Appendix

Improvement of radiation exposures by workers who exceeded the dose limit while engaging in emergency works at Fukushima Daiichi Nuclear Power Station

August 12, 2011
Tokyo Electric Power Company

As we identified that two of TEPCO workers exceeded the dose limit during emergency works, we reported the cause and measures to NISA on June 17, 2011.
In response to that, NISA indicated 8 points for improvement on July 13, 2011.
In addition to countermeasures to those 8 points, we clarified the cause and set out the recurrence prevention measures for persons exceeding the dose limit on top of two TEPCO workers reported on June 17, 2011 and reported to NISA today.
Also, we identified that a person incorrectly wore a mask at Fukushima Daiichi Nuclear Power Station on July 26, 2011. In order to prevent internal exposure, we consider that establishment of countermeasures is urgent. We compiled the cause and countermeasures. We report this together with the above.

NISA Instruction

1. To adhere to the dose limits, increase the number of persons for exposure management, expedite measurement of the effective dose of TEPCO workers and co-operating companies' workers at work at Fukushima Daiichi NPS and establish the administration system that can accurately administer the exposure dose.

Per appendix 1.

NISA Instruction

2. When working in areas with high concentrations of radioactive substances, establish the work procedures as follows: (i) determine the content of work by estimating the internal dose in advance; and (ii) check the exposure dose during work by WBC etc.

Per appendix 2.

NISA Instruction

3. Set out and implement the screening procedures in order to adequately evaluate the contamination that may cause internal exposure at areas with high level of radioactive substances.

Per appendix 3.

NISA Instruction

4. Conduct appropriate exposure administration as follows: (i) establish the administration system and secure equipments for measurement of exposure dose to administer the sum of internal exposure dose (preliminary assessment) and external exposure dose; and (ii) determine the final internal exposure dose in cooperation with specialized medical institutions.

Per appendix 4.

NISA Instruction

5. Set out the manual, educate and train in order that the instruction for usage of equipments for unforeseen circumstances, such as elevated levels of radioactive substances (full-face mask fitted with charcoal filters against radioactive iodine, iodine preparation and protective garments for high dose) is issued promptly.

Per appendix 5.

NISA Instruction

6. Consider the fitting and workability of full-face mask fitted with charcoal filters against radioactive iodine and introduce promptly.

Per appendix 6.

NISA Instruction

7. Ban food and drink at areas currently allowed to do so and future additional areas if unforeseen circumstances, such as elevation in level of radioactive substances occurs again that may cause internal dose.

Per appendix 7.

NISA Instruction

8. Ensure that the instruction under "Regarding the evaluation result of radiation administration at Fukushima Daiichi NPS and Fukushima Daini NPS (instruction)” (May 25, 2011, NISA No 1) is thoroughly adhered to.

Per appendix 8.

NISA Instruction

9. In addition to two workers TEPCO reported the cause analysis by ("Cause analysis and formulation of preventive measures of exposure dose exceeding the dose limit for radiation workers engaged in emergency work at Fukushima Daiichi NPS" June 17, 2011, nuclear admin report to the government 23 No 153), conduct the cause analysis and formulate the preventive measures for exposure dose exceeding the dose limit for other workers and report to NISA.

Per appendix 9.

Others

10. Develop and report the cause analysis and recurrence prevention measures for the oversight in attaching the charcoal filter to the full-face mask occurred at Fukushima Daiichi Nuclear Power Station on July 26, 2011

Per appendix 10.

END

Personal dose administration for restoration work of Fukushima Daiichi Nuclear Power Station

1. Preface

As to the dose administration for workers at Fukushima Daiichi Nuclear Power Station, we could not use the automatic dose administration system because of inundation and contamination by released radioactive substances. We had to do the administration manually allocating tremendous human resources. We have been gradually enhancing manpower whereas it took substantial time to confirm occurrence of excess of the dose limit.

Therefore, instead of the safety team, a temporary organization during emergency, we established Personal Dose Administration Group, Safety and Environment Department, Fukushima Daiichi Stabilization Center to bolster the administration. This Group is dedicated to personal dose administration for restoration work of Fukushima Daiichi Nuclear Power Station

2. Organization

As the personal dose administration for workers in charge of restoration work of Fukushima Daiichi Nuclear Power Station is of urgent matter, on July 1, 2011, we established a new organization "Fukushima Daiichi Stabilization Center". In this Center, we established Personal Dose Administration Group, Safety and Environment Department, dedicated to personal dose administration.

At the safety team, a temporary organization during emergency, there were several urgent works conducted at the same time. Also, the individual job allocation was unclear. At Personal Dose Administration Group, we made it clear that this group summarizes the tentative evaluation and final figures of external dose and internal dose of all persons, TEPCO workers and subcontractors, in charge of restoration works of Fukushima Daiichi Nuclear Power Station and confirms and administers that the statutory dose limit is observed.

In summarizing external dose, this Group will coordinate with (i) Radiation Safety Group (safety team) in charge of radiation administration at Fukushima Daiichi Nuclear Power Station, (ii) Radiation Protection Administration Group, Safety and Environment Department in charge of radiation administration at J-Village and (iii) Work Radiation Administration Group in charge of radiation administration at Fukushima Daiichi Stabilization Center.

We will review and allocate sufficient human resource from time to time.

3. Coordination with contractors

After the occurrence of the incident, we have been sharing info regarding adherence to statutory dose limit between members of Fukushima Daiichi Nuclear Power Station Radiation Administration Committee consisted of radiation protection supervisors of TEPCO and contractors and checking with Safety team, Head Office. In order to make this scheme more effective, Personal Dose Administration Group, Safety and Environment Department, Fukushima Daiichi Stabilization Center is obtaining exposure doses of contractors periodically, as for external exposure doses every month and as for internal exposure doses every three months, and reviewing to confirm adherence to dose limit.

Also, we decided to unify the dose administration such as discussing radiation administration matters at Safety Promotion Committee (once a week) with representatives of prime contractors. We have been implementing this since March 27.

END

Appendix 2

Administration of internal exposures at areas with high density of radioactive substances

1.Preface

One of the causes for workers to exceed the dose limit during this incident was the absence of instantaneous response to unforeseeable events such as explosion of R/B. We deliberated on an adaptive internal exposure administration to the working environment.

2.Background of deliberation

We are checking the density of radioactive substances outdoor everyday. Also, we are checking the density of radioactive substances before work in buildings with relatively higher density of radioactive substances. As such, we are conducting an organized dose administration. However, as protective garments may not be worn adequately due to interference by glasses, internal exposure dose can be ascertained only after measurement. As such, as for works at high level contaminated areas, there is a need to establish an adaptive internal exposure dose confirmation procedure to the working environment.

3.Measures

For works with the density of aerial radioactive substances exceeding below conditions, in order to confirm the internal exposure dose in expeditious manner, we measure the internal exposure dose before work. After work, we check the internal exposure dose once a week and notify the evaluation result as soon as practicable.

I-131 :1×10^{0} Bq/cm^{3}
Cs-137 :1×10^{0} Bq/cm^{3}
Cs-134 :$5\times10\text{-}^{1}$ Bq/cm^{3}

Assumptions used for the calculation is as follows:

・Work with one's mask is broken (I-131)or leaking in entirety (Cs-134, 137), inhale contaminated air and reach the record level

・leakage rate: 2.67% (I-131), 1% (Cs-137, Cs-134)
・rate of respiration: 1.20×10^{6} cm^{3}/h
・Work time: 120 minutes
・effective dose coefficient: 2.0×10^{-5}mSv/Bq(I-131)
6.7×10^{-6} mSv/Bq(Cs-137)
9.6×10^{-6} mSv/Bq(Cs-134)
・record level: 2mSv

4.Commencement of implementation

We will notify work sites and commence from August 22.

Appendix 3

Internal dose screening and evaluation procedure

1.Preface

Per “Improvement instruction regarding the exposure of radiation workers exceeding dose limit at emergency work in Fukushima Daiichi Nuclear Power Station, Tokyo Electric Power Company (instruction) (July 13, 2011 NISA No.6)”, in order to conduct the contamination check-up taking account of the path for internal dose, we set out the internal dose screening and evaluation procedures.

