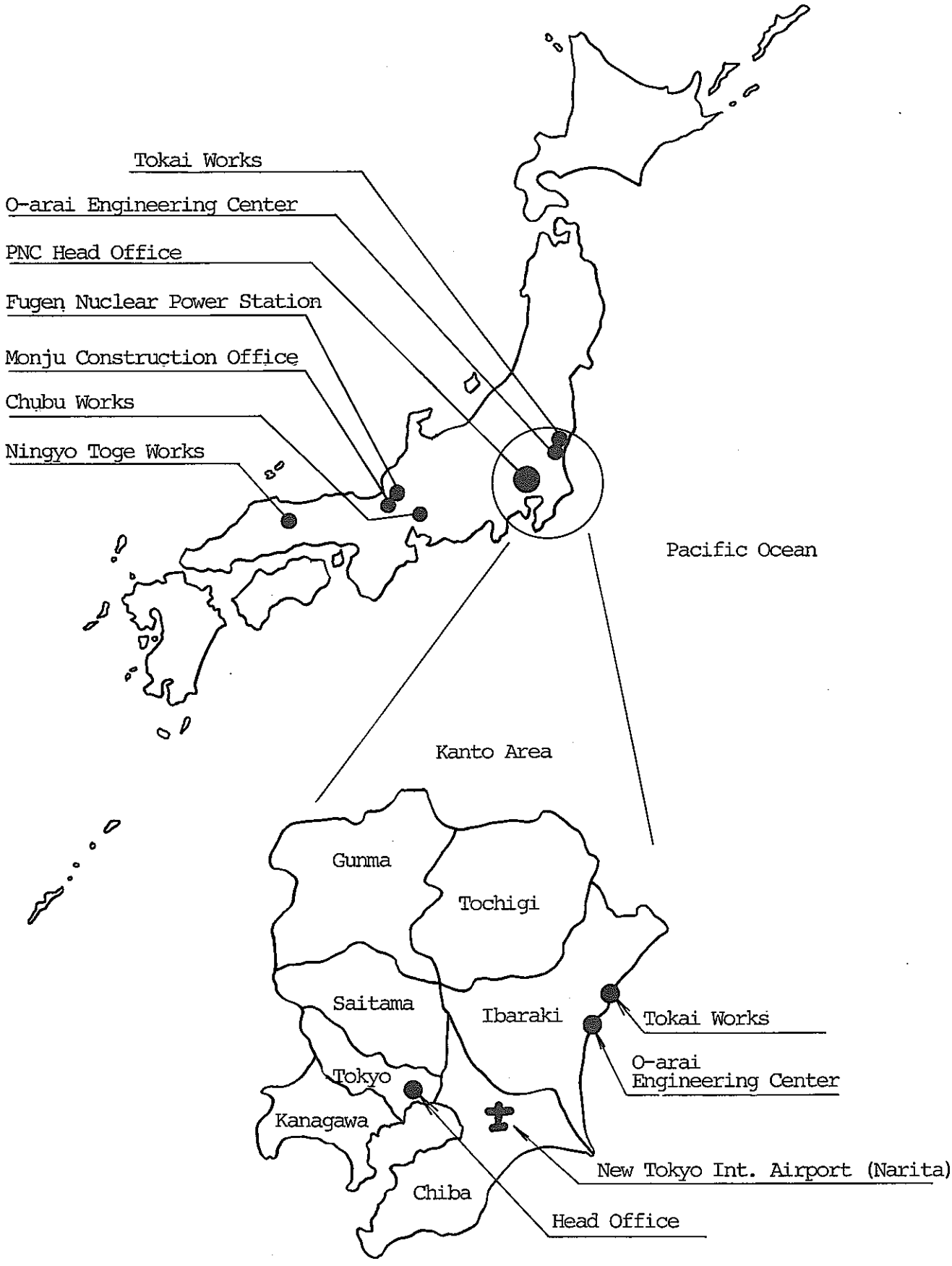


Fig. 1-1 Locations of PNC Facilities

2. Waste Control

2.1 Waste Discharge Limits

In the safety assessment of the Tokai Reprocessing Plant, daily radioactive discharges to the atmospheric and marine environments were estimated considering the specifications of the design basis spent fuel, material balance in each process, decontamination capacity and operational factors. After the safety assessment, gaseous and liquid waste discharge limits for major nuclides from the plant were implemented. These limits are described in the Safety Regulations of the Tokai Reprocessing Plant.

(1) Gaseous Discharge Limit

Gaseous waste is discharged to the atmosphere from the stack whose height is 90 m above the ground level. The authorized limits for gaseous discharge are shown in Table 2-1. ^{85}Kr is monitored continuously, and iodine (^{129}I and ^{131}I) are measured weekly after being sampled by charcoal cartridge and filter. Tritium is measured by weekly composite sample. The Radiation Control Section- Ⅱ is in charge of the gaseous waste monitoring.

Table 2-1 Gaseous discharge limits of the Tokai Reprocessing Plant

Nuclide	Daily Limit (Ci)	Quarterly Limit (Ci)	Annual Limit (Ci)
Kr-85	8×10^{3}	7.2×10^{5}	2.4×10^{6}
H-3	5×10^{1}	4.5×10^{3}	1.5×10^{4}
I-131	1.44×10^{-3}	1.3×10^{-1}	4.3×10^{-1}
I-129	1.5×10^{-4}	1.4×10^{-2}	4.5×10^{-2}

Remarks : Daily Limit is applied to quarterly average.

(2) Liquid Discharge Limit

Radioactive liquid waste from the Tokai Reprocessing Plant is discharged to the sea through a discharge pipe. A discharge nozzle is located 1.8 km distant from the shoreline. Liquid waste is under control of the authorized limits shown in Table 2-2. Environmental Protection Section is in charge of the liquid waste monitoring.

Table 2-2 Sea discharge limits of the Tokai Reprocessing Plant

Nuclide	Maximum Concentration (μCi/cm^3)	Daily Limit (Ci)	Quarterly Limit (Ci)	Annual Limit (Ci)
Gross α	8×10^{-7}	3×10^{-5}	2.7×10^{-2}	0.11
Gross β (Excluding for H-3)	3.3×10^{-4}	0.1	6.5	26
Sr-89	6.1×10^{-6}*	1.9×10^{-3}*	0.11	0.43
Sr-90	1.3×10^{-5}*	3.7×10^{-3}*	0.22	0.87
Zr-95, Nb-95	1.6×10^{-5}	4.7×10^{-3}	0.28	1.1
Ru-103	2.5×10^{-5}	7.3×10^{-3}	0.44	1.73
Ru-106, Rh-106	2.0×10^{-4}	5.8×10^{-2}	0.47	13.87
Cs-134	2.3×10^{-5}	6.8×10^{-3}	0.41	1.62
Cs-137	2.1×10^{-5}	6.1×10^{-3}	0.37	1.48
Ce-141	2.2×10^{-6}	6.6×10^{-4}	0.04	0.16
Ce-144, Pr-144	4.5×10^{-5}	1.4×10^{-2}	0.81	3.24
H-3	6.7×10^{-1}	200	1.26×10^{4}	5.11×10^{4}
I-129	1.0×10^{-5}*	3.0×10^{-3}*	0.18	0.72
I-131	4.4×10^{-5}	1.4×10^{-2}	0.80	3.18
Pu(α)	8×10^{-7}*	3×10^{-4}*	0.016	0.062

Remarks : * Limits applied to derived daily average from monthly composite sample.

2.2 Liquid Waste Control

The channels of liquid waste discharge from the Tokai Works are shown in Fig. 2-1. Radioactive liquid waste from the Tokai Reprocessing Plant is discharged to the sea through the discharge nozzle. On the other hand, radioactive liquid waste from the plutonium fuel development laboratory is discharged to the coastal sea surface. Utility liquid waste is discharged to Shin-kawa by a utility liquid waste network.

Before the liquid waste release from the reprocessing plant and plutonium fuel development laboratory, liquid waste is temporary stored in the release vessels and representative samples are taken. Radioactive materials and pollutants are analysed and only the liquid waste below the autholized limits are permited to release. If above the limits, proper treatment must be done. The Environmental Protection Section is in charge of the analysis of every release sample or monthly composite samples, and check whether it can be released or not.

