Attachment VI-1

SPEEDI trial estimation of total discharge of radioactive nuclides

Although accurately estimating the amount of radioactive materials discharged by the accident that occurred at Fukushima Dai-ichi NPS was still difficult, the NSC announced the estimated amounts of iodine-131 and cesium-137 discharged to the air from Fukushima Dai-ichi NPS on April 12 with assistance from the JAEA in an effort to grasp the overall picture of the accident. As the total amount of some radioactive nuclides discharged to the air from Mar 11 to April 5, estimated values of 1.5×1017Bq of iodine-131 and 1.2×1016Bq of cesium-137 (which was corrected as 1.3×1016 on May 12) was obtained.

These values were obtained by an inverse estimation method that estimates discharge rates by comparing them with values obtained by an air diffusion calculation, assuming environmental monitoring data and a unit discharge rate of 1Bq/h. Data used were measured by MEXT, JAEA, and the Japan Chemical Analysis Center. Most of the estimated values were obtained by a comparison between the concentrations of iodine-131 and cesium-137 in the air by dust sampling, and calculated values. However, regarding the discharge of nuclides during the day of March 15 when a large amount of radioactive nuclides were deposited on the earth's surface in the northwest of the NPS while it rained, the discharge rates of iodine-131 and cesium-137 during this period of time were obtained by comparing the air dose rate distributions of surface-deposited nuclides after the radioactive plume disappeared due to unavailability of dust sampling. As a result, the estimated discharge rate of iodine-131 was about 106Bq/h and the estimated discharge period was around 12:00 till 15:00 based on values such as environmental monitoring readings obtained by Fukushima prefecture. However, the conservative 6-hour discharge from 9:00 to 15:00 was assumed for estimating a total discharge because a dose increase was observed at the front gate of the plant after around 09:00 on the day. The amount of iodine-131 discharge remained in the order of magnitude of 1,014Bq/h until March 24 from March 15 when a large amount was discharged. From March 24 to early April, it reduced from the order of magnitude as 1,012Bq/h to 1,011Bq/h. The amount of cesium-137 discharged was estimated from a

comparison between dust sampling data on iodine-131 and cesium-137, and it fluctuated in a similar way to the discharge rate of iodine-131 in a comparative range of 1-100.

The amounts of iodine-131 and cesium-137 discharged to the air, which were used for a presumptive calculation, are important when peripheral exposure doses are evaluated from the occurrence to the end of the accident. These results are just of an exploratory analysis and they require further evaluation with higher accuracy through gathering knowledge from specialists of inside-facility analysis and environmental analysis.

Radioactive materials discharged into the environment after the accident include noble gases, radioactive materials discharged to the sea, and those deposited on the surfaces in the site and the soil.

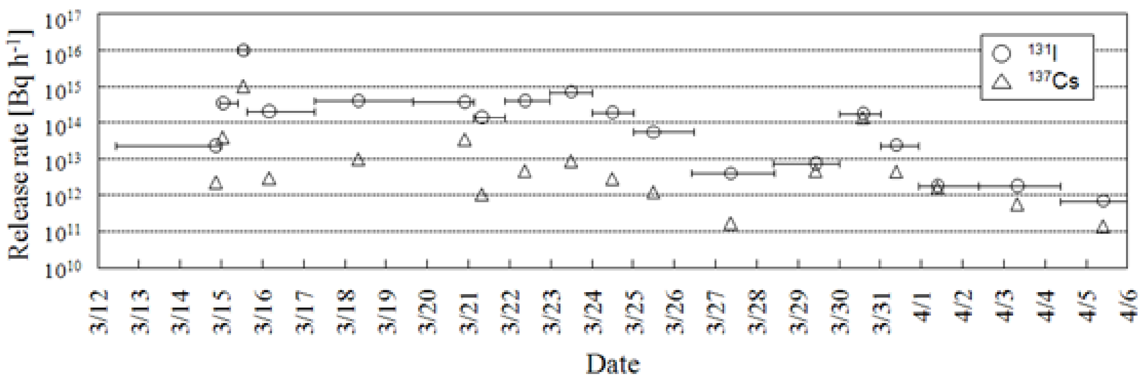


Fig. Provisional discharge rates of Iodine-131 and Cesium-137
The horizontal bar represents estimated continuing discharge time.
(Source: Material 4-2 for NSC the 31th held on May 12, 2011)

Attachment VI-2

Outflow of radioactive water off the site near water intake of Unit 2 at Fukushima Daiichi Nuclear Power Station

1. Evaluation of the fact

At around 9:30 am April 2nd, 2011, outflow was found. It had stopped at around 5:38 pm April 6th, after appropriate counter measure had being taken.

At around noon April 1st, one day before when outflow was found, it was confirmed that atmospheric dose rate near inlet canal screen was 1.5mSv/h and increase of dose rate was not observed, and also it was confirmed that no sound of outflow into sea face had been observed from the pit near the crack. Considering these two facts, it is impractical to estimate, as at the time of April 1st, the outflow had already started in a similar manner which was observed during April 2nd to 6th. However, we have no reasonable evidence to estimate when outflow has started, we have conducted our calculation based on the assumption that outflow was started on April 1st.

After outflow was found, we have been monitoring the situation by remote camera and it is detailed in this report

Stoppage work has been implemented from 3 pm April 5th, injecting "water glass" underneath of trench, and decrease of outflow was observed, however, we have conducted our calculation based on the assumption that outflow has continued as if there were no decrease of outflow due to stoppage work.

Based on above, we estimate the outflow as follows;

- Fall length (height) : 75 cm
- Flying distance : 65 cm
- Diameter of outflow : 30 mm(*)

In addition to above assumptions, we estimate about 4.3 m3/h of water have continuously flown out for 5days, from April 1st to 6th (120 hours), we calculated accumulated volume of outflow will be approximately 520 m3.

(*) By interpreting the photographs and hearing from the workers, we judged the diameter of outflow approximately 30 mm.

2. Concentration of radioactive water

Concentration of radioactive water was analyzed by using sample which

was collected at 4:30 pm, April 2nd, inlet water to screen of Unit 2 are as follows;

Concentration of radioactive substance;

Iodine 131	－	5.4×10^{6}	Beq/cm^3
Cesium 134	－	1.8×10^{6}	Beq/cm^3
Cesium 137	－	1.8×10^{6}	Beq/cm^3

3. Estimated total outflow volume

Total volume of outflow;

Iodine 131	－	2.8×10^{15}	Beq
Cesium 134	－	9.4×10^{14}	Beq
Cesium 137	－	9.4×10^{14}	Beq
(Total sum		4.7×10^{15}	Beq)

4. Estimated source of outflow

According to the result of nuclide analysis of outflow water and retained water in the pit, it has turned out the radiation are both in the same level, therefore, we estimate outflow water is same as the retained water in the pit. And as it is confirmed the pit and trench of Unit 2 is structurally connected, we consider the water has flown out from turbine building of Unit 2 through trench into the sea.

5. Countermeasure to prevent diffusion and outflow of radioactive water

(1) Countermeasure to prevent diffusion of radioactive water

In order to prevent diffusion of radioactive water, we put steel plate on the screen for inlet canal of Unit 2, where radioactive water has flown out into the sea, put silt fence across the harbor, and put large size 62 sandbags around breakwater south to the screen of Unit 4. In addition to above countermeasure, we put 10 sandbags filled with absorbent of radioactive material, zeolite, in front of each screen room of Unit 1 to 4 for the purpose of absorption of radioactive material and minimize diffusion of radioactive material to offshore. In addition, we plan to consider other countermeasure such as putting steel sheet pile or installing facility which absorb radioactive material around the breakwater south to the screen of Unit 4.

(2) Countermeasure to prevent outflow of radio active water

For the purpose of preventing outflow of radioactive water outside with absolute certainty, we transfer high radiation water into the Centralized Radiation Waste Treatment Facility and is under strict control and storage. And we also implement segregation between

trench and turbine buildings. Furthermore, in order to gain steady progress of storage and treatment of retained water, we implement plans such as installing storage tank to meet each radiation level and water treatment facilities for decontamination and salinity treatment of radioactive water.