2.Screening standard

In addition to the existing screening procedure “Check contamination by surface contamination density survey meter. After detecting contamination from nose or mouth”, we set out as below:

Screening level:

When significant fluctuation from background radiation occurs

(The current background radiation at Main Anti-Earthquake Building is approx. 4,000cpm at 50mmφGMAD)

Assumed path	Screening method	Criteria
Oral intake of radioactive liquid such as contaminated accumulated water	Body survey of workers	Detect contamination at the top of the head
	Hearing with workers	Workers declare that getting wet with contaminated water
Radioactive substances enter the full-face mask from gaps by the temple of glasses	Body survey of workers	Detect highest contamination at temples of the full-face mask
	Visual confirmation of workers	Wear glasses
Radioactive materials leak into the mask due to inadequateness of the mask	Visual confirmation of the mask	Abnormalities such as lack of charcoal filter
Break through of the charcoal filter	Check the mask	Detect highest contamination at filters
	Hearing with workers	Work over 70 minutes at Units 1 to 4 or Centralized Rad Waste Treatment Facility
Take out the mask	Hearing with workers	Declare that a worker did not wear the mask

Others	Check the mask	Detect contamination from inside of the mask covering nose or mouth

3.Screening standard

(1) Oral intake of radioactive liquid such as contaminated accumulated water

We assume a case that a worker gets soaked with radioactive liquid and drink the liquid when that worker takes out the mask dripping to the face.

Under such circumstance, as that person gets soaked from the top of the head, it is highly likely that contamination will be detected at the top of the head.

Therefore, we determine that internal dose is possible if both of below conditions are met.

・Body survey reveals that there is contamination at the top of the head.
・A worker declares to have gotten wet with contaminated water.

(2) Radioactive substances enter the full-face mask from gaps by the temple of glasses

We assume a case that the full-face mask does not fit the face because of the temple of glasses and radioactive substances leaks into the mask from there.

Under such circumstance, as radioactive substances will pass by the temple, it is highly likely that the highest contamination will be detected at the temple.

Therefore, we determine that internal dose is possible if both of below conditions are met.

・Body survey reveals that the highest contamination is at the temple.
・The worker wears glasses.

(3) Radioactive materials leak into the mask due to inadequateness of the mask

We assume a case such as the charcoal filter of the mask is missing or there is tear in the rubber part. In that case, radioactive substances enter the mask from that part. We can visually check such cases.

Therefore, we determine that internal dose is possible if below condition is met.

・Visual confirmation of the mask reveals that the charcoal filter falls off or there is tear in the rubber part.

(4) Break through of the charcoal filter

We assume a case that break through of the charcoal filter occurs, radioactive substances are not absorbed by the filter and flows into the mask.

Under such circumstance, as radioactive substances passes through the filter, it is highly likely that the highest contamination will be detected at the filter.

Also, if the mask is worn per “Operation of masks at Fukushima Daiichi Nuclear Power Station (revision 2)” (June 23, 2011, Safety Team, Head Office), break through of the filter does not occur. As such, when the break through occurs, it is highly likely that the mask is worn over 70 minutes (maximum time allowance with less than 70% of humidity).

Therefore, we determine that internal dose is possible if both of below conditions are met.

・The highest contaminated part of the mask is the filter

・The worker declares to have worked over 70 minutes at Units 1 to 4 or Centralized Rad Waste Treatment Facility

(5) Inhalation of radioactive substances because the mask is not worn

We assume a case that a worker does not wear the mask and inhale radioactive substances.

Under such circumstance, we can identify by declaration of the worker.

Therefore, we determine that internal dose is possible if below condition is met.

・When a worker declares that he/she did not wear the mask.

(6) Others

We assume a case that radioactive substances flow into the mask by unidentifiable route.

Under such circumstance, radioactive substances may attach to the inside of the mask covering nose and mouth.

Therefore, we determine that internal dose is possible if below condition is met.

・When contamination is found inside of the mask covering nose and mouth.

4.Screening procedure at Main Anti-Earthquake Building

The current screening procedure at Main Anti-Earthquake Building is as below. This considers the route for internal exposure.

(1) Screening of workers

Surveyor will check for contamination of workers as follows:

<1>Check the entire face including the part contacting the mask. As for workers wearing full-face mask and glasses, pay close attention to contamination at the temple. If (i) contamination is found on the face with the highest at the temple or (ii) forehead, nose and mouth inside the mask, notify the head of Safety Team immediately.

<2>Check the entire body. If contamination is found at the top of the head, talk with the worker to confirm that he/she got wet by liquid. If the answer is “yes”, notify the head of Safety Team immediately.

(2) Screening of the mask

Surveyor will check for contamination of masks as follows:

<1>Check the mask for contamination. If contamination is found on the part covering nose and mouth, notify the head of Safety Team immediately.

<2>Visual inspection of masks in the vinyl bag. If the charcoal filter falls off or there is tear on rubber part, notify the head of Safety Team immediately.

(3) Hearing with workers

Surveyor will have verbal confirmation with workers as follows:

<1>Check the work site and duration. If the work site is in the buildings of Units 1 to 4 or Central Rad Waster Treatment Facility, instruct to change the charcoal filter.

<2>In case the highest contamination is found on the filter during contamination check of the mask and verbal confirmation with the worker reveal that he/she worked in the buildings of Units 1 to 4 or Central Rad Waster Treatment Facility over 70 minutes, notify the head of Safety Team immediately.

5.Actions when contamination is found by screening

Head of Safety Team instructs persons identified by screening to have WBC examination at WBC Center (if that worker is contractor’s employee, instruct the work supervisor or the radiation protection supervisor regarding WBC examination).

6.Date of commencement of this procedure

This procedure is in effect from August 12.

END

Appendix 4

Evaluation and determination of internal exposure dose

1.Preface

We considered measures to evaluate and determine the exposure dose in an expeditious manner because of the following issues:

(1)At the time of the incident, the number of available WBC was limited. Also, it took considerable time to determine the internal exposure dose because of the change of evaluation methodology such as the date of intake.

(2)As we initially did not gather correct personal identification information, we could not identify part of workers. As such, it took time to sum up the external and internal exposure dose.

2.Background of consideration

(1)Summation of external and internal exposure dose

We did not gather correct personal identification information at the time of evaluation of external and internal exposure dose. As such, it took time to sum up the figures. Also, we could not identify part of workers.

(2)Limited number of Whole Body Counter (“WBC”)

We had 4 WBCs at Fukushima Daiichi Nuclear Power Station. After the incident, we could not use these due to power loss and increase in background radiation. We placed one WBC we borrowed from Japan Atomic Energy Agency (“JAEA”) at Onahama Coal Center and measured the internal exposure dose, but the number was totally insufficient to measure all persons concerned.

(3)Establishment of evaluation methodology

At the time of the incident, we did not have the evaluation methodology for internal exposure dose because it was difficult to determine when the intake of radioactive substances occurred while high density of aerial radioactive substances continued for a prolonged duration. We modified the evaluation methodology several times. As such, it took time to notify the primary evaluation result.

3.Measures

(1)Summation of external and internal exposure dose

We are diligently processing the summation of external and internal exposure dose for workers without correct personal identification information at the initial stage by identifying individuals.

Currently, we are using Worker License with ID number.

(2)limited number of WBCs

At first, we had only one WBC. As of August 12, we have 7 WBCs so we have sufficient WBCs. From September, we are planning to conduct WBC measurement once a month.

(3)Establishment of evaluation methodology

At the time of the incident, we did not have the evaluation methodology for internal exposure dose especially when the intake of radioactive substances occurred. We have been modifying the methodology with guidance from NISA as below:

May 23: The time of intake is the middle of work period.

June 6: The time of intake is the middle of work period (if the work period begins in March and ends in April, set the end date as the end of March).