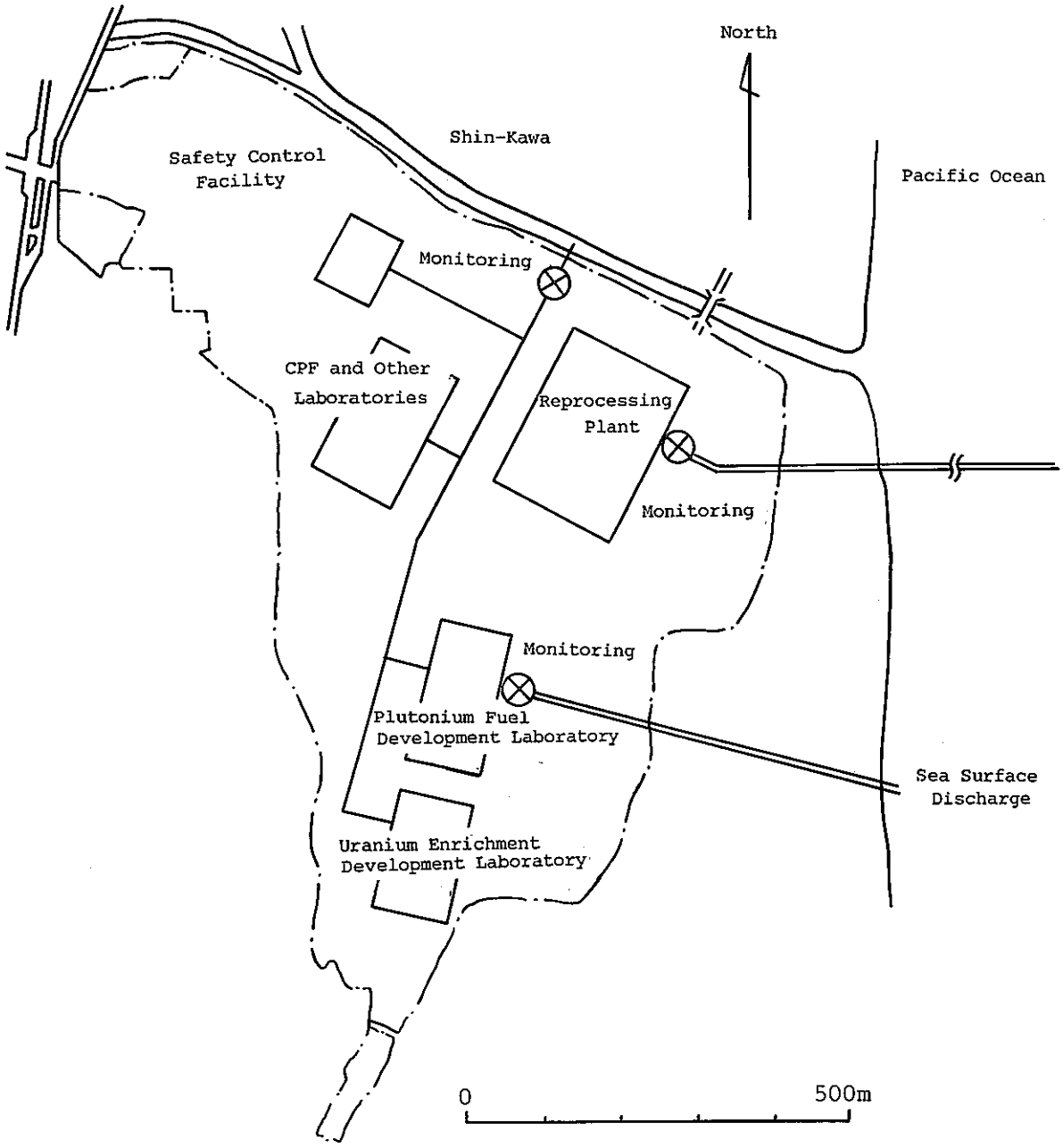


Fig. 2-1 Channels of the Liquid Waste Discharge from the Tokai Works

3. Environmental Monitoring

3.1 Objectives

(1) Major Objectives

According to the ICRP Publication 43, the major objectives of the environmental monitoring program around nuclear fuel cycle facility can be summarized as follows ;

- To assess actual or potential doses to critical groups and populations from the presence of radioactive materials or radiation fields in the environment from normal operations or accidents. This may be limited to the assessment of dose equivalents to populations ;
- To demonstrate compliance with authorized limits and legal requirements ;
- To check the condition of the source, the adequacy of operation of the plant or containment and the effectiveness of effluent control, to provide a warning of unusual or unforeseen conditions and, where appropriate, trigger a special environmental monitoring program

(2) Subsidiary Objectives

Beside the above basic objectives, subsidiary objectives are implemented to satisfy monitoring program. These are summarized as follows ;

- To provide information to the public ;
- To maintain continuing record of the effect of the installation or practice from the contributions from other levels ;
- To distinguish the contribution from the operator's installation or practice from the contributions from other sources ;
- To obtain data on the behavior of the materials in the local environment that may be required in the assessment of the consequences of accidents ;

- To identify the changes in the relative importance of transfer pathways and mechanisms including the emergence of new pathways, and hence to enable to the environmental program to be revised in the light of experience and in response to changing conditions ;
- To verify or refine the predictions of environmental models, in order to improve the structure of the model and to reduce the uncertainties in the parameters ;
- To conduct more general, scientific studies aimed at improving knowledge of the transfer of the radionuclides in the environment.

3.2 Monitoring Program

(1) Statutory Monitoring Program

The object of the statutory monitoring program for the Tokai Reprocessing Plant are also based on the objectives shown in chapter 3.1. Our practical monitoring program are shown in Table 3-1 and Table 3-2, and sampling and monitoring points are shown in Fig.3-1 ～Fig.3-4.

Furthermore, meteorological monitoring is performed following the "Meteorological guideline for the power generating light water reactor". Items of the meteorological observation are listed in Table3-3. Based on the annunl meteorological data and effluent monitoring data, annual dose to the public due to the operation of Tokai Reprocessing Plant is estimated. On the other hand, Ibaraki prefecture has its own environmental monitoring program because nuclear facilities are concentrated in the Tokai area. Most of the nuclear facilities and prefectural organization are included in this program. PNC is also included in the program to report the results of monitoring data and to perform terrestrial and marine monitoring around Tokai-mura.

Table 3-1 Monitoring Program for Terrestrial Environment

Sample		Sampling		Measurement		Remarks
		Sampling point	Frequency	Nuclide	Frequency	
Exposure rate		on site : 7 off site : 3	continuously	γ-ray	continuously	
Cumulative Exposure		on site :15 off site :25	continuously	γ-ray	quarterly	monitoring point (with TLDs)
Air	Airborne dust	on site : 3 off site : 4	continuously	Gross α Gross β	weekly	
				Sr-90 Cs-137	quarterly	
	Iodine	on site : 1 off site : 3	continuously	I-131	weekly	
	Gaseous β	on site : 1 off site : 3	continuously	Kr-85	continuously	
Rain		on site : 1	continuously	H-3	monthly	
Deposited Activity		on site : 1	continuously	Gross β	monthly	
Drinking Water		on site : 1 off site : 3	quarterly	Gross β H-3	quarterly	
Leafy Vegetable		off site : 3	quarterly	I-131	quarterly	
				Sr-90 Cs-137 Pu-239, 240	annually	
Rice		off site : 3	annually	Sr-90	annually	
Milk		off site : 3	quarterly	I-131	quarterly	
				Sr-90	annually	
Surface Soil		on site : 2 off site : 3	annually	Sr-90 Cs-137 Pu-239, 240	annually	
River Water		Shin-kawa : 3 Kuji river : 1	semiannually	Gross β H-3	semiannually	
River bed Sediment		Shin-kawa : 3 Kuji river : 1	semiannually	Gross β	semiannually	