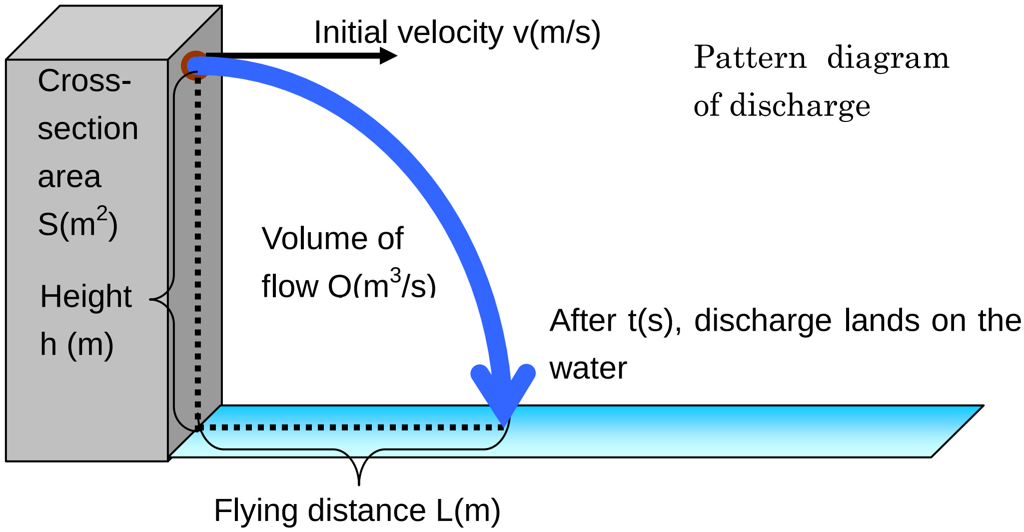
(3) Assessment of environmental impact

We will continue to monitor sea water across on and off shore with additional monitoring point and fish and shellfish to follow up the radiation level.

END

Reference 1

Evaluation method of volume of discharge



Based on the flying distance and height, assuming discharged liquid in falling motion, volume of flow is calculated as follows:

Vertical direction is free-fall motion $h = \frac{1}{2}gt^2 \Leftrightarrow t = \sqrt{\frac{2h}{g}}$

Horizontal direction is uniform motion $v = \frac{L}{t} = \frac{L}{\sqrt{\frac{2h}{g}}}$ Volume of flow $Q = Sv = \frac{SL}{\sqrt{\frac{2h}{g}}}$ …①

<Premise>

Cross-section area : S=Diameter 3cm = $7.07\times10^{-4}(m^2)$

Flying distance : L = 0.65 (m)

Height : h = 0.75 (m)

Gravity acceleration : g=9.8 (m/s^2)

By substituting premise into equation ①, volume of flow is evaluated as fallows:

$$Q = \frac{SL}{\sqrt{\frac{2h}{g}}} = \frac{7.07\times10^{-4}\times0.65}{\sqrt{\frac{2\times0.75}{9.8}}} = 1.17\times10^{-3}(m^3/s) \neq 4300(\ell/h)$$

Reference 2

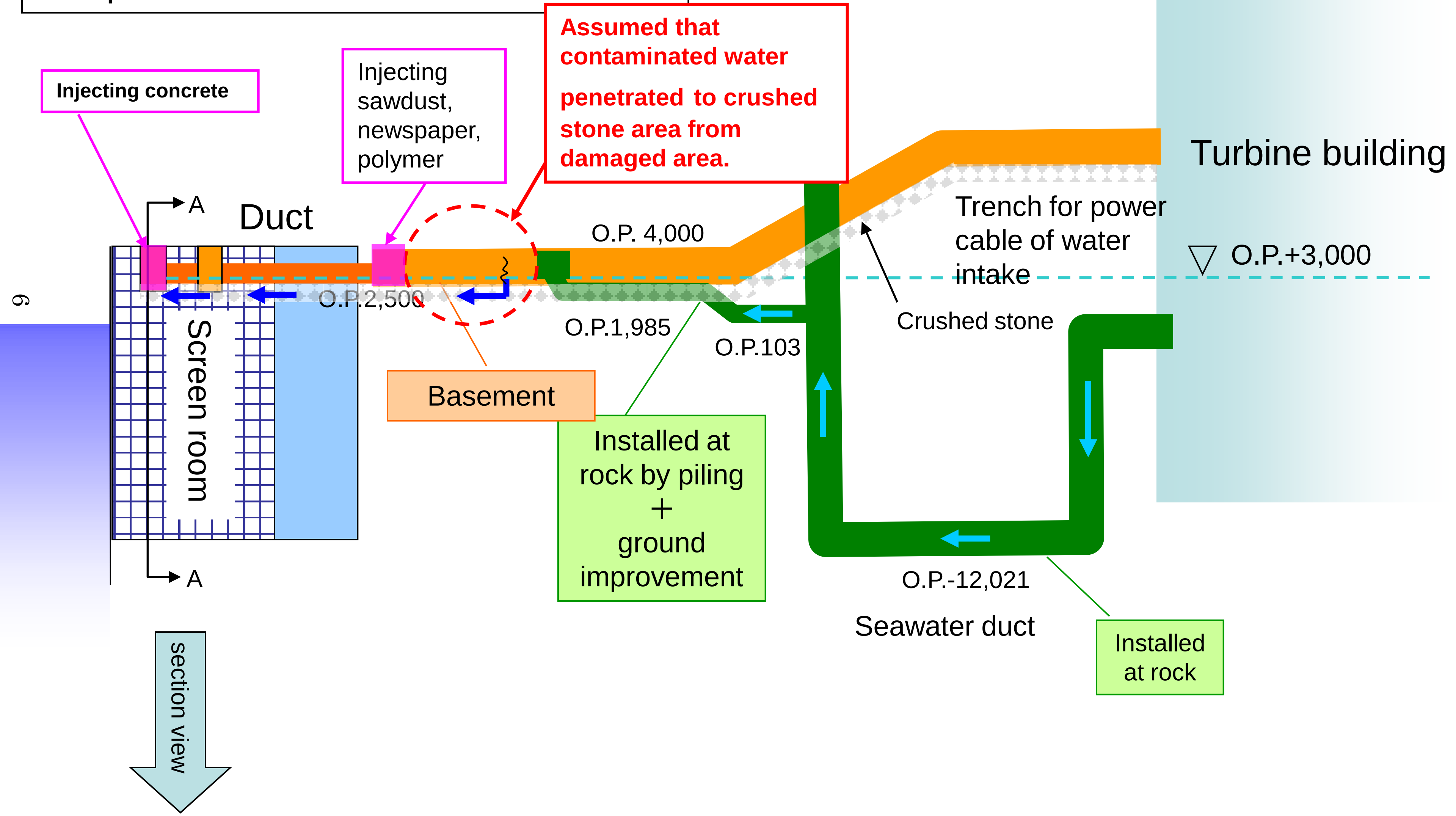
Photo（taken at approx. 2:20 pm on April 5th, 2011)