June 27: The time of intake is the first date of the work period (if that date is in March or April).
The date of intake is the middle of the work period (if the first date is in and after May and there is no change in working environment)

If there is significant time lapse after intake, I-131 with short half-life will decay and cannot be detected by WBC. As for the evaluation methodology of I-131 in such case, we cooperated with JAEA and determined as below:

(1) Evaluate by I-131/Cs-137 ratio in the environment
(2) Evaluate by MDA of I-131
* MDA: minimum detectable amount

First, by (1), we calculate the theoretical I-131 by detected Cs-137. If the result is reasonable, we use this figure as the exposure dose. If the figure per (1) is not reasonable, we use the figure by (2) as the exposure dose.

We are applying the above evaluation methodology to workers in charge at the time of the incident (from March to June). This may result in excessive evaluation result. As such, we are having more detailed evaluation to persons with the primary evaluation result of over 20mSv by Ge semiconductor detector with the cooperation with JAEA.

After July, the density of radioactive Iodine at the working environment is decreasing. If we evaluate by the above methodology (1) and (2), that would result in excessive figures. If there is no change in working environment that may cause intake of radioactive Iodine, we are not making adjustment of internal exposure by radioactive Iodine.

In the event that there is a risk to exceed the dose limit or there is enormous dose due to unforeseeable events, we will implement appropriate detailed evaluation with cooperation from medical institutions with expertise on dose evaluation. We will verify by bio assay, lung monitoring etc. including doctors’ opinion. We began doing so from August 1.

END

Appendix 5

Instruction procedure for prevention of dose intake should an unforeseeable event occur

1. Preface

At Fukushima Daiichi Nuclear Power Station, currently all areas are designated as "wear mask area" except Main Anti-Earthquake Building, each rest station and Main Control Room for Units 5 and 6 with the density of aerial radioactive substances below mask wearing threshold. In order to prevent dose intake should an unforeseeable event occur in the future, we set out the procedures to wear protective garments at Main Anti-Earthquake Building, each rest station and Main Control Room for Units 5 and 6. We also implement education and training.

2. Actual procedures

(1) Report to the headquarters

a.Report the impact of an aftershock etc

Each chief of the team, per instruction by the station chief, will check below and report in the event that a large scale aftershock occurs or certain events that may result in release of radioactive substances such as explosion of R/B or otherwise of significance.

Reporting Person	Matters
Chief, generation team	Check doors of Main Control Room, Units 5 and 6 to see whether doors are distorted
Chief, admin team	Instruct Chief, restoration team (construction) to check whether openings such as doors and windows of Main Anti-Earthquake Building and rest stations are distorted and hear the report. (if the event occurs during the night rest stations are closed , will check before using those rest stations)

b.Report the other events

Each chief of the team will report to the station chief in the event below occurs.

Reporting Person	Matters
Chief, generation team	Air conditioning system of Main Control Room, Units 5 and 6 stops and cannot resume operation.
Chief, admin team	Air extractors at Main Anti-Earthquake Building and rest stations stop and cannot resume operation.
Chief, safety team	The daily checked density of aerial radioactive substances at Main Control Room, Units 5 and 6, rest stations or Main Anti-Earthquake Building exceeds the mask wearing threshold. ※1 ※2

※1 As Main Control Room for Units 5 and 6 has air conditioning system, the frequency is once a week.

※2 When we cannot check due to loss of power, we determine that the level exceeds the mask wearing threshold.

(2) Decision to wear the mask with charcoal filter

Station chief will issue instructions to wear the mask with charcoal filter※3 immediately if above events occur.

※3 Exception is air conditioning system of Main Control Room, Units 5 and 6 or air extractors at Main Anti-Earthquake Building and rest stations stop and we do not observe increase in density of aerial radioactive substances.

(3) Decision to take iodine preparation

Chief, medical team will seek decision from a doctor (if 1F industrial physician is absent, headquarters industrial physician or other nuclear power station industrial physician) whether to take iodine preparation. If the doctor instructs to take, report to the station chief immediately. The station chief instructs to take iodine preparation immediately.

(4) Decision to evacuate to Main Anti-Earthquake Building

If the above events occur at rest stations or Main Control Room for Units 5 and 6, station chief will instruct all persons, other than plant operators, to evacuate to Main Anti-Earthquake Building immediately.

Chief, Safety team will instruct chief, generation team to have plant operators use protective devices.

(5) Delivery of instruction to rest stations etc

Chief, generation team will instruct chief operator, Main Control Room for Units

5 and 6. In turn, chief operator will instruct plant operators in Main Control Room. Chief, admin team will instruct surveyors allocated at each rest station. In turn, surveyors will instruct workers in rest stations.

3. Deployed protective devices

All persons are carrying masks with charcoal filter now. All workers can wear masks upon instruction. As for plant operators in Main Control Room for Units 5 and 6, they may need to stay with high density of aerial radioactive substances and high humidity. To be safe, we deployed 15 sets of positive pressure compressed oxygen circulating breathing apparatus (OXY GEM).

As to iodine preparation, after evacuation to Main Anti-Earthquake Building, persons to take under instruction by a doctor. As for plant operators at Main Control Room for Units 5 and 6, as they may need to stay with high density of aerial radioactive substances and high humidity, we deployed 500 tablets of iodine preparation to Main Control Room for Units 5 and 6.

4. Education and Training

In order to do above procedures without fail should an unforeseeable event occur, deputy station chief will implement below education and training.

(Education)

We will educate wearing masks and intake of iodine preparation during radiation workers education course when a person begins working at 1F.

As for radiation workers already at 1F, we will notify by intranet.

(Training)

We will, every 3 months, have trainings to wear masks assuming that an unforeseeable event occurs at one of Main Anti-Earthquake Building, rest stations, and Main Control Room for Units 5 and 6.

5. Rules when we set out without mask area

From now on, if the density of aerial radioactive substances in 1F will become lower and we set out without mask areas, we will apply the same rule as rest stations.

6.Date of commencement of this procedure

This procedure is in effect from August 12.

END

Appendix 6

Full-face mask with charcoal filter to account for radioactive iodine

1.Preface

At Fukushima Daiichi Nuclear Power Station, prevention for inhalation of radioactive substances is done by selecting masks and taking account of the density of aerial radioactive iodine at work sites.

At the time of the incident, we couldn't select and wear masks to achieve proper protection. We would like to explain the past mask selection criteria and future plan.

2.The past mask selection criteria

In power stations, we have been, from before the earthquake, using several kinds of masks such as "for dust" and "for Iodine" to account for the status of the work site. At the time of the incident, as the entire areas within Fukushima Daiichi Nuclear Power Station were with high level of radioactive Iodine, we used full-face mask with charcoal filter. This mask is negative-pressure type (inhale filtered air by one's own breathing). This does not account for temples of glasses. As such, there could have been gaps between the body of the mask and the face made by temples resulting in leakage of unfiltered air and intake of radioactive substances.

3.The status quo

Right now, at Fukushima Daiichi Nuclear Power Station, we are using full-face mask with charcoal filter, self contained breathing apparatus and powered air-purifying respirator* (from July 21) depending on the density of aerial radioactive Iodine.

* powered air-purifying respirator: This sends cleaned air after removing harmful substances by filter to the mask of the wearer by an electronic fan. This lessens the risk of radioactive substances intake and lessens a wearer's load to breathe.

* Status of deploymen: We are deploying two domestically-made models (500 sets and 1,700 sets) and one imported model (300 sets).

The number is sufficient for now but we will add more to account for the work.

4.Future plan

We will consider two measures below:

(1)Selection of masks that lessens the risk of intake if there are gaps at the temple of glasses

(2)Proper use of masks in order to avoid gaps

(1) Selection

Powered air-purifying respirator currently in use makes inside the nose cap (the part covering nose and mouth) positive pressure. This lessens the risk of intake by breathing.

By using this mask, the risk of intake at places with high density of radioactive Iodine will be lower.

We are considering to introduce a hooded mask with charcoal filter. This also sends purified air inside the mask and lessens the risk of intake. We are planning to introduce as soon as possible (we are planning to deploy too sets of domestically-made model in August).

(2) Proper use

The current full-face mask with charcoal filter has sufficient capacity if worn properly.