Table 3-2 Monitoring Program for Marine Environment

Sample		Sampling		Measurement		Remarks
		Sampling point	Frequency	Nuclide	Frequency	
Sea Water		Above nozzle:1 Surrounding nozzle :4	quarterly	Gross β H-3	quarterly	
				Pu-239, 240 Radioactive Analysis	annually	
		Off Shore : 2	semiannually	Gross β H-3	semiannually	Kuji and Isozaki
		20km to the North : 1	annually	Gross β H-3 Pu-239, 240 Radioactive Analysis	annually	
Bed Sediment		Surrounding Nozzle : 5 Off shore : 2 20km to the North : 1	semiannually	Pu-239, 240 Radioactive Analysis	semiannually	Off-shore : Kuji and Isozaki
Coastal Water		Beach : 5	semiannually	Gross β H-3	semiannually	
				Pu-239, 240 Radioactive Analysis	annually	
Beach Sand		Beach : 5	quarterly	Radioactive Analysis	quarterly	
Marine Products	Whitebait	Tokai Area : 2	quarterly	Radioactive Analysis	quarterly	
	Fish	Tokai Area : 2	quarterly	Radioactive Analysis	quarterly	
	Shellfish	Tokai Area : 2	quarterly	Radioactive Analysis	quarterly	
	Seaweed	Tokai Area : 3	quarterly	Radioactive Analysis	quarterly	
Fishing Net		Dragged by "SEIKAI"	quarterly	γ-ray	quarterly	
Deck		Deck of "SEIKAI"	quarterly	γ-ray	quarterly	

Remarks ; "Radioactive Analysis" means measurement for ^{90}Sr, $^{106}Ru/Rh$, ^{134}Cs, ^{137}Cs and $^{144}Ce/Pr$

Table 3-3 On-Site Meterological Monitoring Program

Meteorological Item	Location of Instruments
Wind Speed and Direction	・70 meters above the ground level (at the top of the meteorological tower) ・10 meters above the ground level (at the top of the safety control building)
Rain	At the roof of the safety control building
Vertical Temperature Difference	Beside the meteorological tower
Solar and Net Radiation	2 meters above the ground level

Remarks ; Atmospheric stability is classified by wind speed at 10 m height, solar and net radiation according to the meteorological guideline.

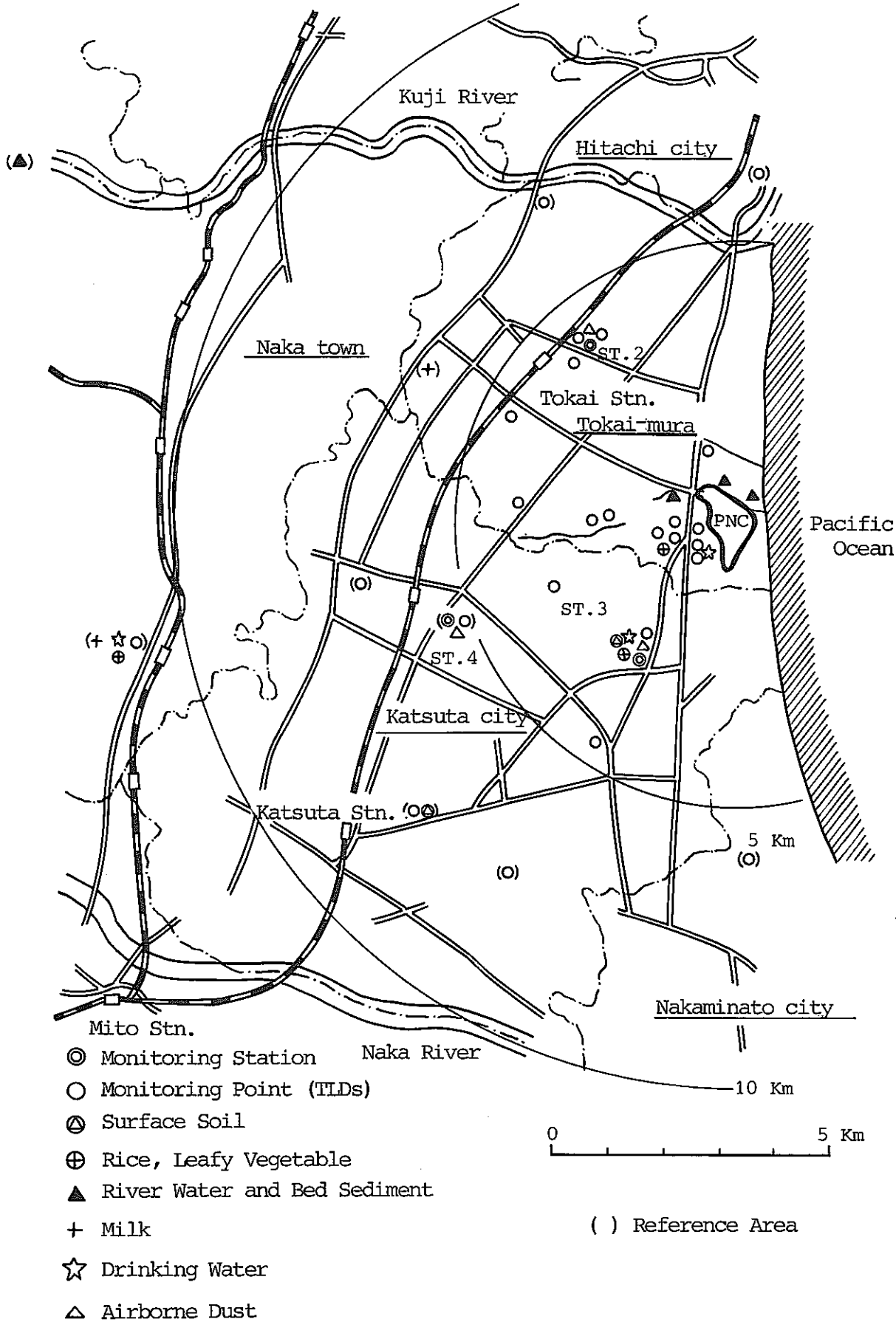


Fig. 3-1 Sampling and Monitoring Points (Off-Site)

