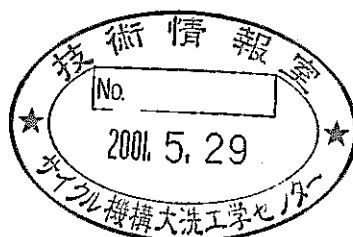


Real-time Environmental Monitoring at the Japan Nuclear Cycle Development Institute O-arai Engineering Center

Using the Internet to Promote Safety and Environmental Transparency

December 2000



O-arai Engineering Center
JAPAN NUCLEAR CYCLE DEVELOPMENT INSTITUTE

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2000

**Real-time Environmental Monitoring at the
Japan Nuclear Cycle Development Institute O-arai Engineering Center**
Using the Internet to Promote Safety and Environmental Transparency

Sheila Motomatsu* and Naoko Inoue Nakashima[◇]

Abstract

The report documents the results of an effort at the Japan Nuclear Cycle Development Institute O-arai Engineering Center (JNC/OEC) to provide via the Internet, in real-time, environmental monitoring data to promote safety and environmental transparency. Provided in Japanese as well as in English, the Internet site provides assurance that OEC nuclear operations are being conducted in a manner that is safe to both people in the surrounding area and the environment.

This work conducted by Environmental Monitoring Team of the OEC Safety Administration Section fulfilled the assignment to release data real-time via the Internet tasked by the Information Disclosure Section of the JNC Headquarters Public Relations Division. The work conducted by the visiting exchange scientist fulfilled the experimental portion of Action Sheet 34 of the Agreement between JNC and DOE for Cooperation in Research and Development Concerning Nuclear Material Control and Accounting Measures for Safeguards and Nonproliferation. In Japan, the project for Action Sheet 34 "Personnel Exchange on Remote Monitoring and Transparency" entailed both a study and an experiment on how remote monitoring technologies can be used to promote nonproliferation, environmental and safety transparency. Environmental airborne radionuclide monitoring falls under the definition of remote monitoring technology more broadly defined as "remotely accessed unattended monitoring system technology."

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核燃料サイクル開発機構大洗工学センター
リアルタイム環境モニタリングデータのインターネット公開
—安全及び環境モニタリング情報の透明性確保のためのインターネットを用いて—

(技術報告)

シーラ 元松*、中島 尚子**

要 旨

本報告書は、安全及び環境モニタリング情報の透明性の確保のために、核燃料サイクル機構(以後JNCと略す)大洗工学センター(OECと略す)が環境モニタリングデータをリアルタイムにインターネットに公開するという努力をまとめたものである。このインターネットサイトは日本語版と同様に英語版も提供しており、OECが周辺住民と環境の両方に安全な方法で、原子力施設を運転しているという安心感を与えている。

本業務はデータをリアルタイムにインターネットに公開するという課題のもと、OEC安全対策課環境監視チームによって実施され、JNC広報部情報公開課が運用するインターネット経由で公開された。本業務はJNCとDOEの、「保障措置のための核物質管理・計量手法及び核不拡散に係る研究開発協力のための協定」に基づくアクションシート34の実施のための客員研究員の協力によって実施された。日本において、アクションシート34「リモートモニタリングと透明性のための人的交流」プロジェクトはリモートモニタリング技術をどのように核不拡散や安全及び環境モニタリング情報の透明性に利用するか、ということについての研究と実験の両方を実施した。大気中放射線モニタリングはリモートモニタリング技術の定義を「モニタリングシステムに遠隔アクセスする技術」とより広義な定義に拡大した。

*シーラ 元松はJNCに派遣されたサンディア国立研究所のSenior Member of Technical Staffである。本業務は、OEC照射管理課及び安全対策課において実施した。

** 中島(井上) 尚子はJNCの環境モニタリング研究員であり、OEC安全対策課の環境監視チームの業務実施者である。本業務は、安全対策課において実施した。

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1 Environmental Monitoring at JNC/OEC