However, the risk of intake of radioactive substances while mask is worn largely depends on the fitting between the mask and face.

We have been instructing and drawing attention to the proper use of masks at radiation protection education. From now on, in addition, we will utilize “mask fitting check, instruction” by each mask manufacturer so that individuals worker can make improvement in wearing masks properly and reduce the risk of intake of radioactive substances.

END

Appendix 7

Prohibition of food and drink in the event that the density of radioactive substances increases again

1.Preface

Per "Improvement instruction regarding the exposure of radiation workers exceeding dose limit at emergency work in Fukushima Daiichi Nuclear Power Station (instruction)" (July 12, 2011 nuclear number 6), this sets out the procedure for prohibition of food and drink in the event that an unforeseeable event such as the density of radioactive substances increases again.

2.Procedure for prohibition

(1) Measurement of surface contamination level, atmospheric dose rate and the density of aerial radioactive substances

Chief, safety team, periodically (once a week) checks surface contamination level, atmospheric dose rate and the density of aerial radioactive substances at rest stations, Main Anti-Earthquake Building and Main Control Room for Units 5 and 6 (Endeavors to collect information from each team to account for an unforeseeable event that results in increase of surface contamination level, atmospheric dose rate and the density of aerial radioactive substance. If there is a risk of increase, check every time.)

If the level violates below standard, immediately terminate use of rest stations. As for Main Anti-Earthquake Building and Main Control Room for Units 5 and 6, instruct to wear masks and prohibit food and drink.

	Standard	Note
Surface contamination level	As for places persons may touch such as floor and wall, to remain equal to or lower than the initial surface contamination level	If the level becomes higher, clean and satisfy the standard.
Atmospheric dose rate	Equal to or below 50μSv/h	Target: equal to or below 10μSv/h
the density of aerial radioactive substances	The density of all nuclides detected (other than natural radioactive substances) are below 1×10^{-4} Bq/cm^3	Even the density is within standard, change filters as a prevention measure on below cases. • At atmospheric dose rate measurement, local air extractor is the factor for increase of atmospheric dose rate. • The density of aerial radioactive substances is showing rapid increase and it is easily foreseeable that the standard will be violated

(2) Report to station chief

If the above standards are violated, chief, safety team will report to station chief immediately regarding termination of use of use of rest stations and prohibition of food and drink.

3.Notification to persons concerned

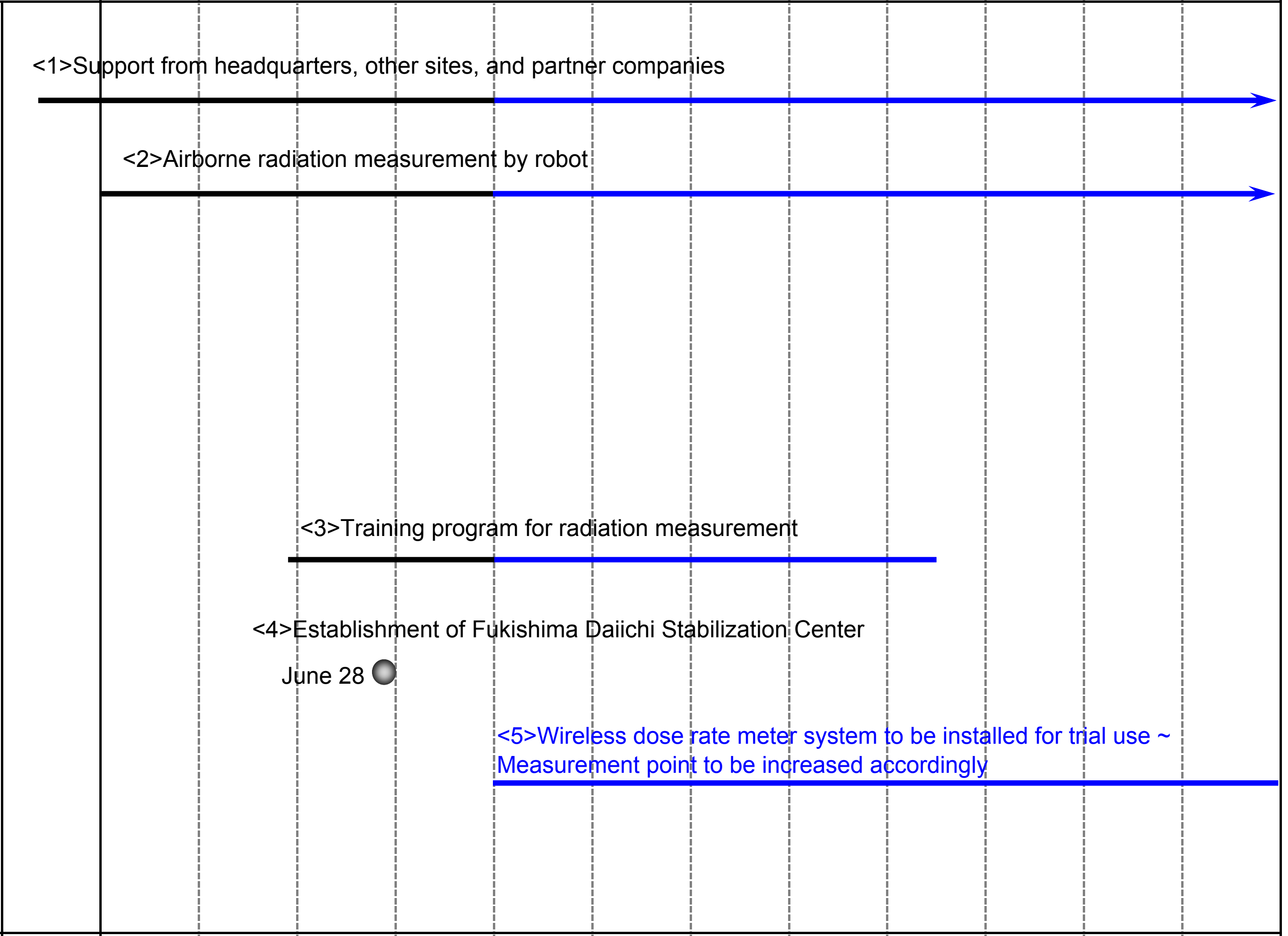
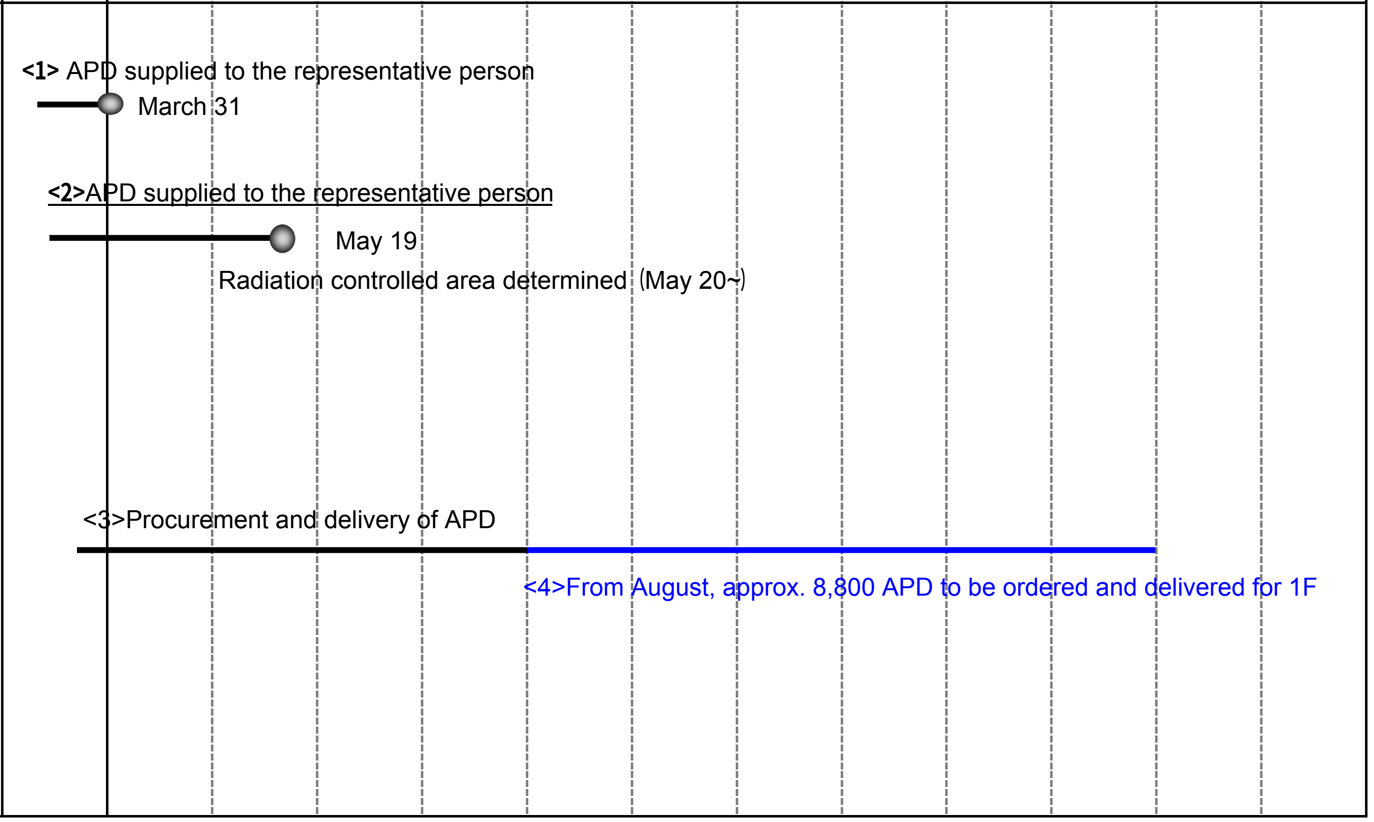
On July 21, 2011, we notified the above section 2.(1) at the safety promotion committee between TEPCO and contractors