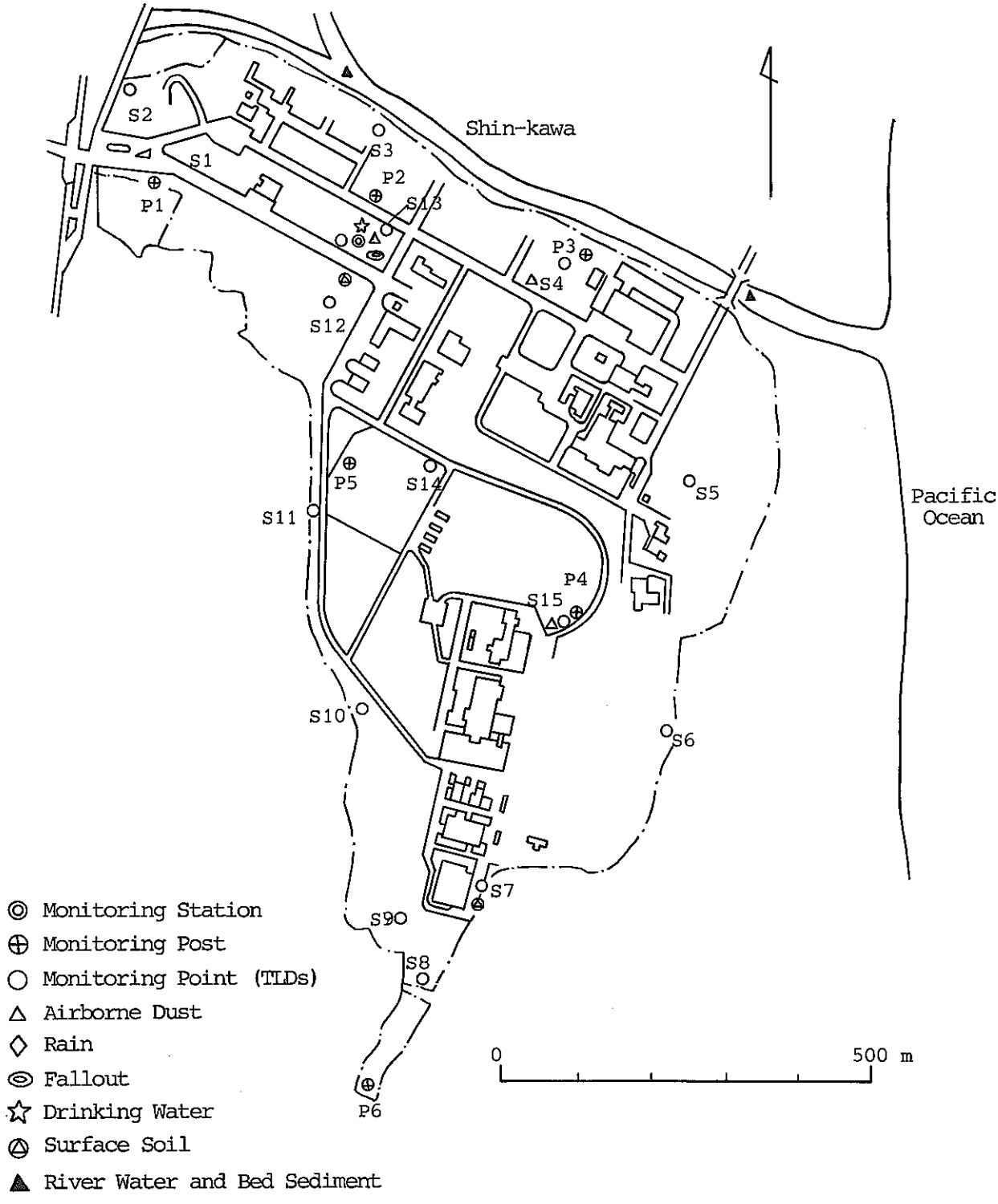


Fig. 3-2 Sampling and Monitoring Points (On-Site)

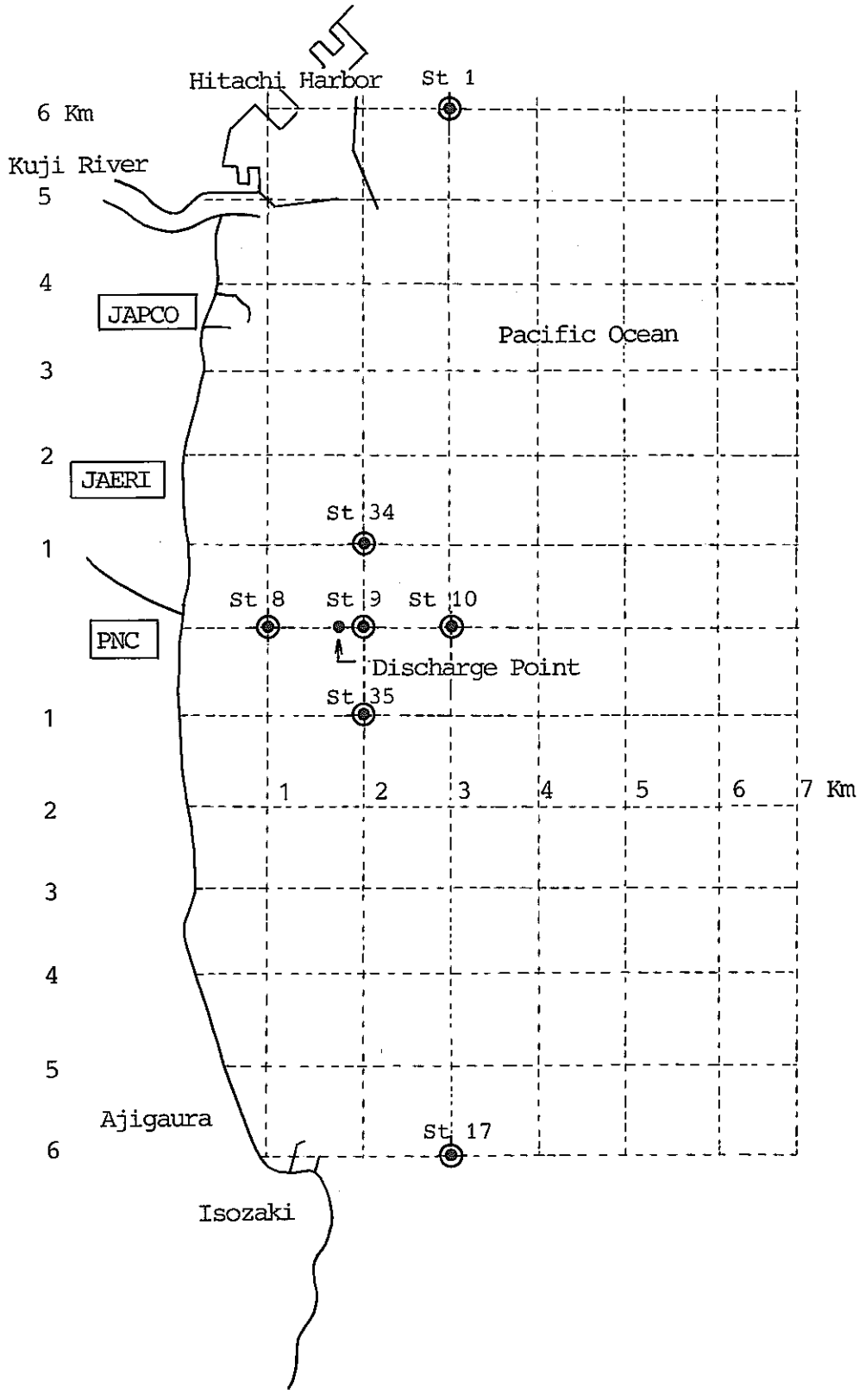


Fig. 3-3 Sampling Points for Sea Water and Bed Sediment

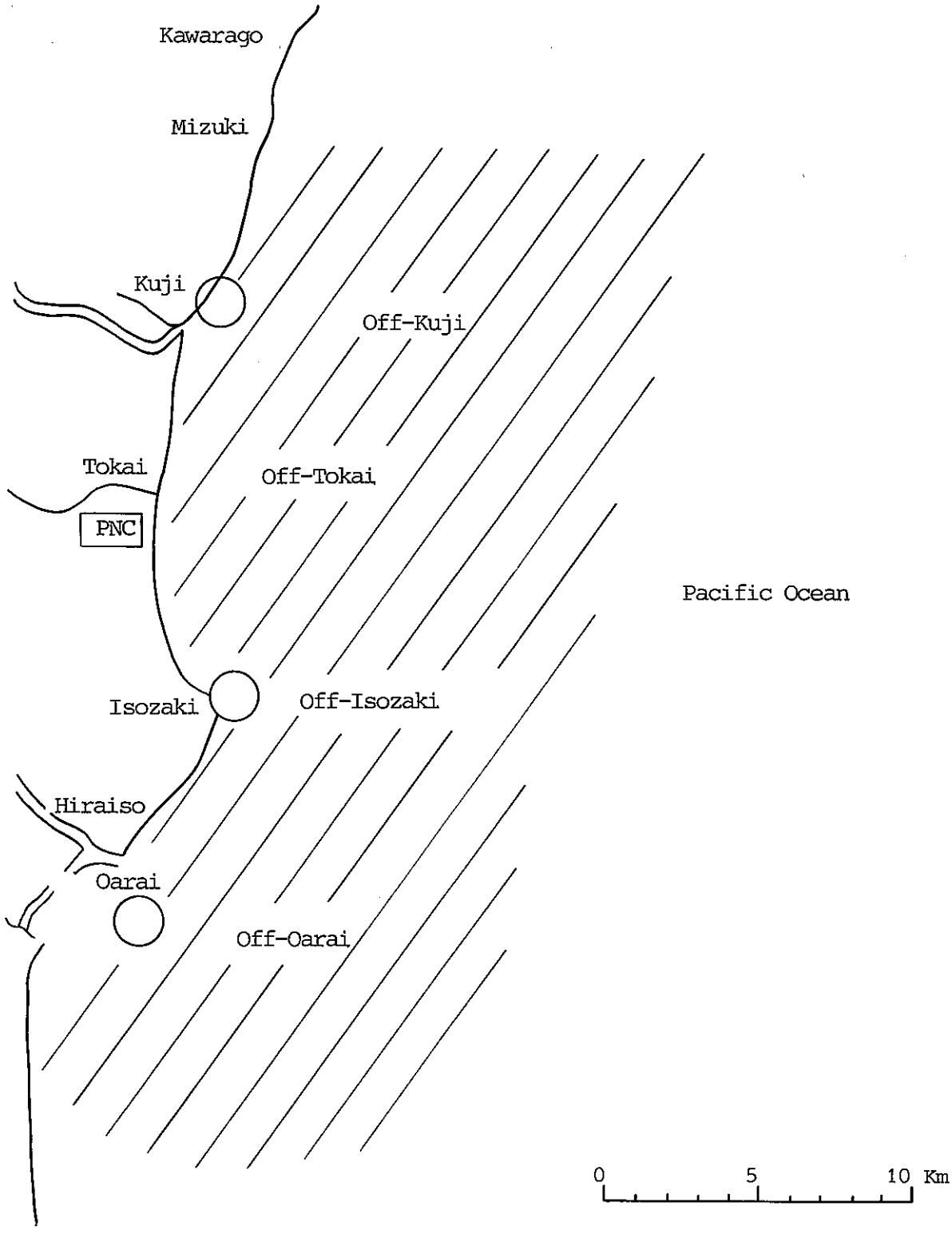


Fig. 3-4 Sampling Area for Marine Products

(2) Subsidiary Monitoring

Primary environmental monitoring program was discussed by the Nuclear Safety Commission in 1975. At that time, following subsidiary monitoring programs are requested to supply further environmental information and to estimate more realistic dose to the public.