1.1 Radiation Control Area and Radiation Monitoring

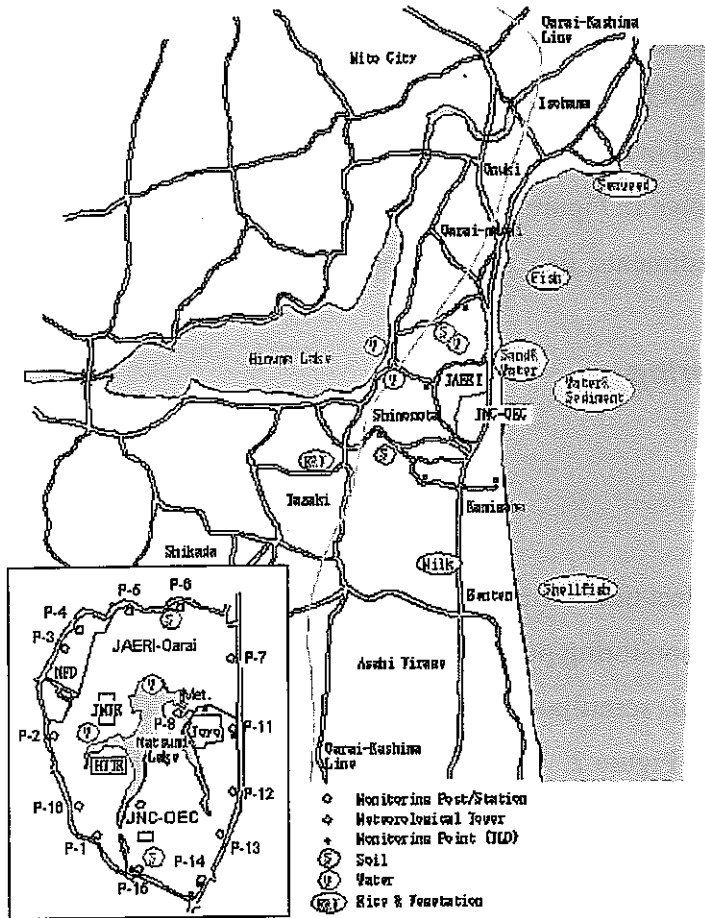


Figure 1: OEC Environmental Monitoring Area

The Japanese Nuclear Cycle Development Institute (JNC) O-arai Engineering Center (OEC) conducts environmental radiation monitoring on-site and in the surrounding area. OEC environmental radiation monitoring is conducted jointly with the Japanese Atomic Energy Research Institute (JAERI), O-arai Research Establishment that shares a common boundary with JNC OEC. A map of the JNC-OEC/JAERI-O-arai area is shown in Figure 1. The JNC-OEC/JAERI-O-arai area is a supervised area. By law, the radiation level attributed to facility activates must not exceed 1 milliSievert per year outside the boundary of this area. To ensure public safety and prove legal compliance, JNC and JAERI conduct environmental airborne radiation monitoring by collecting and analyzing data acquired from monitoring posts and other instrumentation located along the perimeter and within the supervised area (see inset in Figure 1).

In total there are 14 monitoring posts used to acquire data from this radiation control area. Six posts, posts 11 – 16 are used by JNC-OEC; eight posts, posts 1 – 8, are used by JAERI-O-arai. The monitoring posts used by JAERI-O-arai and JNC-OEC are a standard monitoring post used at nuclear facilities across Japan.

In addition to using monitoring posts, JNC-OEC gathers additional environmental airborne

radiation data on site using a monitoring station. The data acquired by monitoring stations are not required for compliance; monitoring station data is limited access data and is used for internal purposes only. To acquire data from locations away from the monitoring posts and the station, JNC-OEC uses a monitoring car; as was the case with the monitoring posts, the monitoring car has standardized instrumentation and similar monitoring cars are used across nuclear facilities in Japan. Finally JNC-OEC samples and analyzes water, soil, and vegetation for radiation at set locations on-site and in the area surrounding the site. Sampling points for water, soil, vegetables, and rice are shown in Figure 1. Radiation sampling and analysis is also conducted on marine water, marine sediments, fish, seaweed and shellfish.

1.2 Airborne Radiation Monitoring

Monitoring Post

At JNC-OEC, six monitoring posts collect time series airborne gamma radiation measurements 24 hours a day. In each standardized monitoring post are two instruments to measure airborne gamma radiation: a sodium iodide (NaI) scintillator and an ionization chamber (IC). A JNC-OEC monitoring post is shown in Figure 2. In the photo, the NaI detector is the smaller diameter instrument top of the roof on the left side, and the IC is the larger diameter instrument on the right.



Figure 2: Monitoring Post at JNC-OEC

At any one time, either the NaI or IC is operational. Under normal conditions, the NaI (range: 1×10^{-2} $\mu\text{Gy/hr}$ to 3×10^1 $\mu\text{Gy/hr}$) measures airborne gamma radiation levels. However, when radiation levels exceed 3×10^1 $\mu\text{Gy/hr}$, measurements are conducted by the IC (range: 1×10^{-2} mGy/hr to 1×10^2 mGy/hr). For the case when measurements are being acquired by the IC, the NaI resumes measurement when radiation levels decrease below a threshold of 1×10^{-2} mGy/hr .

The NaI scintillator is 2 inches high and 2 inches in diameter. The IC has a volume of 3.5 liters.

Monitoring Station

A monitoring station is generally defined as a monitoring post with additional measurement instruments, for instance, dust monitor or meteorological observation instrument. JNC-OEC has one monitoring station. It is located throughout JNC facilities; unlike monitoring post instrumentation, monitoring station instrumentation is not standardized and varies with site. Measurements conducted by the monitoring station are for internal use and are not shared.

At JNC-OEC, two types of instruments were used by the monitoring station: a dust monitor and an iodine monitor. The dust monitor had a dust filter and a GM detector, continuously monitored for total beta-gamma. The iodine monitor had a charcoal cartridge for absorb iodine and a NaI scintillator detector. The filter and charcoal cartridge were collected every week and analyzed gamma spectroscopy. At JAERI-O-arai there are two monitoring stations.

As of March 1999, at JNC-OEC, the dust monitors use germanium semiconductor detector systems. It can identify some energy peaks like as Cs-137 or Cs-134, in 24 hours. It has two sampling heads, one of them can use for weekly sampling, the other for daily sampling in case of an accident would occur. So that it would be clear when radioactive nuclides arrive from the facility that an accident occurs. And then, this is effective to advance the dispersion model.

Monitoring Point



Figure 3: OEC Monitoring Point

In addition to its monitoring posts, JNC-OEC has eleven monitoring points throughout the site and the surrounding area with thermo luminescent dosimeters (TLD). The TLDs measure the total gamma accumulated on a quarterly basis. Measurements are taken in March, June, September, and December. A monitoring point is shown in Figure 3.

Monitoring Car



Figure 4: OEC Monitoring Car

With its monitoring car, JNC-OEC has the capability to conduct airborne radiation measurements at any location and even while moving. The type of instrumentation outfitting the monitoring car is an NaI scintillator, a dust monitor, a GPS receiver and mapping system, and a data storage system. September 2000, a

new data transmission system has been placed in the monitoring car; this data transmission system is capable of transmitting data via cellular phone.