END

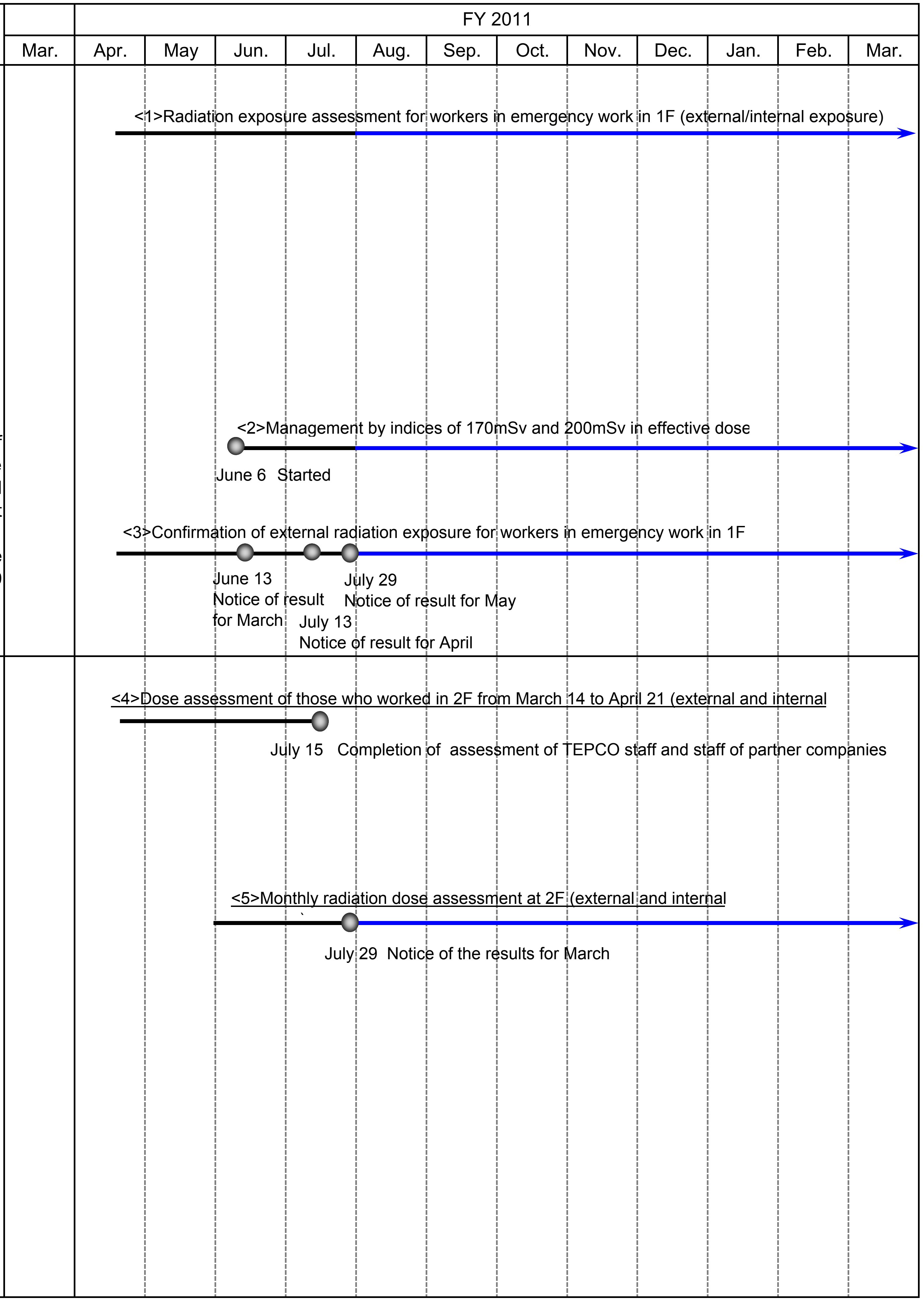
Progress Situation of the Recurrence Prevention Measures for Radiation Workers Exceeding the Dose Limit at Fukushima Daiichi Nuclear Power Station