a) Study on atmospheric dispersion (1977 ~ 1978)

— Dispersion experiment by tracer gas (SF_6) and ^{85}Kr to validate the atmospheric dispersion equation

b) Study on behaviour of atmospheric tritium (1977 ~)

— Development of analytical method for measurement of atmospheric HT and HTO and to observe variation of the level

c) Study on accumulation of I-129 (1975 ~)

— Development of analytical method on measurement of ^{129}I in the environmental samples and to observe long-term accumulation

d) Study on oceanic dispersion phenomena (1977 ~ 1978)

— Dispersion experiment by ^{3}H and dye to validate the oceanic dispersion equation

e) Monitoring of sea bed sediment (1973 ~)

— Measurement of sea bed sediment to observe long-term accumulation

f) Study on external exposure pathways in the marine environment (1976 ~ 1980)

— Investigation on monitoring methods for external exposure pathway in the marine environment such as contaminated fishing gears, shore sand and deck of ship

g) Pre-operational radiation monitoring (1971 ~ 1977)

— Pre-operational radiation monitoring for the background of operational monitoring

Studies on a), d), f), and g) have already been finished, and b), c), and e) are being performed as subsidiary monitoring to estimate the long-term variation of radiation fields.

3.3 Analytical methods

Environmental samples are periodically taken following the monitoring program shown in Table 3-1 and Table 3-2. After samples are treated physically and chemically depending on their properties, the radioactivities in the samples are measured by proper instruments. These treatments and instruments are listed inTable 3-4.

Table 3-4 Radioactive Analysis of the Environmental Samples

NUCLIDE	SAMPLE	TREATMENT	INSTRUMENT
Gross α and Gross β	Drinking water Rain water Fallout River water	Evaporate and dry up	2π-gasflow counter, GM counter or ZnS counter
	Milk	Ash	
	Dust	- (Direct measurement)	GM counter or ZnS counter
	Surface soil River sediments Sea sediments	Dry up	
	Sea water	Fe-Ba coprecipitation	2π-gasflow counter,
^{106}Ru	Sea water	Coprecipitation and distillation	Low background β counter
	Sea sediments	Acid-exudation and distillation	
	Marine products	Ash, acid-exudation and distillation	
^{90}Sr	Agricultural products Milk Surface soil Sea water Sea sediments Marine products	^{90}Y milking (Oxalate)	Low background β counter
^{134}Cs and ^{137}Cs	Agricultural products Milk Surface soil	Ash	γ - spectrometer
	Sea water	Coprecipitation (Ni ferrocyanide)	
	Sea sediments	Dry up	
	Marine products	Ash	

Table 3-4 (Continued)

NUCLIDE	SAMPLE	TREATMENT	INSTRUMENT
^{144}Ce	Sea water Sea sediments	TBP-extraction	Low background β counter
	Marine products	Ash, TBP-extraction	
$^{239,240}Pu$	Sea water Sea sediments Surface soil	Ion-exchange	Si-SSD α spectrometer
	Marine products	Ash, ion-exchange	
^{3}H	Drinking water River water Sea water Rain water	Distillation	Liquid scintilation counter
^{131}I	Air	(Direct measurement) (Activated charcoal cartridge)	γ spectrometer
	Milk	- (Direct measurement)	
	Leafy vegetables	- (Direct measurement) (juice)	

3.4 Computer Application for Routine Monitoring

Environmental monitoring includes continuous monitoring such as variation of exposure rate, meteorological data and continuous effluent monitor, as well as periodical monitoring. Accordingly, it is indispensable to introduce a computer system to minimize the load of data management. Representative examples of computer application systems applied to the routine monitoring are called "Environmental data telemetering system" and "Environmental data control system (TECS)".

Environmental data telemetering system is applied for the continuous monitoring. Schematic diagram of the telemetering system is shown in Fig. 3-5. On site monitoring data is collected directly from each instrument. Off site data is transported from each monitoring station by way of telephone line. Total number of data account for 103 items and when it includes secondary converted data, it accounts for 130 items. These data are stored temporarily in the telemetering data processor and transfered to the continuous data base : FANTOM. FANTOM is served for statistical calculation and dose assessment.

Environmental data control system (TECS) is a data base applied to data management of periodical monitoring. A schematic diagram of TECS is also shown in Fig. 3-5. TECS consists of Environmental data base (ENV), Plan data base (PLAN) and Data Dictionary (DD). PLAN includes a monitoring program shown in Table 3-1 and Table 3-2, excluding the exposure rate. DD is a code conversion table and ENV is a data base of periodical monitoring results.

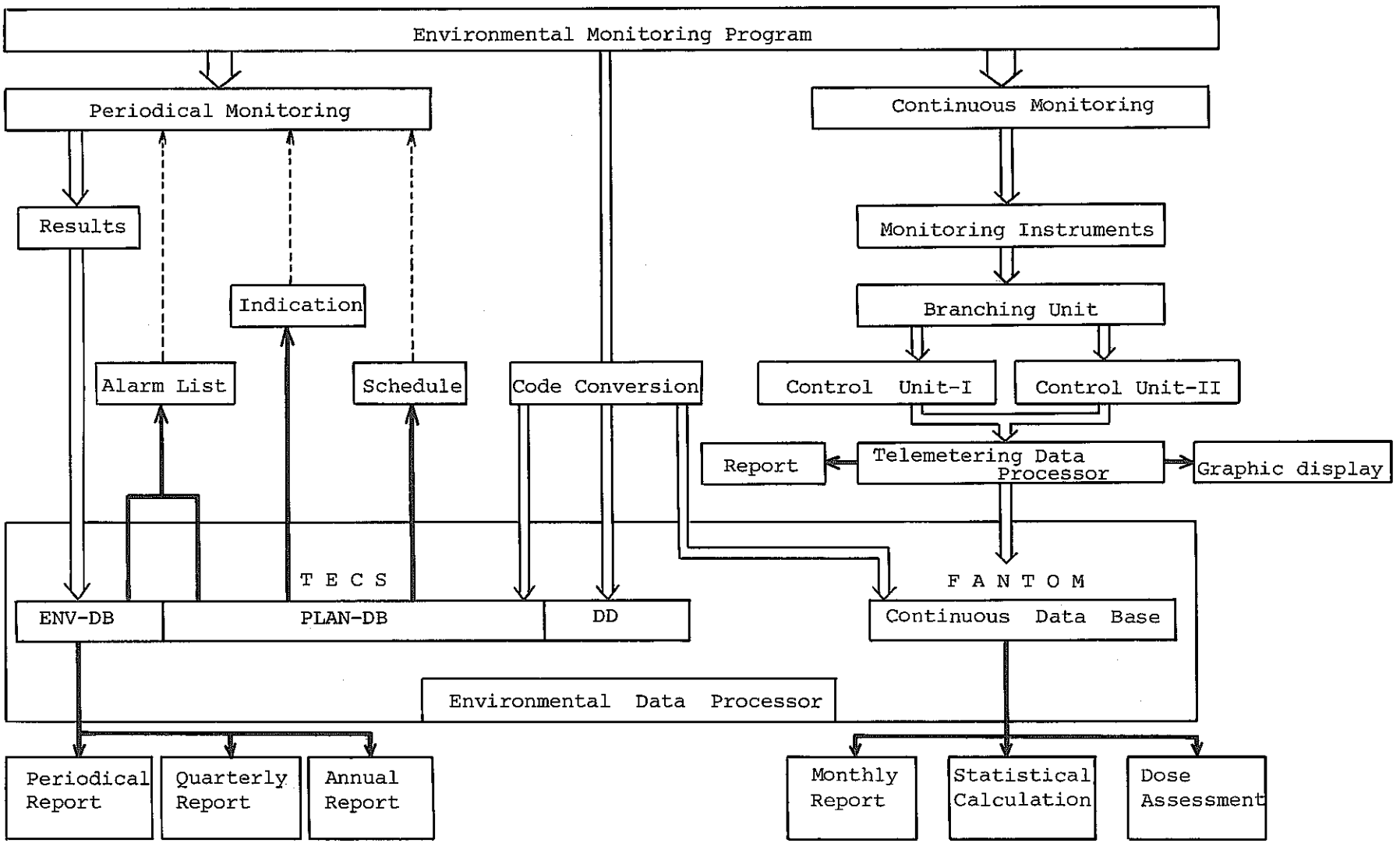


Fig. 3-5 Representative Computer Application System for Routine Environmental Monitoring