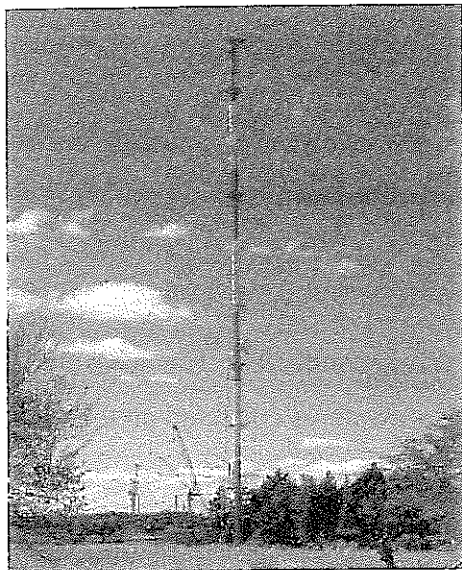
As for measurements acquired on a regular basis, the monitoring car is used twice a year in April and October to collect total gamma at twelve points and along three routes predetermined.

1.3 Meteorological Measurements

OEC also conducts meteorological measurements, an essential supplement to its airborne radiation measurements.

Located on JAERI-O-arai property, near the boundary of the JNC-OEC and JAERI-O-arai is a 90-meter meteorological observation tower pictured in Figure 5. From this tower, measurements are collected including wind direction, wind speed, and air temperature. To measure wind direction and speed there are five propeller type anemometers located on the tower: two at 80 meters, two at 40 meters, and one at 10 meters. To measure air temperature,

instruments are located at 90 meters, 40 meters, 10 meters, and 1.5 meters.



**Figure 5: JAERI O-arai
Meteorological Tower**

Solar radiation and radiation valance quantity are measured using pyranometer and net radiometer at 1.5 meters above ground.

Rainfall measurements are also acquired.

Continuous time series measurements are acquired 24 hours per day. The data is sent via buried cable to the Safety Management building at JNC-OEC where it is displayed and recorded. March 2000, this cable was replaced with Ethernet using a fiber optic cable.

1.4 Radiation Measurement through Laboratory Analysis

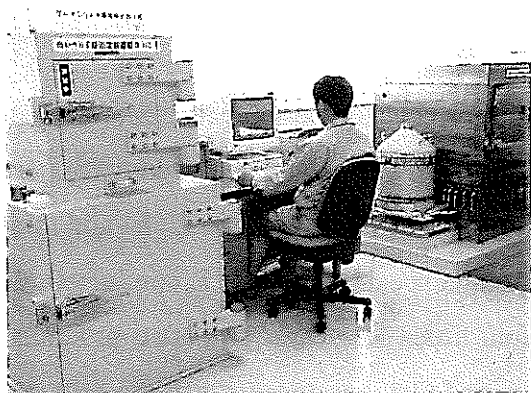


Figure 6: Laboratory Analysis

In addition to measuring airborne radiation levels, JNC-OEC measures radiation levels in environmental samples. For example, they are seawater, lake water, soil, vegetation, milk, fish, shellfish, etc. Sampling and measurement are conducted quarterly for seawater and milk, and semiannually for other samples. Though rice grain is done annually, and wastewater is weekly.

Water

Waste Water Discharge

The wastewater that is no-contaminated water, from controlled areas is released to a drain after checking the activity. JNC-OEC drains join the JAERI's drains and lead to the sea. The overflow is belongs to JAERI. The wastewater sampled at the overflow is analyzed on a weekly

basis by both of JAERI and JNC-OEC. JNC-OEC usually measures total alpha and total beta, and in case of the result is higher than usual, a gamma spectroscopy would be conducted.

The wastewater from the JAERI wastewater discharge pond is also analyzed on a weekly basis. JNC measures total alpha, total beta, and conducts a gamma spectral analysis.

Rain Water

Rainwater is checked for total beta. A gamma spectral analysis is conducted; ^3H is measured. Measurements are conducted once per month as necessary. Rainwater is collected on the roof of the JNC-OEC Safety Management building.

Fresh Water Bodies

Similar to rain water, fresh water bodies are checked for total beta and ^3H . A gamma spectral analysis is conducted. This analysis is conducted twice per year in April and October. Water is collected at Hinuma Lake, Natsumi Lake, and well water at Kitamatsugawa, O-arai town water purification facility, and the JAERI water purification facility.

Marine Water

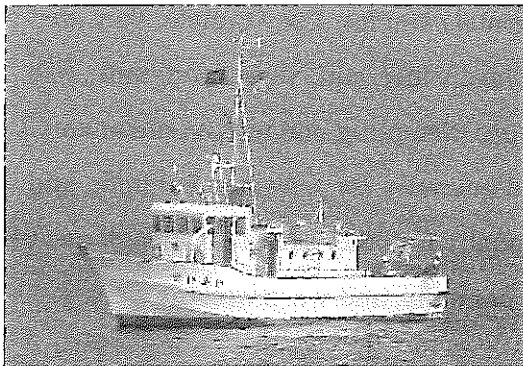


Figure 7: Marine Water Sampling

Marine water is checked periodically. Marine water is collected at two points and analyzed twice per year in April and October for total alpha and total beta. A gamma spectral analysis is conducted. In addition four times per year at two areas in January, April, July, and October, marine water is collected and analyzed for total beta; a gamma spectral analysis is conducted; ^3H is measured. ^{90}Sr is measured twice per year.

Soil

Surface Soil

Surface soil is collected and analyzed twice per year in May and November for total beta. A gamma spectral analysis is conducted. Surface soils are collected from JNC grounds, Shim-ohta, Nichuji, and from the JAERI waste treatment facility.