Estimated Cause

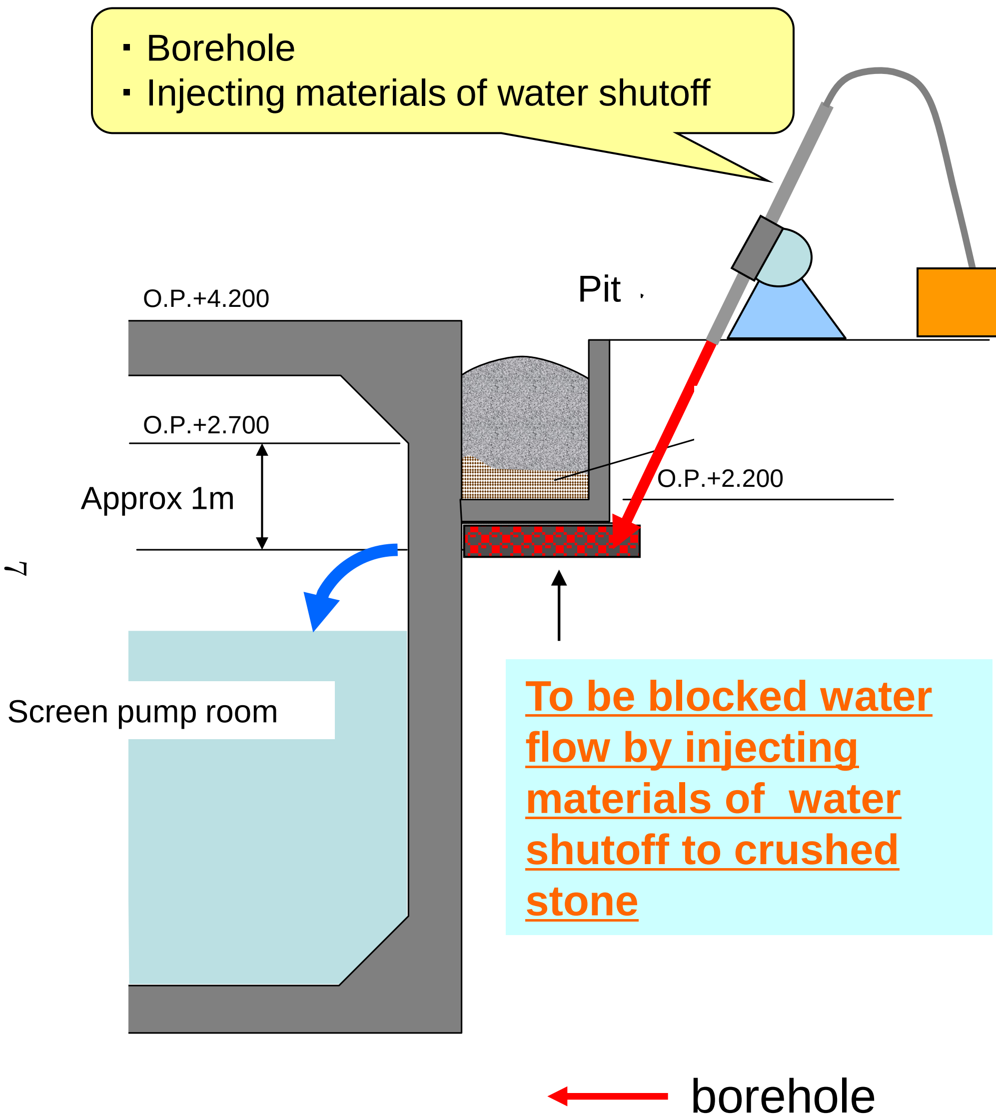
Reference 3

<Estimated cause>

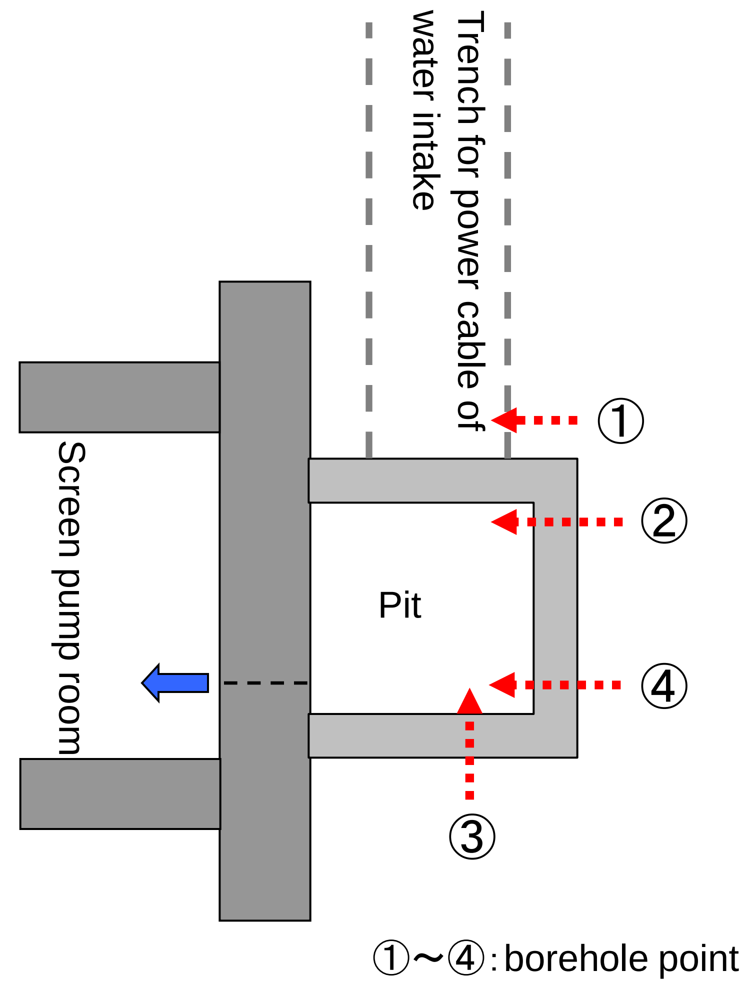
・High probability that water flowed because crushed stone area installed at the bottom of trench became water path.



Tentative planned countermeasure construction



A-A Section view



Plain view

Attachment VI-3

Outflow of radioactive water off the site near water intake of Unit 3 at Fukushima Daiichi Nuclear Power Station

1. Overview of the event

At around 12:30 pm on May 11, 2011, a worker, who was working to block the vertical shaft near the intake canal, heard the water flowing into the pit and understood the situation by opening the lid of the pit. However, at that time we were not aware of the outflow to the screen area.

Later, when we checked the site again we opened the cover hatch to the screen room and observed the inside by CCD camera. We confirmed that the water in the pit was flowing into the screen area at around 4:05pm on the same day.

Seeing that the inflow water contains highly radioactive materials, we assume that drainage water in the turbine building of Unit 3 flowed out into the power cable pit on the ocean side of the turbine building through the trench for sea water pipes, the connection point to the trench for power cables, and the duct, the connection points to the power cable pit, and ducts for electric wires, and it further flowed out into the screen area of the intake canal of Unit 3 through the penetration created on the concrete wall between the power cable pit to the north of such pit and the screen pump room.

After we confirmed the outflow from such pit into the screen area, we immediately cut the duct for the electric wires in the pit and stuffed fabrics, and blocked the pit by concrete. As a result, we confirmed by CCD camera that the outflow was stopped at 6:45pm on May 11, 2011.

2. Estimation of amount of flow

(1) Estimation of amount of flow

We estimated the amount of flow based on the observation of the status of flow into the power cable pit from ducts and into the screen area through the wall of the pit.

a. Status of flow into power cable pit

The water flew into the pit through the void part in ducts where electric wires were laid out. Based on the data (diameter of a duct: 10cm, number of

ducts: 4, and the photo of void part (taken at around 10:30am on May 11), we assumed the details of the outflow as follows – width of the flow: 6cm, drop: 1.27m, flying distance: 0.5m. As a result, the estimated amount of flow is approx. 6m^3/h (approx. 100 litters/min).

b. Status of flow into screen area from power cable pit

We observed the water flowed cylindrically into the screen area from the pit. Based on the photo taken (at around 6:30pm on May 11) after fabrics were stuffed into the duct, we assumed as follows – diameter: 5cm, drop: 1.4m, flying distance: 0.3m. The estimated amount of flow is approx. 4.3 m ^{3}/h (approx. 72 litters/min)

However, in an interview on the status of the flow into the screen area from the pit, a worker answered that the amount of flow before fabrics were stuffed into the duct was larger than that after the stuff, thus we assumed approx. 6m ^{3}/h.

(2)Duration of flow

The record of the water level in the vertical shaft at Unit 3, which is the upstream of the power cable pit where the outflow was found, shows;
from 7:00am on May 4 (o.p. +3,140mm) to 7:00am on May 10 (o.p. +3,240mm): the water level was increased by 10 to 30 mm per day, whereas
from 7:00am on May 10 to 5:00pm on May 11: the water level was decreased by 20 mm per day.
By calculating correlations using the least square method to each increase period and decrease period, we estimated that the increase turned to the decrease at 2:00am on May 10.
Based on the above, we assumed the water started to flow out at 2:00am on May 10 when the water level turned to decrease.

Separately, we conduct surveys of radioactive doses of sea water at the south of the intakes of Units 1 to 4 and near the bar screen of Unit 2 at Fukushima Daiichi Nuclear Power Station to monitor periodically the radioactive materials contained in the sea water near the intake of Unit 3. The study of the monitoring results showed that generally the doses were decreasing until 7:00am on May 10, whereas it turned to increase after 7:00am on May 11. In addition, the record of radioactive doses at the north of intakes for Units 1 to 4 which is a little to the north from the screen area of Unit 3 showed the same

trend. Judging from the above, we estimate that the outflow started at 7:00am on May 10 and we consider that the estimation of starting time based on the change of the water level in the vertical shaft is conservative.

We confirmed the outflow was stopped at 6:45pm on May 11. Therefore, we estimated that the duration of the outflow is approx 41 hours from 2:00am on May 10 to 7:00pm on May 11.

In conclusion, based on (1) and (2) above, the estimated amount of outflow is approx. $250m^3$ ($6\ m^3/h$, and lasted for 41 hours).