3.5 Reporting

The monitoring results have been compiled as a quarterly report and reported to the Science and Technology Agency (STA) and Ibaraki prefectural government. STA holds a "Special Committee for the Evaluation of Environmental Radiation Monitoring" once a year, and Ibaraki Prefectural Governmert holds its own "Committee on Environmental Radiation Monitoring in the Tokai Area" quarterly. According to the results of the discussion on each committee, in ten years of operating experience, no significant increase of radiation fields due to Tokai Reprocessing Plant has been detected.

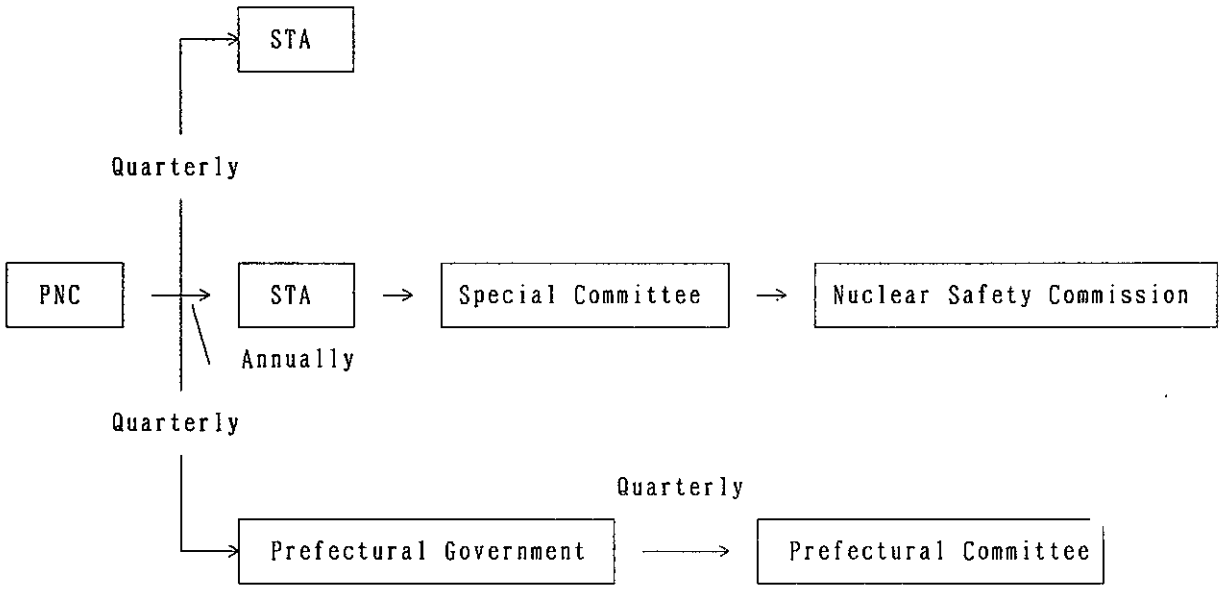


Fig. 3-5 Reporting System of Environmental Monitoring Data

4. Emergency Preparedness

4.1 Monitoring System

Every conceivable care is taken in the design, construction and operation of the nuclear facilities to ensure that accidents will not happen. Nevertheless, there exists theoretically possible occurrence of an accident which may release fission products and other radionuclides to the environment.

From that point of view, responses to be taken in case of a nuclear emergency were standardized by the Japanese government in a "Guideline on Emergency Environmental Radiation Monitoring". Following the guideline, prefectural governments which are siting nuclear power reactors compiled a "Manual for EmergencyEnvironmental Radiation Monitoring". For example, data acquisition network, phase-to-phase responses, monitoring group, instrumentation provided in each organization and related information are presented in the manual compiled by Ibaraki Prefecture.

PNC has also been providing instrumentations and equipments for emergency monitoring. The instrumentations provided in our section are as follows ;

a) Monitoring car (Monitoring car Ⅰ & Ⅱ, Sampling car)

b) Survey meter (GM, NaI(Tl), Ionization Chamber)

c) "Survey and sampling kit" (which includes sampling equipments, maps, simplified anemometer, and other tools for emergency monitoring)

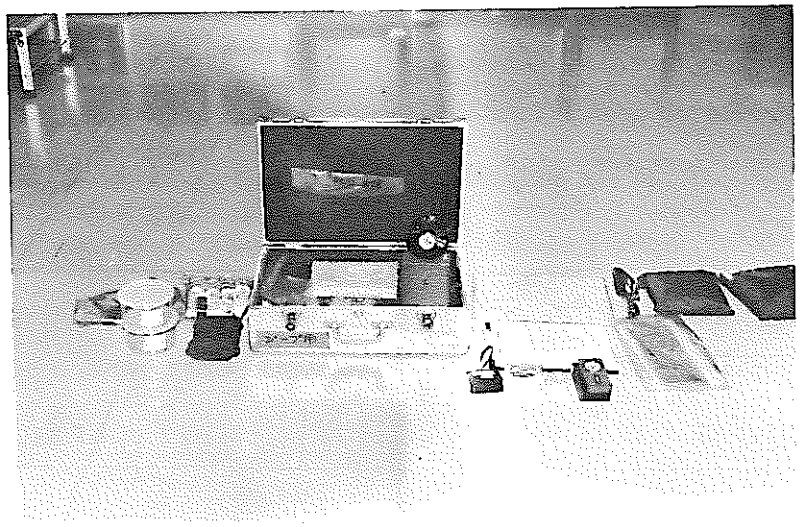
d) Instruments for radioactive measurement

e) Portable dust sampler

f) Portable electric power generator

Figures of the Monitoring Car-Ⅱ and "survey and sampling kit" are shown in Fig. 4-1.

(1) Monitoring Car- Ⅱ



(2) Survey and Sampling Kit

Fig. 4-1 Instrumentations for Emergency Preparedness

4.2 Dose Assessment System

In case of a nuclear accident, radioactive material might be released to the atmosphere. Dose assessment system, DIAMOND, which was provided in 1979, is a computerized system to visualize the result of calculation as a contour map.