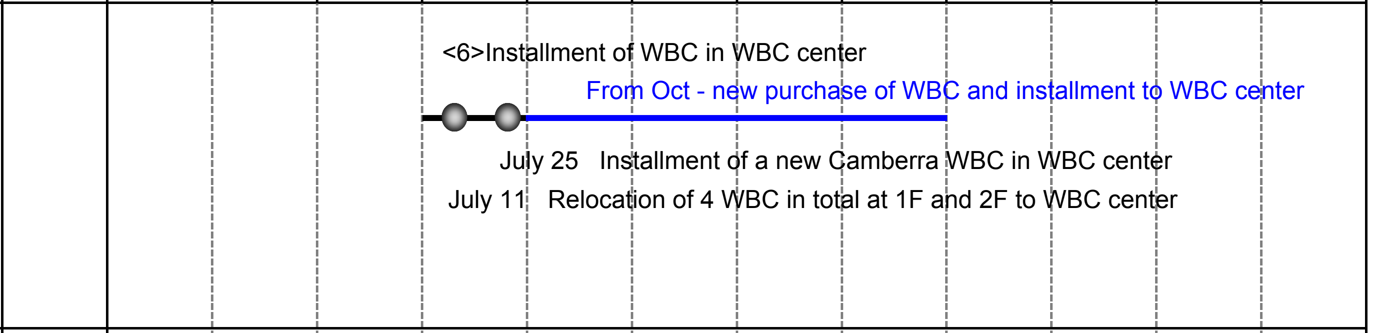
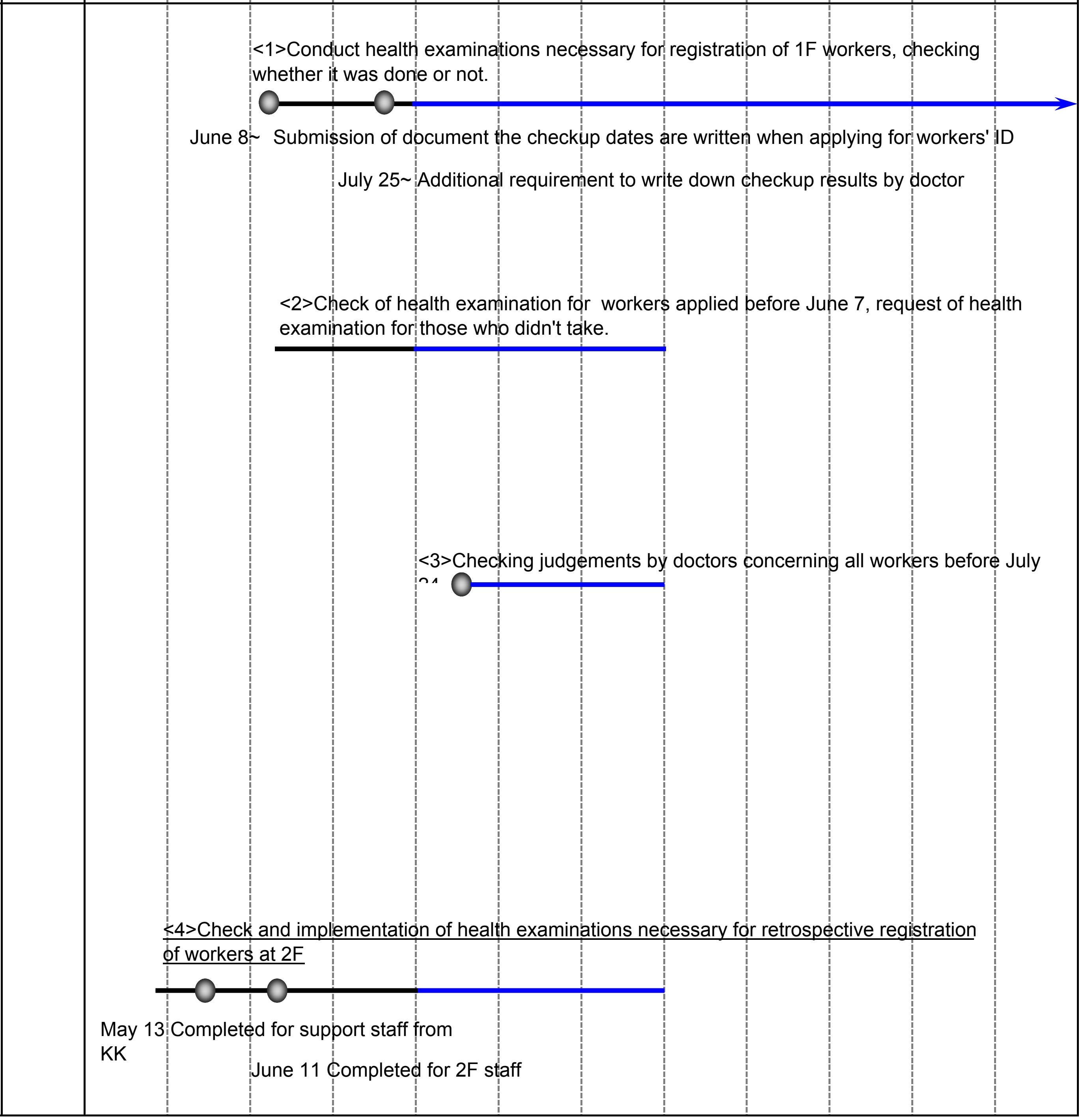
<Progress Situation of the Recurrence Prevention Measures for Radiation Workers Exceeding the Dose Limit at Fukushima Daiichi Nuclear Power Station (1F)>

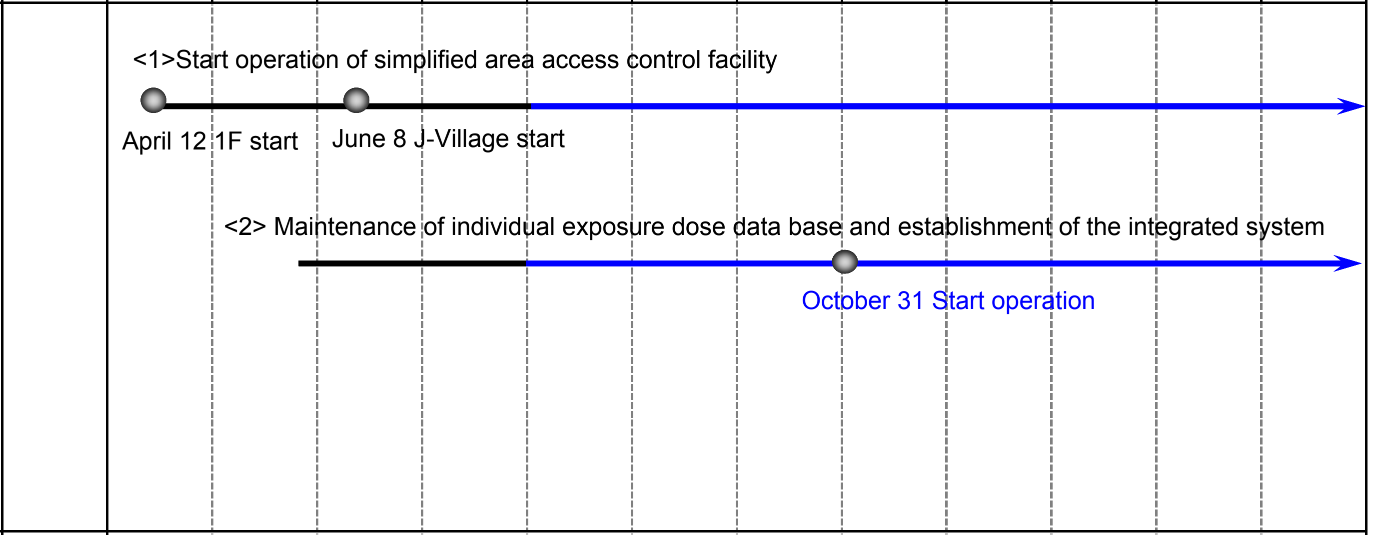
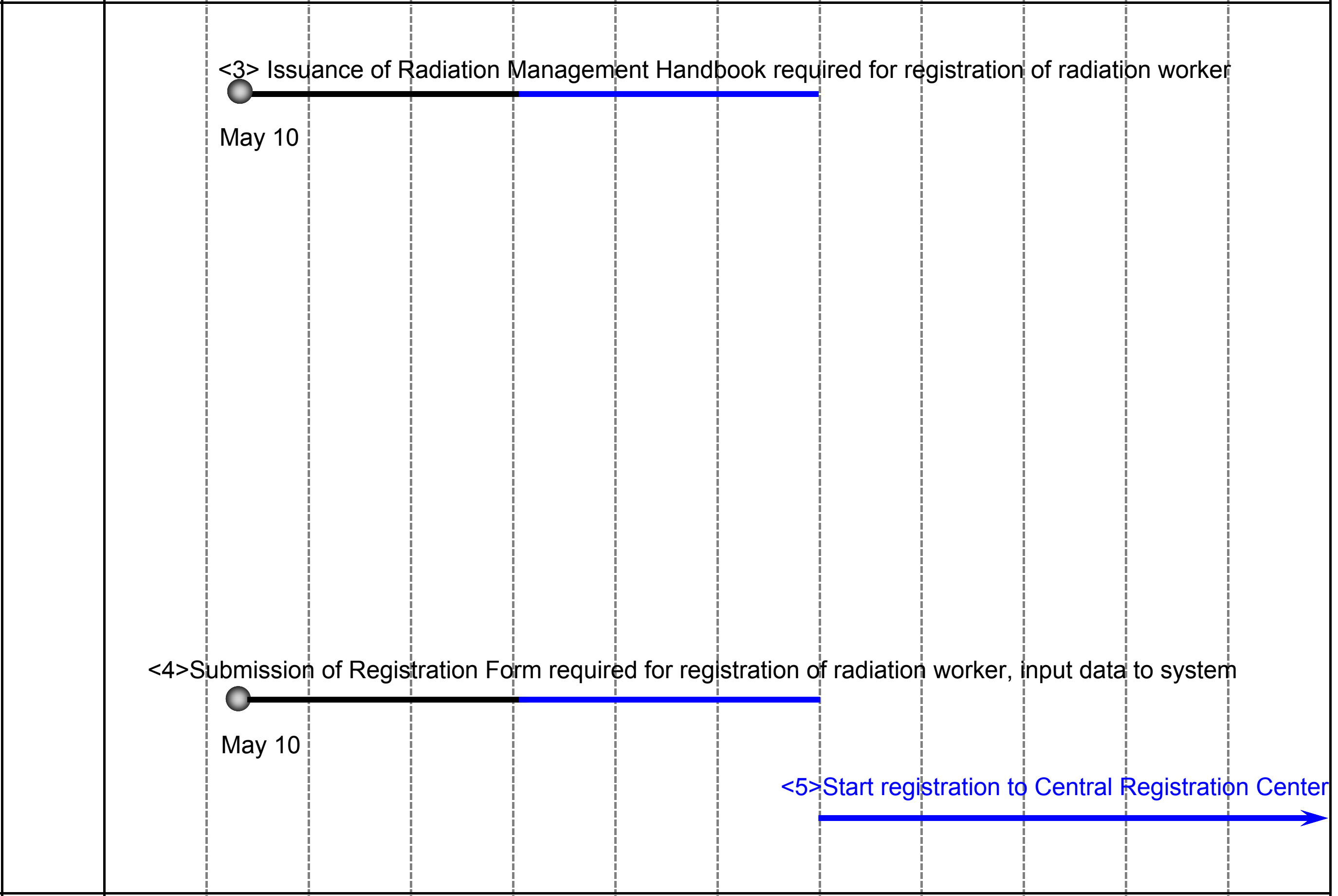
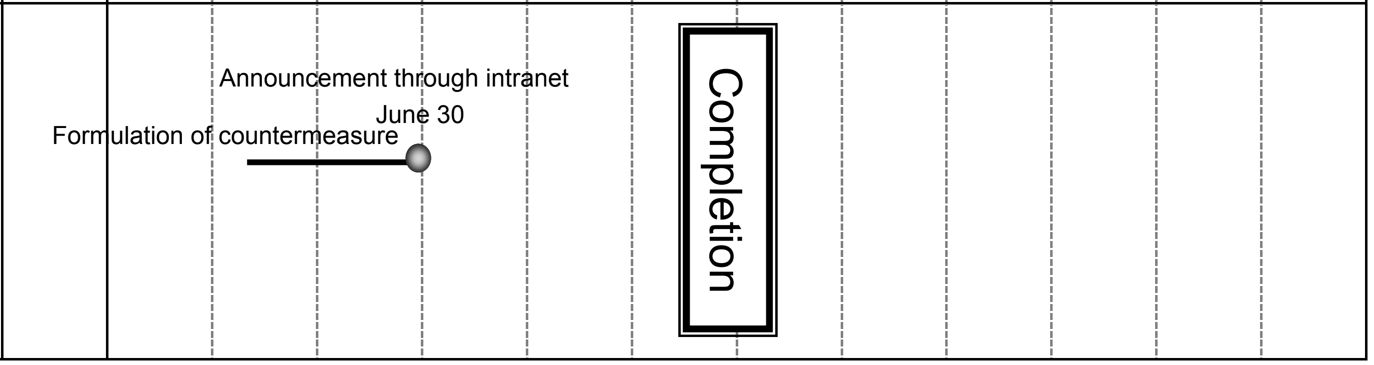
As of July 31, 2011