(3) Amount of radioactive materials flowed out

a. Radioactive dose of inflow water

The radioactive doses of the water into the power cable pit sampled at 1:30 pm on May 11 are as follows;

Cesium 137	$:3.9 \times 10^4 Bq/cm^3$
Cesium 134	$:3.7 \times 10^4 Bq/cm^3$
Iodine131	$:3.4 \times 10^3 Bq/cm^3$

We calculated the amount of radioactive materials flowed into the screen area using the amount of outflow water in (2) and radioactive doses above as follows;

Cesium 137	$:3.9 \times 10^4 Bq/cm^3 \times 250m^3 = 9.8 \times 10^{12} Bq$
Cesium 134	$:3.7 \times 10^4 Bq/cm^3 \times 250m^3 = 9.3 \times 10^{12} Bq$
Iodine 131	$:3.4 \times 10^3 Bq/cm^3 \times 250m^3 = 8.5 \times 10^{11} Bq$
Total	: $2.0 \times 10^{13} Bq$

3. Preventive measures and plans to prevent scattering to the outside of harbor

(1) Blocking pits the water might flow out from

Before May 15 we completed all the work to block the pits the radioactive water might flow out from. Furthermore, as an additional measure, we will block 27 pits which are connected to the trenches for sea water pipes by concrete etc.

(2) Isolation of screen pump rooms at Units 1 to 4
We will install waterstop etc. in front of each screen pump room until the end of June.

(3) Installation of sandbags which contains zeolite
As a first step countermeasure, we will install sandbags which contains zeolie inside the intake.

(4) Installation of circulating water purification equipment
We will install circulating water purification equipment in the screen area. By circulating the sea water in the intake, we will remove radioactive cesium (installment: by the end of May, commencement of operation: early June).

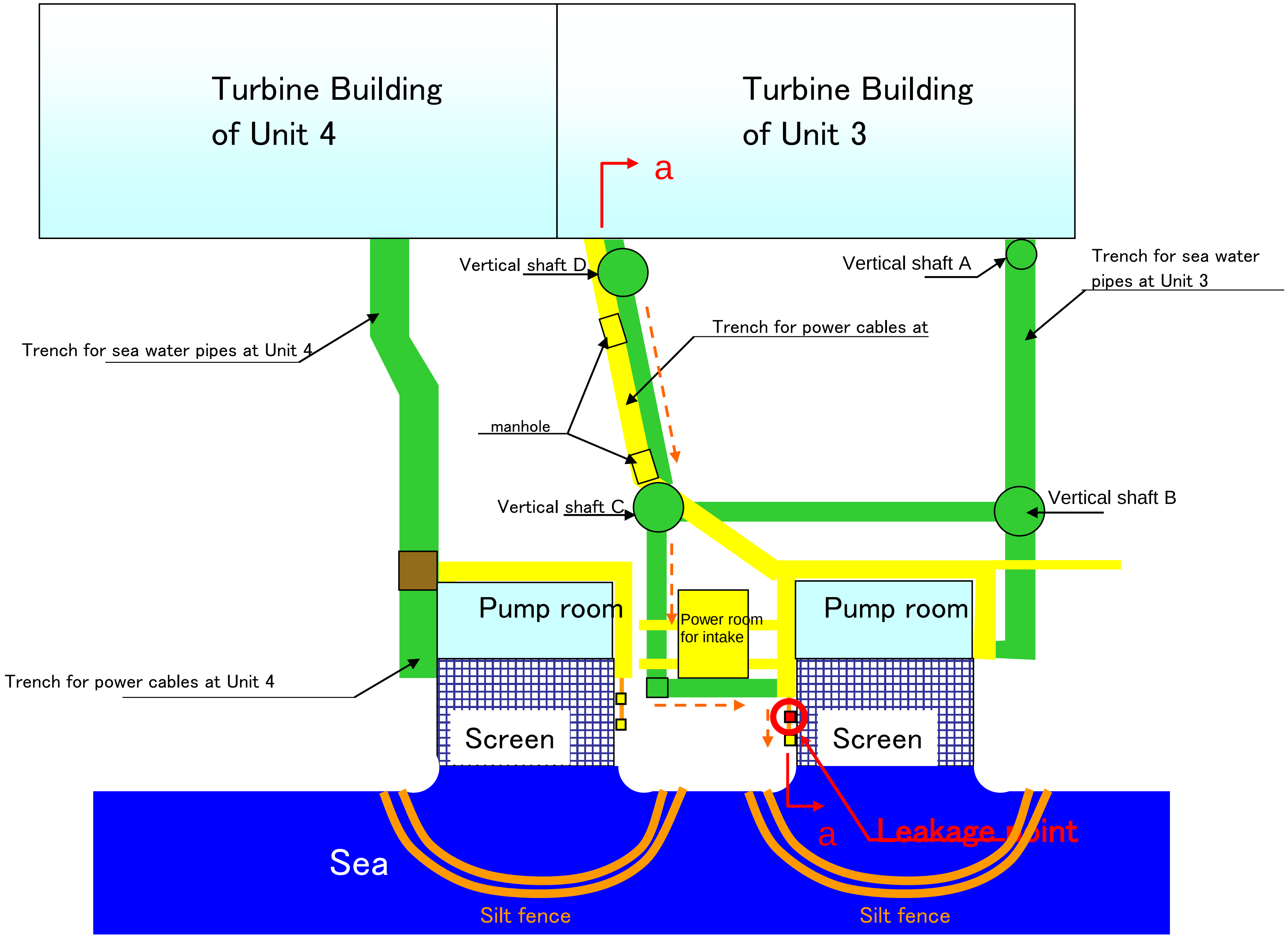
(5) Continuance and reinforcement of monitoring
We will continue monitoring of sea water inside and outside of the harbor to check whether there is any significant difference in radioactive doses.

As for Units 1, 3 and 4, we will analyze sea water inside the silt fence as we do for Unit 2, to reinforce the monitoring system.