DIAMOND can calculate following items ;

a) Atmospheric dispersion (DIFFS and DIFFR)

— A Gaussian plume model is applied to calculate atmospheric concentration

b) Cloud gamma dose (CLOUDS and CLOUDR)

— Point kernel integration method is applied to calculate exposure to ^{85}Kr cloud

c) Concentration of deposited activity (DEPOST)

— Dry deposition and precipitation scavenging can be considered as causes of deposition on the ground surfaces

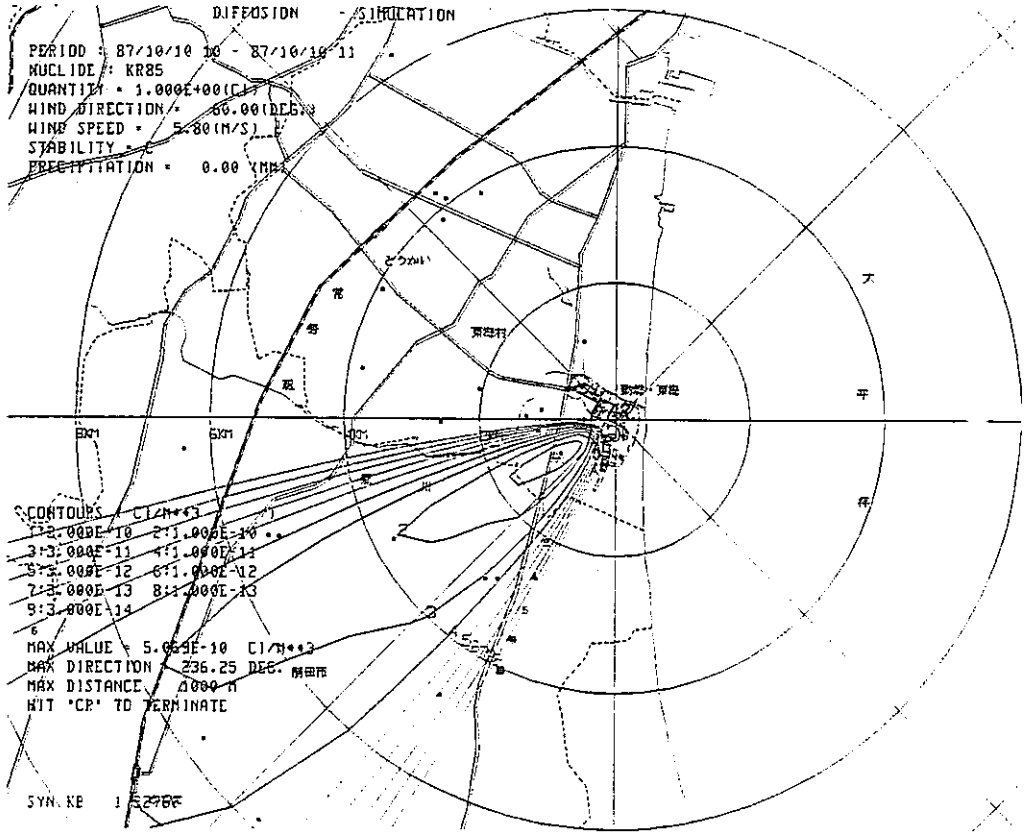
d) Inhalation dose (INHAL)

— Inhalation dose to each age group is calculated by US NRC RG 1.109 model

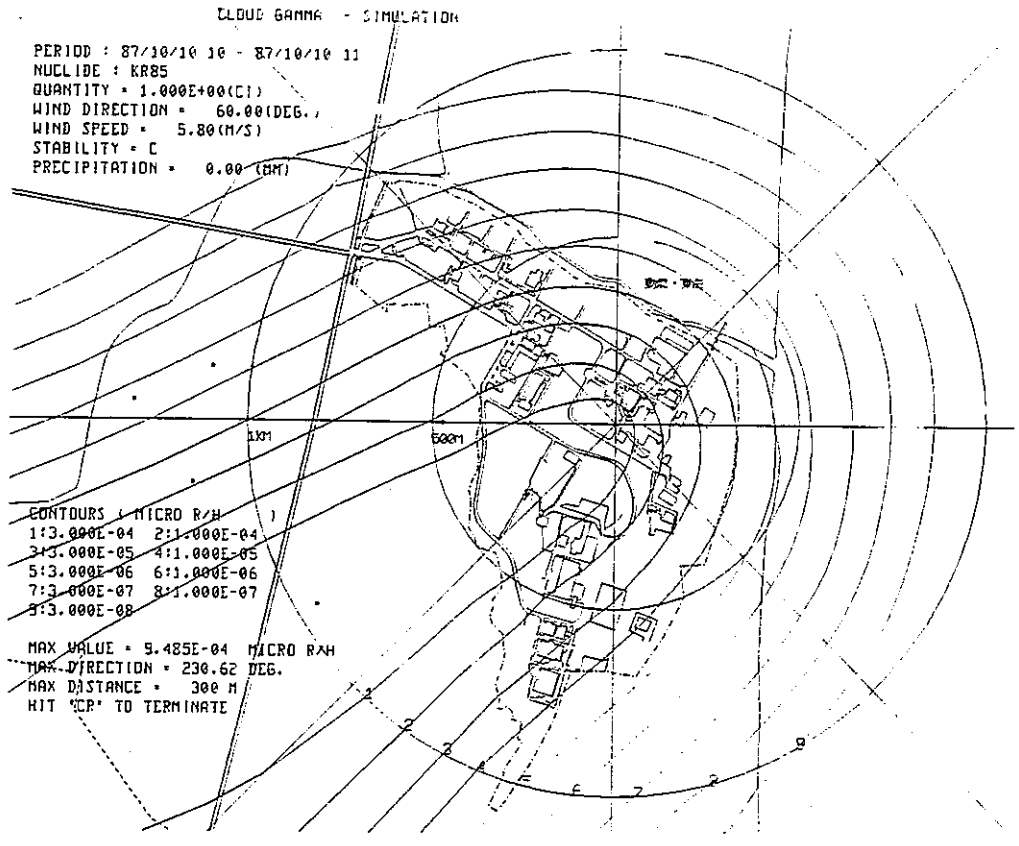
e) External exposure to contaminated ground surface (GROUND)

— External exposure to contaminated ground surface is calculated by US NRC RG 1.109 model

DIAMOND can execute on two modes ; real time and simulation modes. The realtime mode can only be applied to ^{85}Kr release and its resultant atomospheric concentration and cloud gamma dose. Under the simulation mode, parameters needed for dose assessment can be set by an operator. A typical output of DIAMOND is given in Fig. 4-2.



(1) Atomospheric Dispersion



(2) Could Gamma Dose

Fig. 4-2 Typical Output of DIAMOND

5. Environmental Research

Research on environmental transfer pathways of various radionuclides and development of dose assessment model are important for the development of fuel cycle technologies. Environmental Protection Section has been engaged in the development of analytical methods for radionuclides in the environment and development of dose assessment models applied to the Tokai Reprocessing Plant. Present environmental studies in our section are summarized as follows ;

a) Behavior of Plutonium and Americium in the Environment

— Measurement of environmental levels of Polutonium and Americium to watch long term accumulation

b) Behavior of Iodine in the Environment

— Neutron activation analysis of ^{129}I in various kinds of environmental samples to watch long term accumulation around Tokai Reprocessing Plant

— Measurement of stable iodine in various kinds of environmental samples for the study on the transfer parameters

c) Behavior of Tritium in the Environment

— Measurement of atmospheric HT and HTO.

— Development of an analytical method for Tritium in vegetation

d) Behavior of Carbon-14 in the Environment

— Development of a rapid analytical method for Carbon-14 in atmosphere and vegetation

e) Behavior of Np-237 in the Environment

— Development of an analytical method for Neptunium-237 in environmental samples

f) Behavior of Tc-99 in the Environment

— Development of an analytical method for Technetium-99 in environmental samples

g) Deposition and Resuspension of Atmospheric Radionuclides

— Study on deposition and resuspension mechanism

h) Study on Optimization of Environmental Monitoring

— Statistical approach based on the 10 years of monitoring experience

i) Mathematical Modeling of Radioactive Material Transport in Coastal Waters

— Development of mathematical model to calculate transport of radioactive materials released to coastal waters (FETRA-PNC is in pogress)

j) Study on Radiological Parameters for Marine Discharge of Radionuclides

— Study on parameters such as concentration factor and consumption rate ofmarine products

k) Development of a Computer Code Applied to the Normal Operation of the Reprocessing Plant

— Development of a computer code to calculate annunl doses due to atmospheric and oceanic releases during the normal operation of reprocessiong plant (Computer codes provided in our section are listed in Table 5-1)

1) Study on Parameters Used for Radiological Assessment

— Study on uncertainties of parameters used for radiological assessment byliterature survey and above-mentioned studies