Seashore Sand along Waste Water Release Point

The sand from the seashore near the wastewater release point is sampled and analyzed twice a year in May and November for total beta. A gamma spectral analysis is conducted.

Fallout

Fallout is collected and a gamma spectral analysis is conducted. The fallout is collected on the roof of the JNC-OEC Safety Management building.

Marine Sediments

Marine sediments are collected and analyzed for total alpha and total beta. A gamma spectral analysis is conducted; ^{239}Pu , and ^{240}Pu are measured. Measurements are conducted twice a year in April and October using samples collected 500 meters and 5 km from shore.

Vegetation and Animal Products

Rice

Rice grain is measured once a year for total beta. A gamma spectral analysis is conducted. The rice grain is collected during harvest from a rice field in Asahi village.

Grass

Grasses or pastures for grazing animals are sampled and measured twice a year for total beta. A gamma spectral analysis is conducted. The grasses are collected during harvest season from a pasture in Asahi village.

Vegetables

Vegetables are collected and analyzed twice a year for total beta. A gamma spectral analysis is conducted. Vegetables are collected from a farm in Asahi village.

Cow's milk

Cow's milk is sampled and analyzed four times a year in April, July, October and January for total beta. A gamma spectral analysis is conducted. Cow's milk is sampled and analyzed twice a year in April and October for ^{90}Sr . Cow's

Cow's milk is collected from cows in Asahi village.

Seaweed

Two different types of seaweed are collected and analyzed twice a year during harvest for total beta. A gamma spectral analysis is conducted; measurements are made for ^{90}Sr , ^{239}Pu , and ^{240}Pu . The seaweed is collected seashore at O-arai.

Fish

Fish is harvested and analyzed twice a year for total alpha and total beta. A gamma spectral analysis is conducted; ^{90}Sr is measured. The fish are obtained from O-arai fishermen. The types of fish analyzed are sardines in addition to one of the following three – flounder, white croaker, and flat fish. They spend their lifetime in the sea near O-arai.

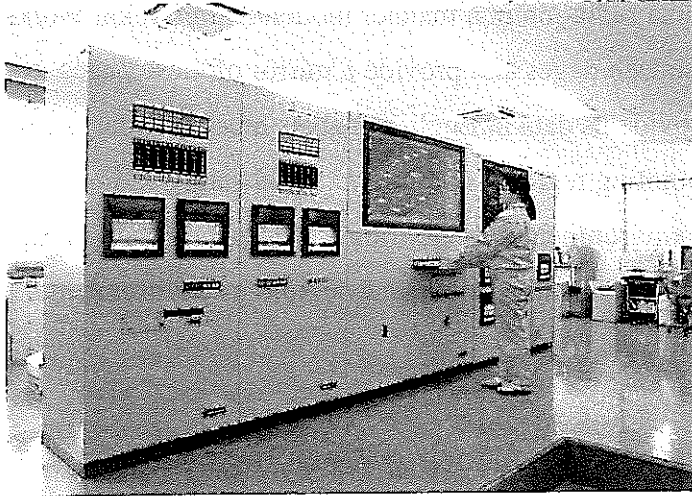
Shellfish

Shellfish are harvested and analyzed twice a year for total alpha and total beta. A gamma spectral analysis is conducted; ^{90}Sr , ^{239}Pu , and ^{240}Pu are measured. The shellfish are obtained from O-arai fishing organization. Two types of shellfish are analyzed from among the following: miniature clams, clams, ark shells and abalone.

1.5 Data Distribution to the Prefecture and Other Governmental Authorities

Continuous time series measurements from airborne radiation and meteorological data are sent via cable to data storage and analysis instrumentation located in JNC-OEC Safety Management building. The data storage instrumentation is shown in Figure 8. An analysis workstation is shown in Figure 9. From here, data is shared with various organizational entities.

JNC-OEC and JAERI-O-arai have joint ownership of the radiation monitoring area and thus mutually share data from their monitoring posts. In the past and at present JNC-OEC has sent all of its monitoring post data, i.e., data from posts 11 – 16, averaged over 1 minute to



JAERI-O-arai. In addition, JNC-OEC has provided data from post 11 and post 15 to the Science and Technology Agency (STA) Mito Office. The data shared with the STA Mito Office is averaged over 10 minutes.

In addition to sharing its airborne radiation monitoring post data, JNC-OEC has provided its meteorological 80-meter wind direction and wind speed data with the STA Mito Office. This data is provided every hour. This same meteorological data is shared with the Ibaraki Prefecture Environmental Pollution Center.

Figure 8: Environmental Data Storage

Equipment

1.6 Formal Publications

In addition to the time series radiation and meteorological data being electronically transmitted to various locations, the environmental measurements, which are obtained through laboratory sampling and analysis, e.g., radiation data on water, soil, and vegetation, are formally recorded and published. On a regular basis, the Ibaraki Prefecture Tokai Area Environmental Radiation Monitoring Committee evaluates and reports the data. Committee members include the Ibaraki prefecture Vice Governor, the leaders of relevant cities, towns, and villages, Ibaraki prefecture assembly members, and members of the academic community knowledgeable about environmental radiation monitoring. The secretary of the committee is the Ibaraki prefecture. Official announcements of the environmental radiation monitoring seasonal report are published quarterly. The reports are available at public city, town, and village locations.

2 Transparency via the Internet

In April 1999, OEC began releasing real-time airborne gamma radiation data to the public via the Internet; OEC's release of data followed that of JNC Tokai Works in October 1998. The JNC Headquarters Information Disclosure Section tasked this release of airborne radiation data.