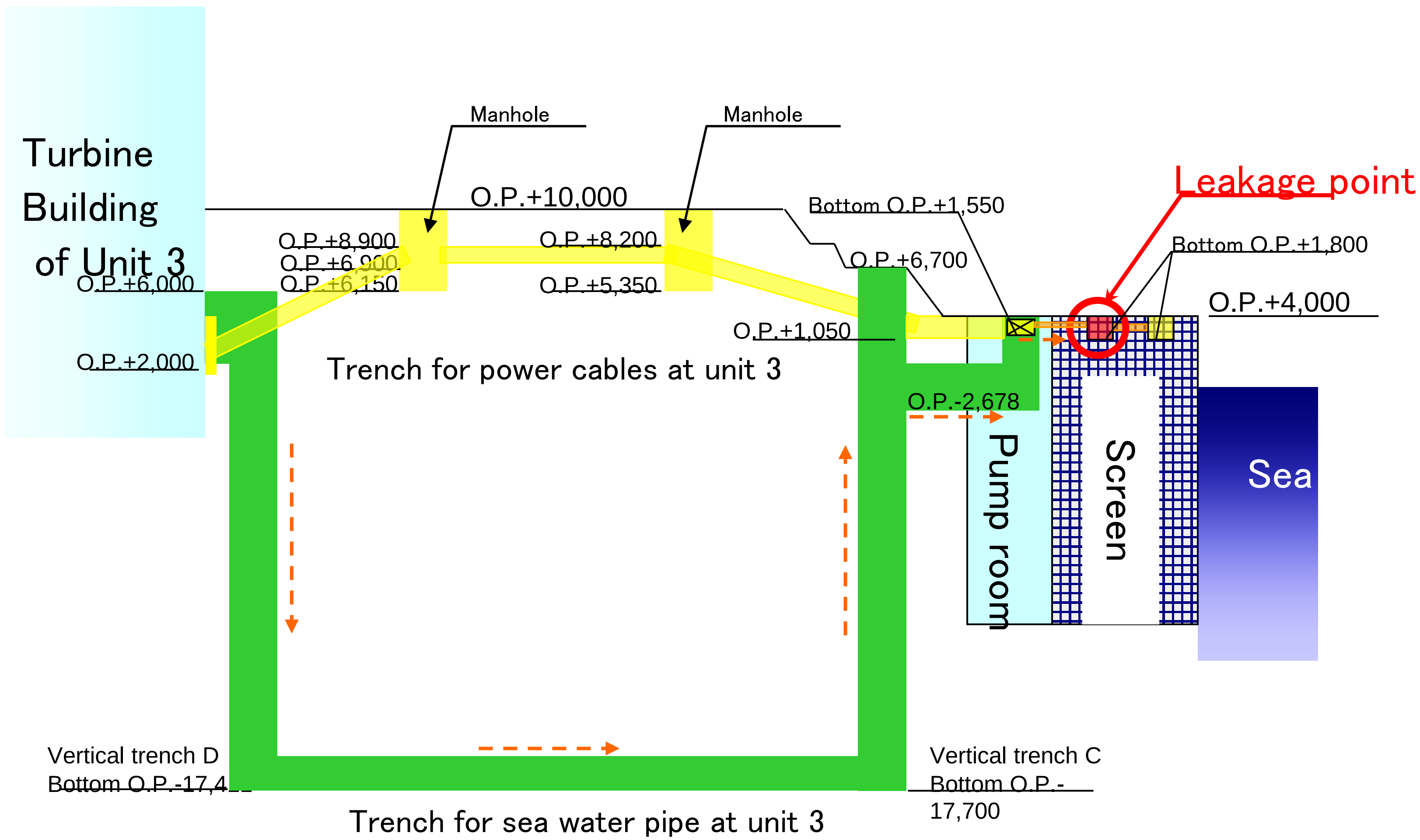
END

Trench for sea water pipes at Unit 3 (plain view)

Reference 1



Trench for sea water pipes at Unit 3 (a – a vertical cross sectional view)

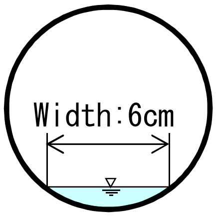


Status of outflow to near intake of Unit 3

Reference 2

【Status of flow into power cable pit】

(Enlarged view of the left photo)



Cross-sectional view of a

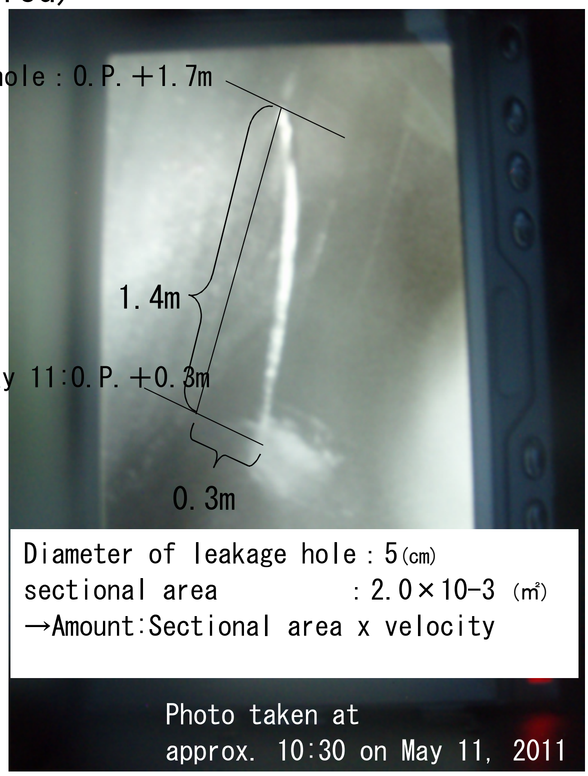
Time required to drop 1.27m:
√ { (2×1.27) /9.8} =0.51(s)
Horizontal velocity：
0.5(m)÷0.51(s)＝

Diameter of a duct：10(cm)
Width of flow ：6(cm)
Sectional area ：4.1×10-4 (㎡)
→Amount：sectional area×4 ducts×velocity
＝approx. 100(litters/min.)

【Status of flow into screen area from power cable pit】 (after fabrics were stuffed)

Height of leakage hole：O.P.＋1.7m

Height of tide at 6:30pm on May 11:O.P.＋0.3m

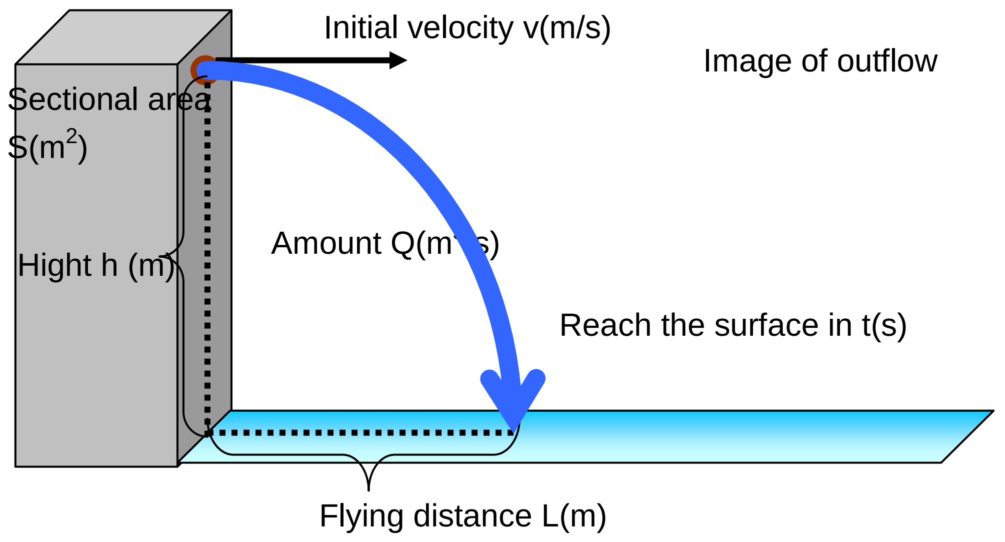


Diameter of leakage hole：5(cm)
sectional area ：2.0×10-3 (㎡)
→Amount:Sectional area x velocity

Time required to drop to the sea level:
√ { (2×1.4) /9.8} =0.55(s)
Horizontal velocity：
0.3(m)÷0.55(s)=0.6(m/s)

Reference 3

Method taken to estimate amount of flow



Assuming the flowed liquid free-falls, calculate the amount by applying the formulas below based on the flying distances and heights.

Free-fall vertically $$h=\frac{1}{2}gt^2 \Leftrightarrow t=\sqrt{\frac{2h}{g}}$$

Uniform motion horizontally $$v=\frac{L}{t}=\frac{L}{\sqrt{\frac{2h}{g}}}$$

Amount $$Q=Sv=\frac{SL}{\sqrt{\frac{2h}{g}}} \quad \cdots ①$$

＜Assumptions＞

Diameter of a duct	:10 (cm)
Width of water flow	: 6 (cm)
Sectional area of water flow in a duct	: S = 4.1×10^{-4}(m^2)
Flying distance	: L = 0.50 (m)
Height	: h = 1.27 (m)
Gravity acceleration	: g=9.8 (m/s^2)

Calculate the amount by inputting the assumptions above into formula① as follows;

$$Q=\frac{SL}{\sqrt{\frac{2h}{g}}}\times 4=\frac{4.1\times10^{-4}\times0.5}{\sqrt{\frac{2\times1.27}{9.8}}}\times 4=1.6\times10^{-3}(m^3/s)\neq 6(m^3/h)$$

Attachment VI-4

Result of discharge of low level radioactive accumulated water from Fukushima Daiichi Nuclear Power Station to the sea

There is currently great amount of radioactive wastewater in the turbine buildings of the Fukushima Daiichi Nuclear Power Station. Especially, the wastewater in Unit 2 is extremely highly radioactive.
We think it is necessary to transfer the radioactive wastewater to the Central Radioactive Waste Disposal Facility in order to store it in a stable condition. However, ten thousand ton of low level radioactive wastewater is already stored and we have to discharge the existing low level radioactive wastewater in order to receive new liquids.
In addition, as low radioactive subsurface water is piling up in sub-drain pits of Unit 5 and 6 and a part of subsurface water is running into buildings, we are concerned that important equipment to secure the safety of reactors will be submerged.
Therefore, based on the Section 1 of the Article 64 of the Nuclear Reactor Regulation Law, we have decided to discharge to the sea approximately ten thousand tons of the accumulated low level radioactive water and a total of 1,500 tons of the low level radioactive subsurface water stored in the sub drain pits of Unit 5 and 6 as soon as we got ready.

Afterwards, we were preparing to discharge the low radioactive waste water to the sea. As preparation was completed, we decided to start discharging the low radioactive waste water stored in the Central Radioactive Waste Disposal Facility to the sea at 7:00 pm on April 4th. In addition, at 9:00 pm on April 4th, we decided to start discharging the low level radioactive subsurface water stored in the sub drain pits of Unit 5 and 6 to the sea.