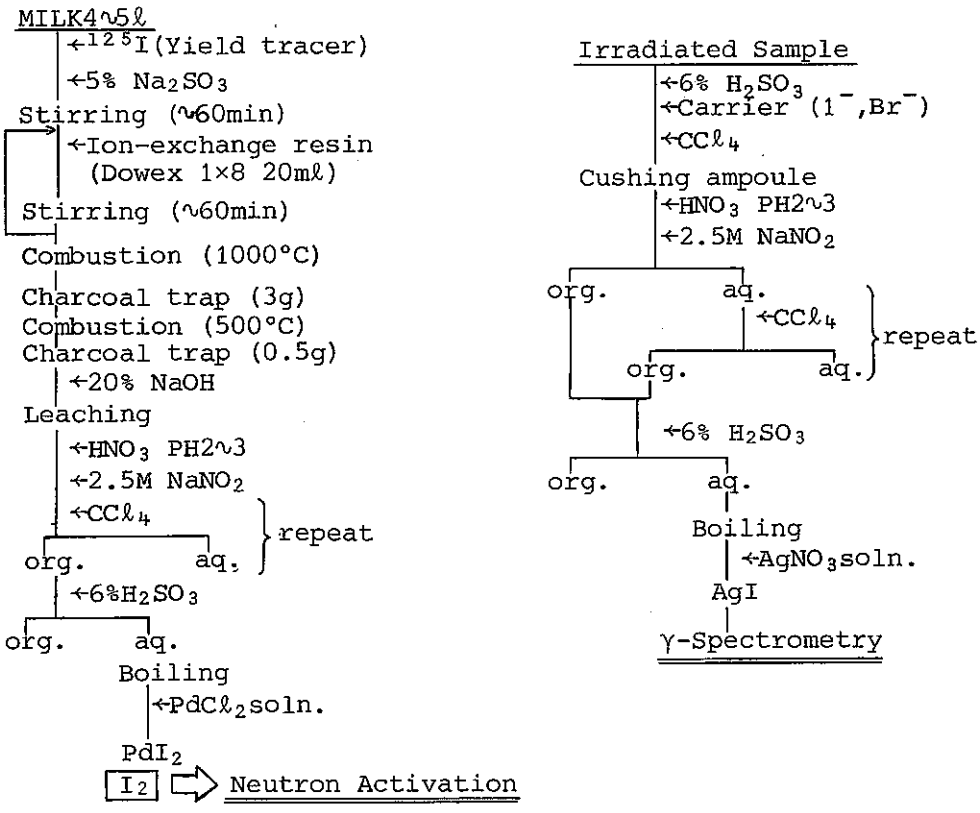


Fig. 6-1 Flow Diagram for ^{127}I and ^{129}I analysis in milk

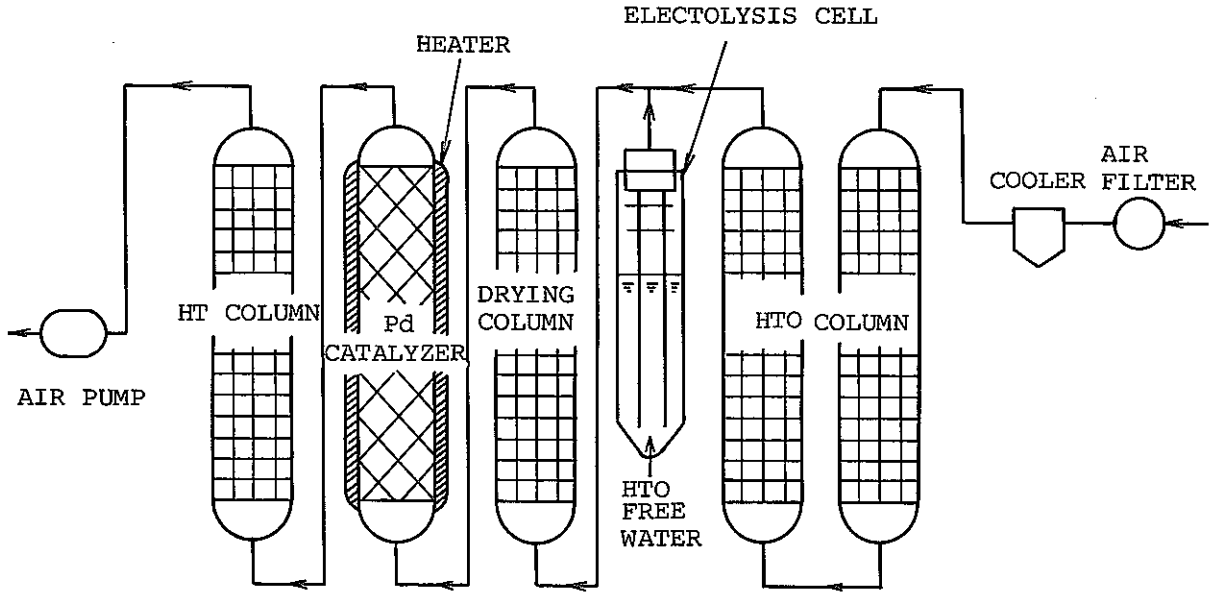


Fig. 6-2 Atmospheric HTO and HT sampler

Table 6-1 Representative Computer Codes Provided in the Environmental Protection Section

Code	Language	Developer	Atmospheric Pathway					Water Pathway				
			Concentration	Cloud Gamma	External Exposure	Inhalation	Ingestion	Concentration	Sedimentation	Ingestion	External Exposure	Dosimetry
ACRO	FORTRAN	PNC										○
AIRDOS-EPA	FORTRAN	ORNL	○		○	○	○	○		○		
ANDOSE	FORTRAN	JAERI	○	○	○	○	○	○		○		
BEACH-III	FORTRAN	PNC								○	○	
CONTE	FORTRAN	PNC	○		○	○						
FETRA-PNC	FORTRAN	PNL, PNC						○	○			
INREMII	FORTRAN	ORNL										○
KR85G	FORTRAN	PNC		○								
MARINRAD	FORTRAN	ORNL						○		○	○	
ORION-II	FORTRAN	PNC	○		○	○	○					
PLUMEX	FORTRAN	PNC	○	○								
PANDA	FORTRAN	PNC	○	○								
RADRISK	FORTRAN	ORNL										○
SPIDER	FORTRAN	PNC	○	○								

Appendix : Organization

○ Tokai Works :

- ○ Health and Safety Division
  - ○ Health Control and Medical Service Office
  - ○ Safety Training Center
- ○ Administration Division
  - ○ Technology Management Office
- ○ Engineering Technology Development Division
- ○ Plutonium Fuel Division
- ○ Conversion Technology Development Division
- ○ Uranium Enrichment Technology Development Division
- ○ Tokai Reprocessing Plant
  - ○ Co-ordination Section
  - ○ Processing Division
  - ○ Technical Service Division
- ○ Waste Management Technology Development Division

April, 1986

Fig. A-1 Organizational Chart of the Tokai Works

○ Health and Safety Division :

Director, Mutsumi KINOSHITA

Deputy Director, Yoshihisa KITAHARA

- ○ Satety Administration Section : General Manager, Aiji YAMATO
  - ・General affairs
  - ・Personal dosimetry
  - ・Licensing procedure, Quality assuarance
- ○ Radiation Control Section-Ⅰ : General Manager, Akio SEKI
  - ・Radiation control for the facilities except Tokai reprocessing plant
  - ・Caliblation of instruments
- ○ Radiation Control Section-Ⅱ : General Manager, Hideharu ISHIGURO
  - ・Radiation control for the Tokai reprocessing plant
- ○ Environmental Protection Section : General Manager, Osamu NARITA
  - Environmental Assessment Group (19 staffs including co-workers)
    Manager, Hiromi KATAGIRI
  - Environmental Observation Group (14 staffs including co-workers)
    Manager, Jun-ichiro ISHIDA
  - Effluent Control Group (13 staffs including co-workers)
    Manager, Takahisa IDESAWA
  - Reseach Group (3 staffs including co-workers)
    Tomohiro ASANO

November, 1987

Fig.A-2 Organizational Chart of the Health and Safety Division and the Environmental Protection Section

○ Environmental Monitoring

- Continuous and periodical measurement of external exposure
- Sampling of various kinds of environmental samples
- Analytical measurement of radionuclides in the environmental samples
- Development of the analytical methods for long-lived nuclides
- Meteorological observation
- Oceanic observation

○ Effluent Control

- Liquid waste Control
- Measurement of gaseous effluent filter
- Development of the analytical methods of typical radionuclides

○ Dose Assessment

- Environmental safety design of nuclear fuel cycle facilities
- Development of the safety assessment models and computer codes
- Research on environmental transfer parameters

Fig. A-3 Main activities of the Environmental Protection Section