In addition to releasing real-time gamma radiation in a manner modeled after Tokai Works, OEC decided to transcribe its Japanese web pages and provide a mirror of these pages in English. OEC's additional effort to provide its data in English enables much broader access by the international community, thus promoting regional and international safety and environmental transparency. Though environmental monitoring is well established in Japan, JNC-OEC is one of the first, if not first organization, to make available its environmental monitoring data in real-time and in English.

3 OEC Real-time Environmental Monitoring Web Pages

OEC's real time environmental monitoring data can be accessed by linking to the data from JNC's home page: <http://www.jnc.go.jp>. As mentioned previously, the information is provided in both Japanese and English. The URLs are

Japanese

http://www.jnc.go.jp/zoO-arai/Oantai_j/html/index.html for Japanese, and

English

http://www.jnc.go.jp/zoO-arai/Oantai_e/html/index.html for English.

The site is comprised of four main sections of data: current data at different sites, tabular airborne gamma radiation and meteorological data, graphical airborne gamma radiation and meteorological data, and additional information. The frequency at which data is provided differs depending upon the type of data. Total gamma, wind speed, and wind direction are updated hourly, and up to seven days of past data can be accessed. Daily temperature and precipitation are recorded on a daily basis, and again, up to seven days worth of data can be accessed. The site also provides additional information to educate the user about environmental radiation and reasonable radiation measurements.

In the following figures are examples of the type of information that can be found on the site.

4 JCO Accident

September 30, 1999, a criticality accident was occurred at JCO Company in Tokaimura. The airborne radiation monitoring post data could be shown continuously on the JNC web site (Figure 15). At this time, airborne radiation at Tokaumura was increased by the gaseous cloud

Environmental Radiation Monitoring

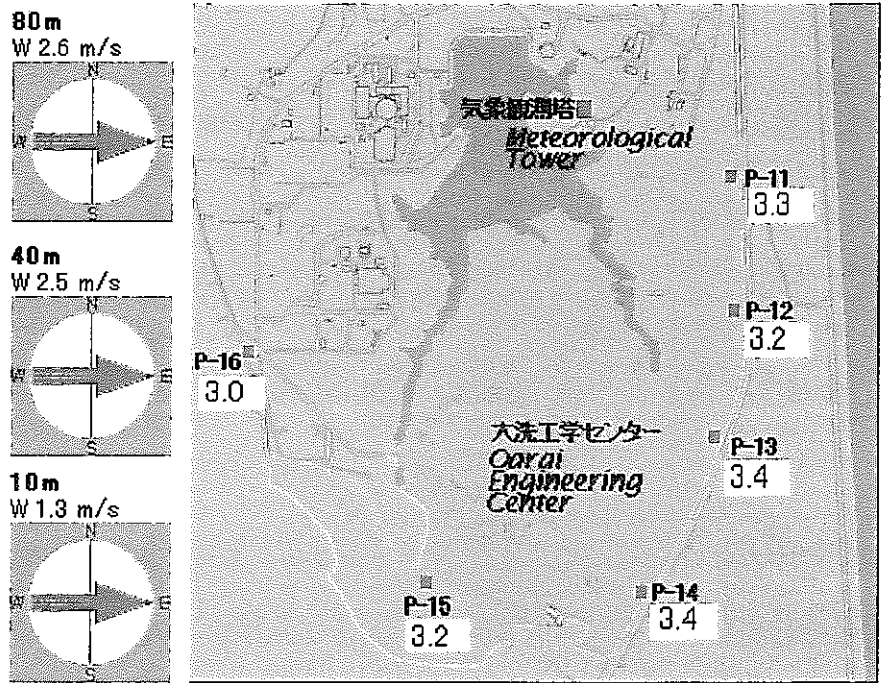
JNC [Current Data](#) [Tables](#) [Graphs](#) [Additional Information](#) [To Tokai](#)

Current Environmental Monitoring Results

2000 December 13 15:00

Environmental Gamma Radiation Levels

Unit : $\times 10^{-2} \mu\text{Gy/h}$



Meteorological Measurements

	Wind Direction	Wind Speed (m/s)	Temperature (°C)	Humidity (%)	Precipitation (mm)	Atmospheric Stability
80m	W	2.6	11.2	31.3	0.0	B
40m	W	2.5				
10m	W	1.3				

[Back](#)