As to the low level radioactive wastewater stored at the Central Radioactive Waste Disposal Facility, we began discharging at 7:03PM, April 4th to the south of the water discharge channel and finished at 5:40PM, April 10th. After that, at 9:55AM, April 11th, we confirmed that the wastewater in the building had been discharged sufficiently so that the preparation work to accept high level radioactive wastewater (such as water sealing) in the building could be done.
In relation to the low level radioactive subsurface water in sub-drain pits of Units 5 and 6, we began discharging from 9 PM, April 4th via the water

discharge channel of Units 5 and 6 and finished by 6:52PM, April 9th.

In terms of the discharge of low level radioactive accumulated water to the sea, as instructed by NISA, we have been conducting ocean monitoring in a steadfast manner. We have been increasing the number of monitoring points and the frequency to investigate and confirm the influence of the dispersion of radioactive substances and have been notifying the result.
The radioactive density monitored at the measurement points including near the power station did not indicate significant fluctuation in comparison with the trend one week before the discharge.

The amount of low level radioactive wastewater discharged to the sea this time was approx 9,070 tons from the Central Radioactive Waste Disposal Facility and approx 1,323 tons from the sub-drain pits of Units 5 and 6 (Unit 5: approx 950 tons, Unit 6: approx 373 tons). The total radiation discharged was approx 1.5 x 10^{11} Bq.

With the completion of discharge, as soon as the preparation work to accept high level radioactive wastewater at the Central Radioactive Waste Disposal Facility such as water sealing is over, we will transfer the extremely highly radioactive wastewater in the turbine building of Unit 2 to the Central Radioactive Waste Disposal Facility and store under stable conditions.
Also, from now on, as to the low level radioactive subsurface water in sub-drain pits of Units 5 and 6, we will transfer to a temporary outdoor tank and consider an appropriate radiation mitigation plan.
Furthermore, we will closely monitor the evaluation result of the seawater sampling and conduct the environmental assessment.

END

Reference 1

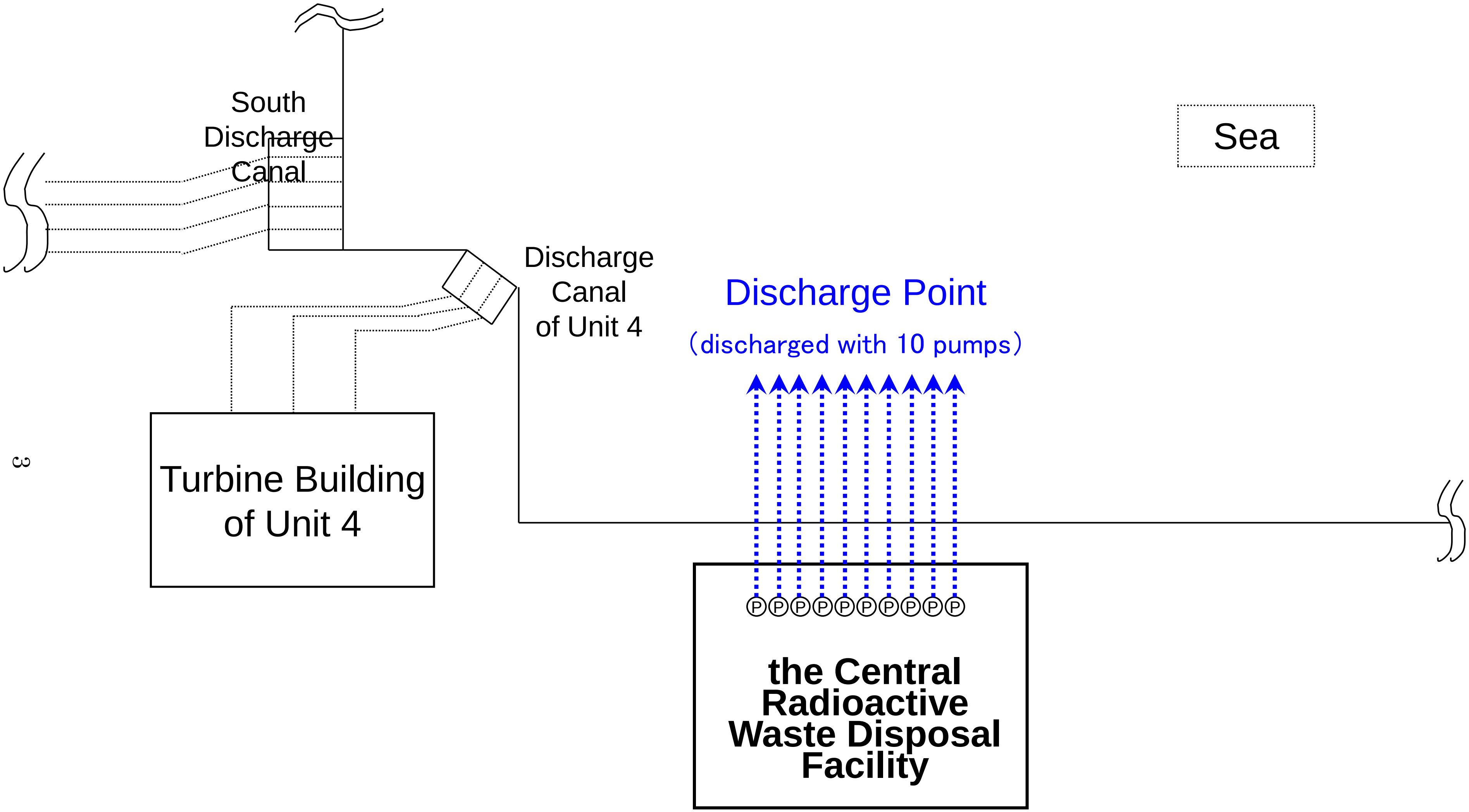
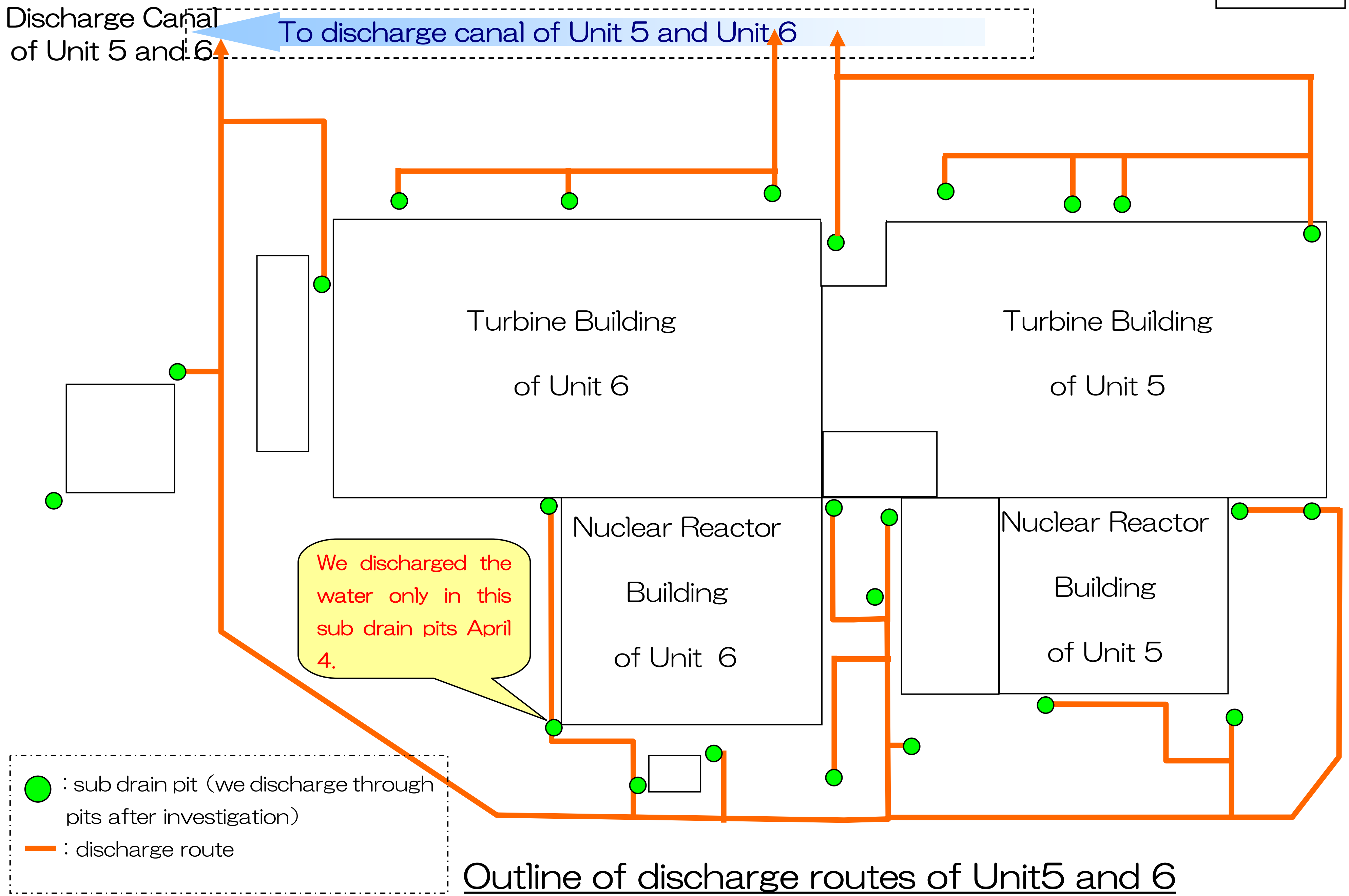