NISA Direction		Progress Situation (Black: Completed/ Underway, Blue: Planned, Red: Plan Changed, For 2F: Underlined)	Mar. FY 2011: Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec. Jan. Feb. Mar.
■ **Evaluation Results of Radiation Management at Fukushima Dai-ichi and Fukushima Dai-ni Nuclear Power Stations (Direction) [Dated May 25, 2011]**			▼ Receipt of the Direction Document
(1) Reinforcement of the radiation dose measurement system, etc	In order to measure radiation dose of the operational site in advance and properly supervise operation, reinforce the system by increasing the number of staff to measure radiation, etc.	<1> From Kashiwazaki Kariwa (KK) NPS, from March 12 until May, there was the support for the scale of 10 persons per day, for the support of wearing/removing protective clothing, instruction of radiation leak check, and so on. In addition, we increased assignment for the partner companies gradually, for the works such as radiation dose management during onsite work, management for check and maintenance of radiation dose meters, and so on. It was the scale of 10 persons at right after the earthquake, and is the scale of 100 persons per day at present. Besides, there are support by experienced personnels in radiation dose management in headquarters and so on, as necessary (a few persons at a time, onsite radiation dose management during the works by the Distribution Department). <2> Radiation exposure is reduced by unmanned work, i.e., measurement of airborne radiation by robot, such as Packbot and γ(gamma) camera. <3> The training program is conducted to bring up radiation measurement staff for radiation measurement work outside of the Fukushima Daiichi NPS (Started on May 30, it is planned to bring up 4,000 staffs. Approximately 1,700 personnels ware trained as of the end of July, and approximately 450 personnels were dispatched as the radiation measurement staffs). By increasing the radiation measurement staff outside of the Fukushima Daiichi (1F) NPS, the radiation measurement staff in the Fukushima Daiichi NPS are secured. <4> With the establishment of the Fukushima Daiichi Stabilization Center, the group was set up to work as the base of radiation management for each project conducted by the Fukushima Daiichi Stabilization Center. <5> Continuously monitorable dose rate meters are planned to introduce, for further radiation exposure reduction and reinforcement of the radiation dose monitoring system.	
(2) Securing and operation of personal dosimeters	Secure sufficient numbers of personal dosimeters so that every employee can carry one. Until sufficient number of personal dosimeter is secured, if a representative person carries a dosimeter in areas where radiation dose should be controlled, operational sites should be limited to areas that are confirmed to have homogenous radiation dose inside the controlled area in advance.	<1> Since the amount of personal dosimeters (APD) was insufficient at the early stage after the earthquake, it was supplied to the representative person in the group and the radiation was measured by a group (approximately 320 APD were supplied at this moment). After headquarters procured APD, 1,060 APD were supplied by April 1, which made possible for all wokers to equip APD. <2> Since dose level at the onsite working area is constant, APD was equipped by a representative person in a group. After establishing the radiation controlled area in 2F and ensuring approximately 200 APD by transferring APD, APD were equipped for all workers to work in the radiation controlled area since May 20. <3> Headquaters procured APD, which made possible for all wokers to equip APD since April 1. Approximately 3,600 APD were delivered for 1F and J-Village, as of the end of July (Available APD is approximately 4,100 in total (approx. 2,500 in 1F and approx. 1,600 in J-Village)). <4> It is planned to increase the number in order to check and calibrate existing meters, to replace with unworked meters and to prepare for introducing the personal dose management system. (Approx. 8,800 APD were procured for the use in 1F, and are delivered sequentially.)	