Any Information or Questions to www-admin@inc.go.jp

Figure 9: Current Data

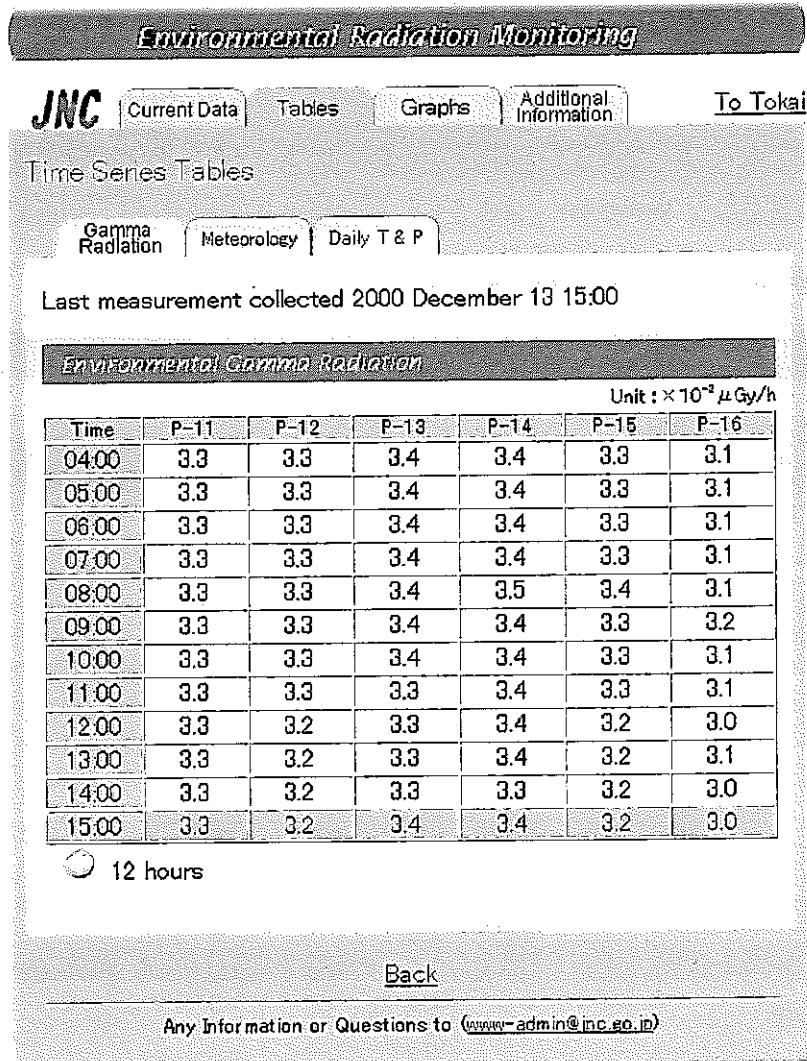


Figure 10: Gamma Radiation Data in Tabular Form

JNC [Current Data](#) [Tables](#) [Graphs](#) [Additional Information](#) [To Tokai](#)

Time Series Tables

[Gamma Radiation](#) [Meteorology](#) [Daily T & P](#)

Last measurement collected 2000 December 13 15:00

Meteorology

Time	80m		40m		10m		Temperature (°C)	Humidity (%)	Precipitation (mm)	Atmospheric Stability
	Wind Direction	Wind Speed	Wind Direction	Wind Speed	Wind Direction	Wind Speed				
04:00	NW	5.0	WNW	2.8	calm	0.3	-2.2	77.3	0.0	G
05:00	NW	3.8	NW	2.0	SW	0.6	-2.3	87.7	0.0	G
06:00	WNW	3.0	WNW	2.5	WSW	0.6	-2.7	90.9	0.0	G
07:00	NNW	3.8	NNW	3.0	WSW	0.6	-3.0	92.9	0.0	D
08:00	NW	4.8	NW	3.3	calm	0.3	-1.7	84.8	0.0	D
09:00	WNW	2.9	W	1.5	WSW	0.9	2.4	68.4	0.0	B
10:00	W	2.4	W	1.8	WSW	1.8	6.7	47.9	0.0	A-B
11:00	WNW	2.2	WNW	2.2	W	0.9	8.6	37.6	0.0	A-B
12:00	W	2.4	W	2.0	WSW	1.7	9.5	35.5	0.0	A-B
13:00	NW	2.3	NW	2.1	NNW	1.0	10.3	32.0	0.0	B
14:00	W	1.8	W	1.7	WSW	1.2	11.2	31.7	0.0	A-B
15:00	W	2.6	W	2.5	W	1.3	11.2	31.3	0.0	B

12 hours

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Any Information or Questions to www-admin@jnc.go.jp