Image of discharge of the low radioactive waste water to the sea

at Fukushima Daiichi Power Station



Outline of discharge routes of Unit5 and 6

Nuclide analysis of accumulated water and sub-drain water, 1F

Reference 3

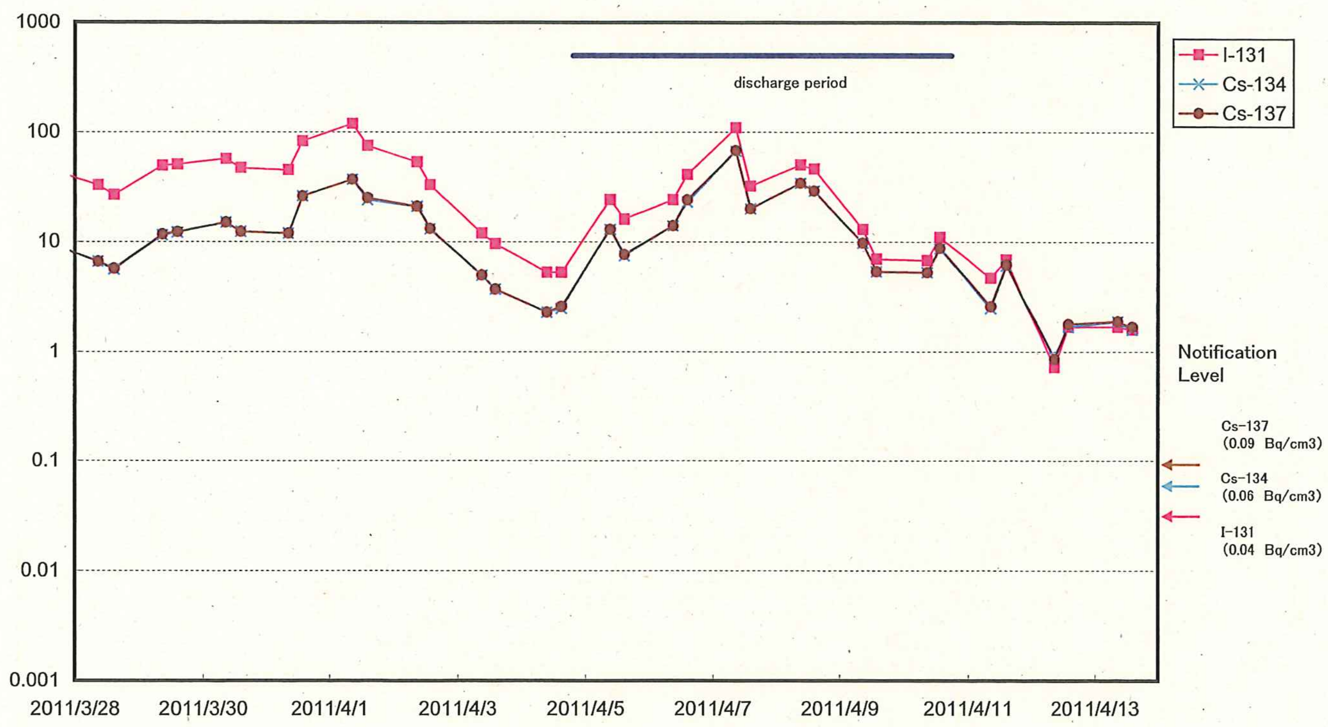
Time and Date of sample collection	15:30, Mar 28th, 2011	16:00, March 28th, 2011	10:30, March 30th, 2011	10:40, March 30th, 2011
Place of sampling	Accumulated water, Centralized Radiation Waste Treatment Facility (out of controlled area)	Accumulated water, Centralized Radiation Waste Treatment Facility (controlled area)	Sub-drain pit water, Unit 5	Sub-drain pit water, Unit 6
Detected Nuclides (Half-life)	Density of Sample (Bq/cm3)			
I-131 (approx 8 days)	6.3E+00	8.7E-01	1.6E+00	2.0E+01
Cs-134 (approx 2 years)	2.7E+00	4.4E+00	2.5E-01	4.7E+00
Cs-137 (approx 30 years)	2.8E+00	4.4E+00	2.7E-01	4.9E+00

※ ○.○E−○ means ○.○×10−○.

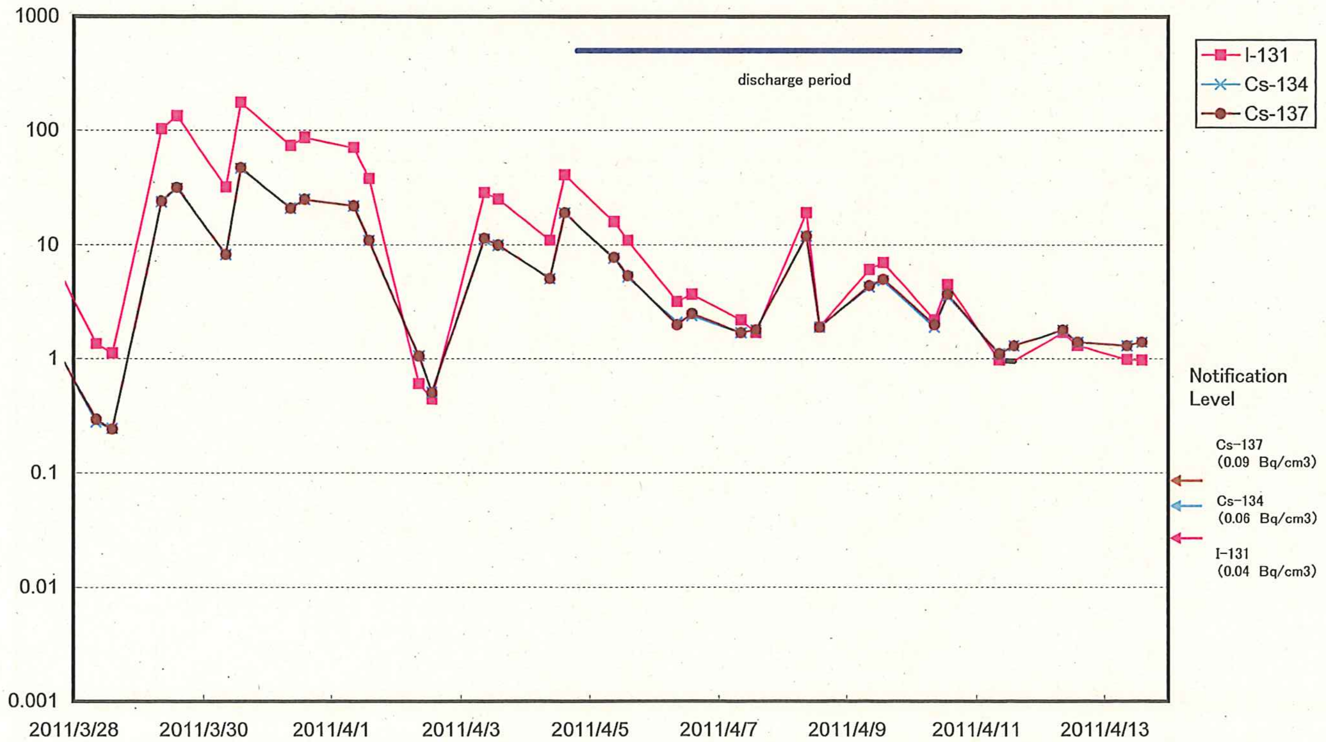
※I-131, Cs-134, Cs-137 are fixed figures. Data of other nuclides are under evaluation.