Figure 11: Meteorological Data in Tabular Form

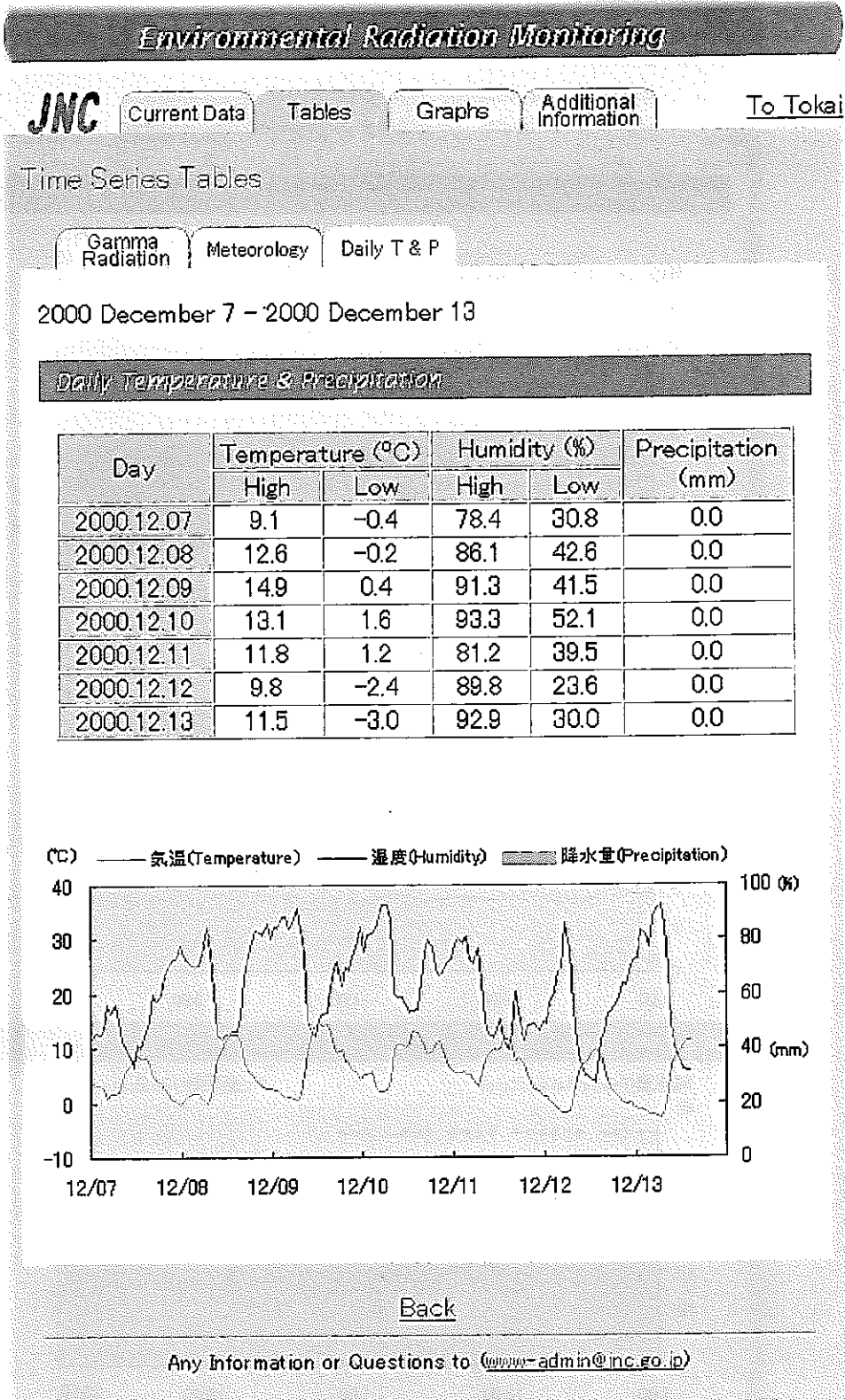


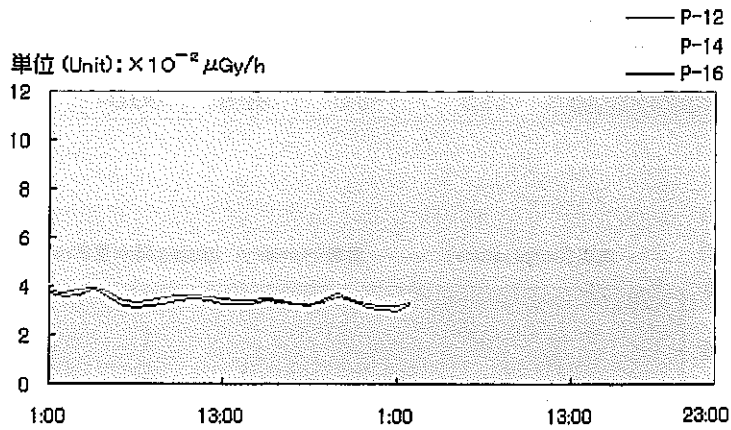
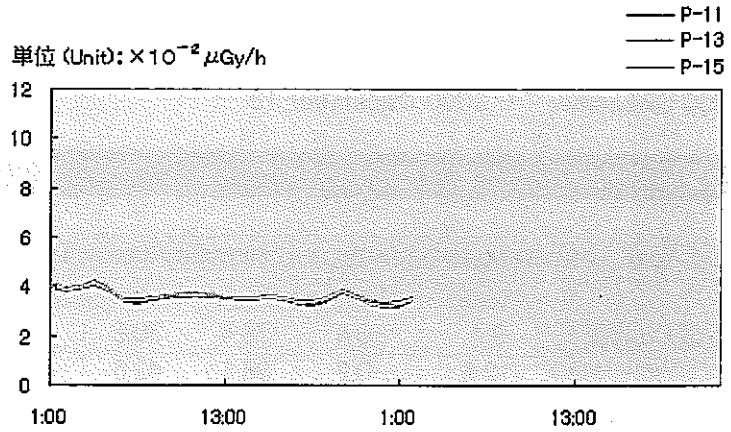
Figure 12: Temperature and Precipitation

Trend Graphs

Last measurement collected 1999 June 19 2:00

24 hours 48 hours 7 days

Gamma Radiation



Precipitation

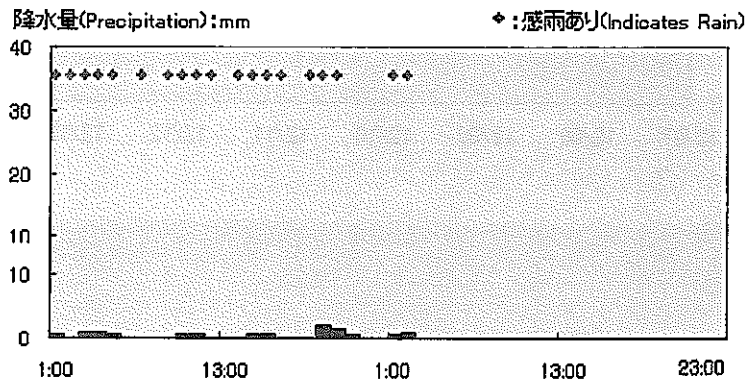


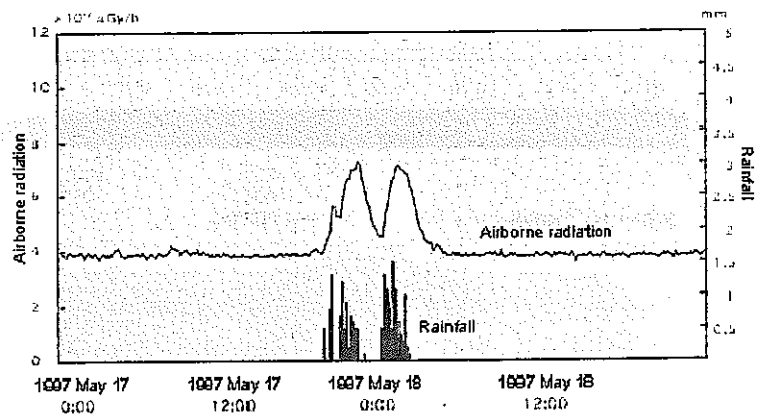
Figure 13: Gamma Radiation Data in Graphical Form

Environmental Radiation Monitoring

JNC [Current Data](#) [Tables](#) [Graphs](#) [Additional Information](#)

[Airborne Radiation](#) [Meteorology](#) [Radioactivity & Radiation](#) [Rainfall & Radiation](#) [F A Q](#)

Rainfall and Airborne Radiation



A rise in airborne gamma radiation due to rain.
 (Data acquired every 10 minutes from MP-1 around the JNC Tokai)

A temporary rise in airborne gamma radiation can be seen when it rains, this is due to radon daughter radionuclide products, which naturally occur in the atmosphere, descending to the ground with the rain.

[Back](#)

Figure 14: Additional Explanatory Information

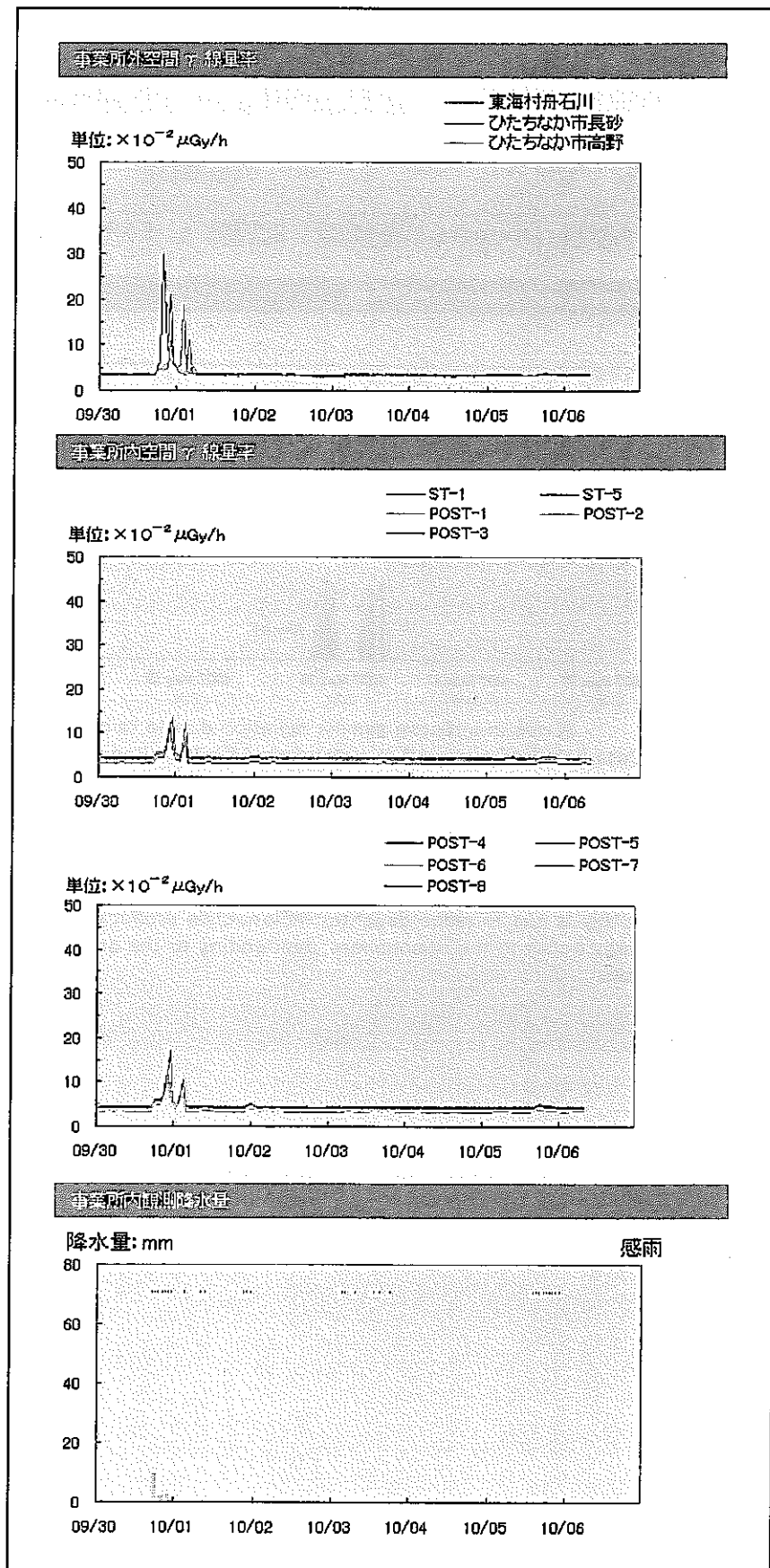


Figure 15: Gamma Radiation Data at Tokai site in JCO Criticality Accident

5 Summary

JNC-OEC has opened its real-time environmental airborne gamma radiation monitoring data and associated data and information to the Japanese public. Its proactive actions increase safety and environmental transparency to the local community and will hopefully result in alleviating any concerns about its safe and responsible operations.

Furthermore, its creation of an English web site extends transparency to the international community, thus helping build regional confidence on nuclear activities.