Reference 4

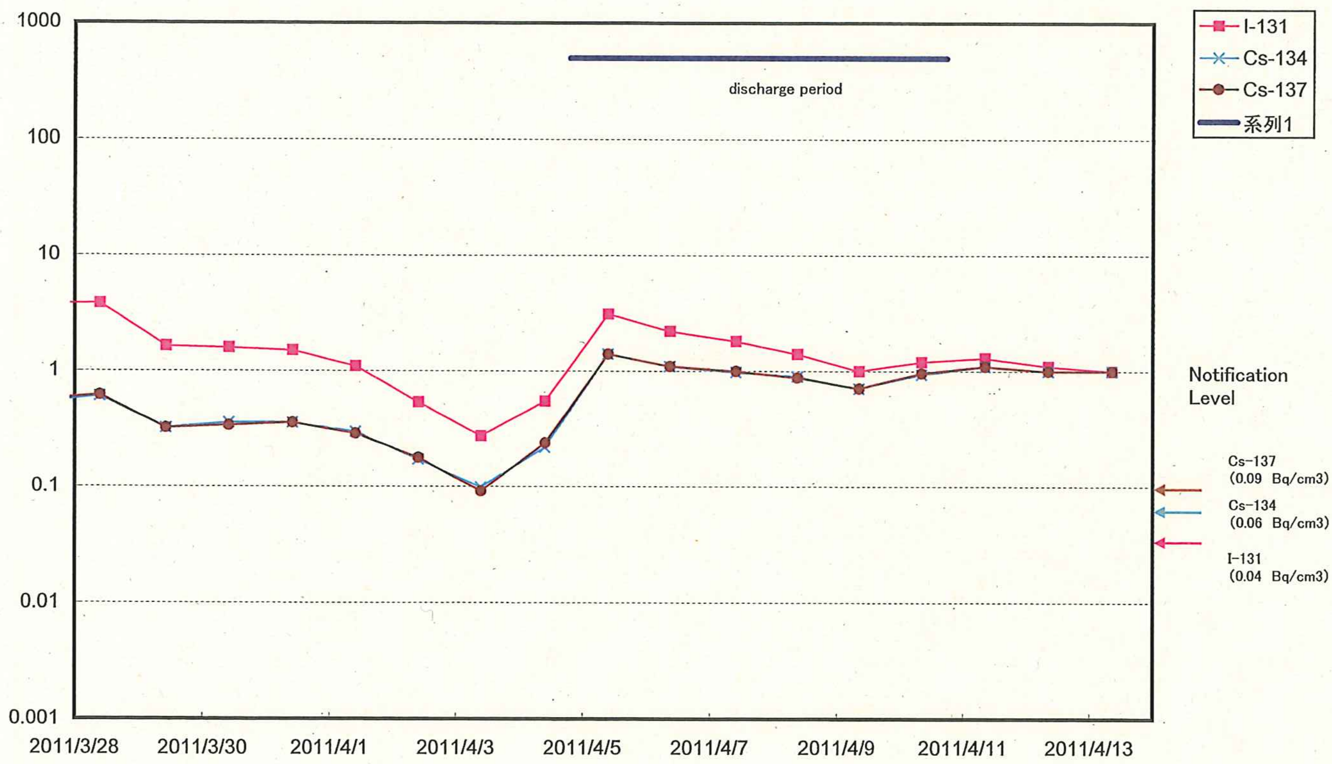
Radioactivity Concentration of Seawater at North of 1F 5 – 6 Discharge Channel (approx. 30 m north of 5–6u discharge channel) (Bq/cm3)



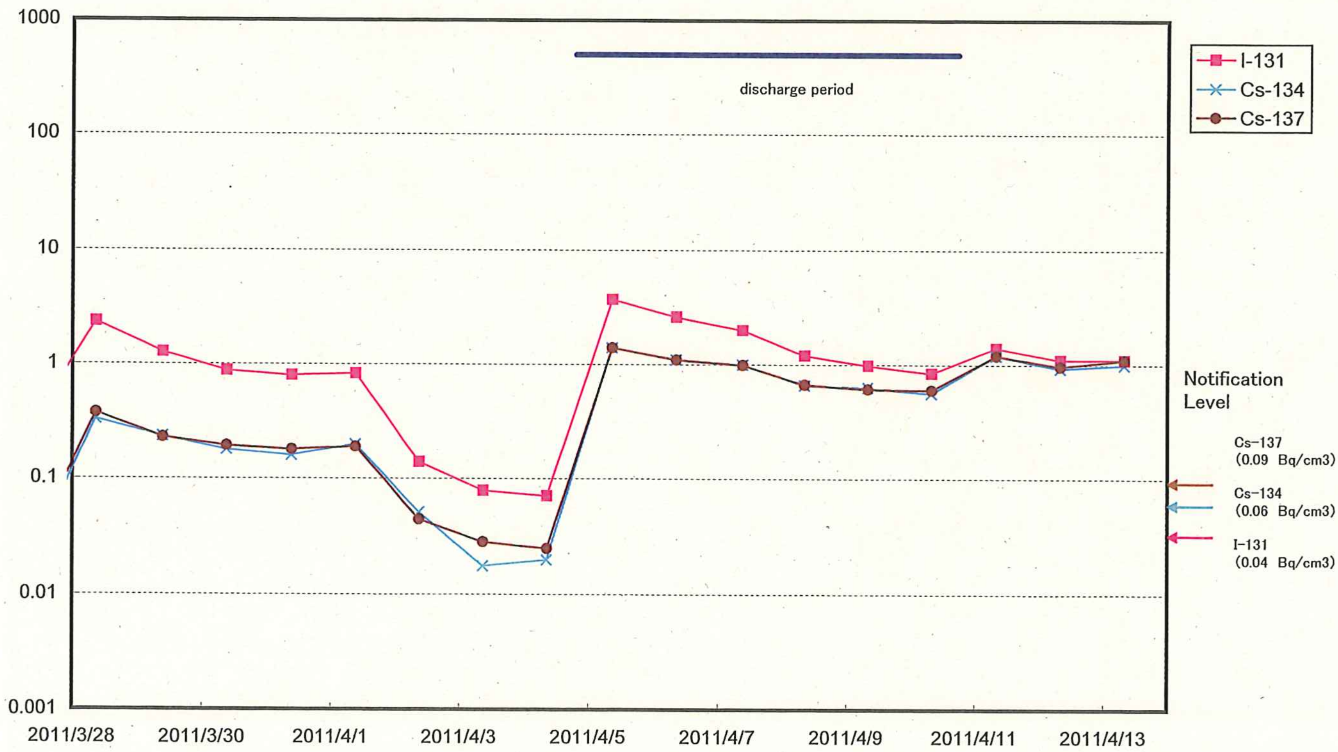
Radioactivity Concentration of Seawater at South Discharge Channel of 1F (Bq/cm3)



Radioactivity Concentration of Seawater at North Discharge Channel of 2F (Bq/cm3)



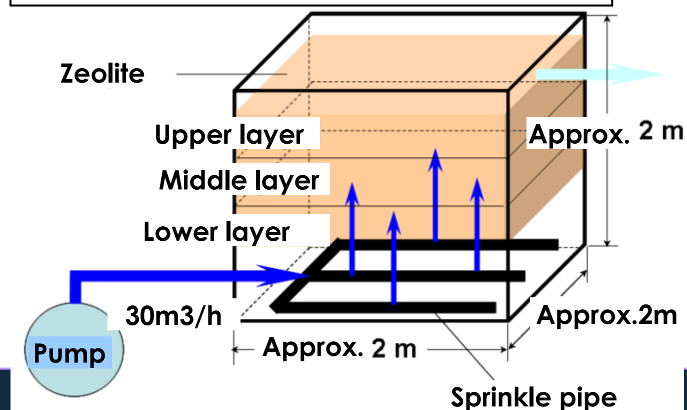
Radioactivity Concentration of Seawater at Iwasawa Shore at 2F (Bq/cm3)



Attachment VI-5
Countermeasures for preventing diffusion of liquid containing radioactive material

Sliding Timber weir

Seawater circulating filtering system



Blockage of pits, etc