NISA Direction		Progress Situation (Black: Completed/ Underway, Blue: Planned, Red: Plan Changed, For 2F: Underlined)
(3) Periodical assessment of radiation exposure	Conduct promptly radiation exposure assessment of employees who have not completed, and conduct quarterly internal radiation assessment as soon as possible pursuant to the operational safety programs of Fukushima Dai-ichi and Dai-ni NPSs.	<1> Radiation exposure assessment is conducted for workers engaged in emergency works (including partner companies). (For wokers of March, 52 workers remained out of 3,747 as of July 20, and for workers of April, 388 workers remained out of 3,776 as of July 29) Although it is possible to conduct assessment in every 3 months, settlement of some wokers are delayed for following reason. 【Reason】 Based upon the APD users list, workers are identified for radiation exposure assessment. However, it takes time to identify workers since contact can not be made with the worker, or due to the wrong company name or the reading error. 【Countermeasure】 Identification of workers is continuing, through announcenent in web page, rechecking of name and company in the list, request for information to the prime contract company, the company of the worker, and other partner companies. <2> Regarding the management to prevent exceeding the dose limit, indices of over 170 mSv in effective dose (limited to the work in Main Aiti-Earthquake Building) and over 200 mSv in effective dose (can not work in 1F) are set and managed since June 6. (These indices are applied for provisional value, but definite value supersedes it when confirmed.) <3> Regarding the confirmation on external exposure, notices of the results were made on June 13 for the part of March, on July 13 for the part of May, on July 29 for the part of June. Currently confirmation work is conducted for the part of July.
		<4> Both external and internal dose assessment of those who worked during the period external radiation doses measured by monitoring posts exceeded the legitimate limit for the controlled area (March 14 to April 21). Total number of examinees: 2,995 (2F: 692, back up from other branches/offices: 633, TEPCO Hospital: 10, companies in the site: 1,288, secondees to TEPCO: 23, power distribution partner companies: 349) <5>Regarding monthly dose assessment at 2F, the assessment for March was finished and the results were delivered on July 29. Total number of examinees: 3,347 (2F: 600, back up from other branches/offices: 541, TEPCO Hospital: 9, companies in the site: 1,825, secondees to TEPCO: 23, power distribution partner companies: 349) It is supposed to be assessed every three months, the collection of data takes time due to the following reasons. [Reason] We couldn't use WBC until April 10 because of the rise of the background radiation dose due to the accident at 1F. In addition, individual radiation dose data couldn't be transferred to the individual radiation dose data management system, thus those data were recorded on papers, therefore it took time to collect data for March. [Countermeasur] Data collection for April and thereafter is started after fixing the dose in March, however, since the individual radiation dose data management system has been recovered, we will collect data for April and May until early August, and data for June until mid August. Radiation dose in the controlled area is still recorded on papers. We are considering automating the collection of radiation dose.



NISA Direction		Progress Situation (Black: Completed/ Underway, Blue: Planned, Red: Plan Changed, For 2F: Underlined)	Mar. | FY 2011: Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec. Jan. Feb. Mar.
		<6>For monthly dose assessment, we are working on the followings; -3 WBC at 1F, and 2 WBC at 2F were relocated to WBC center. -As of the end of July, 1 WBC is in operation. The other 3 WBC will be in operation by August 10. -One new Camberra WBC was installed in WBC center. It is in operation together with a car-mounted WBC borrowed from JAEA as of the end of July. -We will purchase 6 WBC and install in WBC center accordingly (in October to November).	
(4)Medical checkup of radiation workers	Implement quickly health examination necessary to register for radiation workers which is specified in your company regulations.	<1>On and after June 8, health examination is required for applying for workers' ID as a condition to work. In paralell, workers applied before June 7 need to submit the records stating the (planned) date of the health examination (if it is planned, it must be within approx. one month so that he/she takes checkup promptly), and we check whether health examinations are given or not. Also on and after July 25, we added to check the health examination result which should be written by the doctor (if the result is good, the date of judgement shall be written), in the application document for workers' ID. <2>We checked whether workers applied before June 7 got medical checkup, and requested it those who didn't. (As of the end of July, workers newly engaged in March (TEPCO staff): approx. 1,400 out of approx. 1,700 had completed the checkup. Workers newly engaged in April (TEPCO staff): approx. 400 out of approx. 600 had completed. Workers engaged in March to July (TEPCO and partner companies' staff): approx. 12,000 out of approx. 18,000 had completed the checkup. We are planning to implement health examinations to all workers by around October. <3>Health examination results of workers before July 24 need to be reaffirmed by doctors. We are planning to finish this by around October. We are working on <2> and <3> above, however, it takes time to complete checking all workers due to following reasons; [Reason] We listed and checked whether each of all workers received health examinations. Some wrote down expired examination dates (more than 3 months ago), others stated planned examination dates but didn't actually receive it later. We need to request them to have it again. In addition, we need to review examination results of all workers written by doctors. [Countermeasure] To facilitate the implementation of the health examination, we will announce that those who don't receive it before the end of September are requested to return workers' ID and won't be allowed to work. <4>In 2F, regarding retrospective registration of radiation workers, health examinations of the station staff and backups from KK were completed. Health examinations of workers of 2F partner companies and of other sectors (TEPCO staff engaged in power distribution work and partner companies) will be implemented gradually. We plan to complete the process by around October.	

NISA Direction		Progress Situation (Black: Completed/ Underway, Blue: Planned, Red: Plan Changed, For 2F: Underlined)	Mar. FY 2011: Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec. Jan. Feb. Mar.
(5) Restore and resistration to the center of the radiation management system	In order to manage exposure dose for radiation workers certainly, the system related to exposure dose management should be recovered quickly and registration of radiation workers to the central registration center of Radiation Workers of Radiation Effects Association (REA) should be completed without fail.	<1> We started area access control by using simplified area access control facility and workers pass, and workers should registrate about area access by setting workers pass and APD on circulation of APD and summarization of radiation dose became possible. (1F: April 12, J-Village: June 8) <2> Currently the individual exposure dose data from simplified area access control facility is processed by PC, however it is needed that the individual exposure dose data management is implemented reliably with adding individual exposure dose management function (output of individual exposure dose list, exposure dose notice etc.) and regular item management function (confirmation of WBC examination, confirmation of attendance to the training for diffence from radiation etc.), therefore in order to make them possible, we will establish the integrated system using the host computer. And with the transfer of the integrated system, the maintenance of individual exposure dose data base (aggregation of names, double count check etc.) is also needed. We will start operation on October as the target.	
		<3> For the registration to the Central Registration Center of Radiation Workers of Radiation Effects Association (REA) (hereinafter referred to as "the Central Registration Center"), the central registration number is needed, which is given when the Radiation Management Handbook is issued. The issuance of Radiation Management Handbook was resumed on May 10. For TEPCO workers, they are already issued to 1,300 workers out of 1,700 which are new workers at March, and 400 workers out of 600 which are new workers at April, and for the workers of partner companies (the number of object person is approx. 14,000), currently we do not comprehend quantatively about the number of issuance, and the process needs long time because of the following reasons; [Reason] At some handbook issuance authorities, the amount of request of issuance is over capacity of process, thus it needs long time for issuance handbook. [Countermeasure] We asked Tokyo Electric Power Environmental Engineering Co. Inc. which is taking charge of issuance of handbook to increase members. We will immediately ask partner companies to speed up the process of issuance by multiplying handbook issuance authorities. <4> In addition, for the registration to the Central Registration Center, it is needed to submit the Registration Form with central registration number, date of medical checkup, date of attendance to the training for diffence from radiation, accumulate radiation dose etc., thus currently we ask relating parties. We will input system the registration information in the Registration Request Form. <5> As the registration to the Central Registration Center is available after above <3> and <4> are prepared in order, thus the start of registration is assumed on November.	
(6) Implementation of adequate investigation regarding exposure dose	As the reinvestigation about the number of female radiation workers which was reported to NISA on May 11, 2011 was not on the basis of adequate method, the countermeasure should be formulated in order that the adequate investigation will be implemented for avoiding reappearance.	<1> Mistaken confirmation was occurred for female radiation workers who were in the power station at the moment of earthquake, since the investigation was implemented through the hearing by the staff of each group. Thus as a countermeasure, it is determined to confirm oneself directly or the group manager when the Operational Safety Team ask the confirmation about exposure dose. This countermeasure was agreed orally by the Security Team Leader. And at June 30 it was announced through intranet with the credit by the Operational Safety Team.	

NISA Direction		Progress Situation (Black: Completed/ Underway, Blue: Planned, Red: Plan Changed, For 2F: Underlined)		FY 2011											
			Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
(7) Report regarding law violation	With the radiation works, in case there are any events which violate laws, the immediate report to NISA should be needed.	<1> On June 10 the exposure dose was confirmed, we reported to the Director-General of NISA from the President of TEPCO about the over limit of exposure dose of 2 raditation worker who were in charge of emergency work. <2> On June 20 the exposure dose was confirmed, we reported to the Director-General of NISA from the President of TEPCO about the over limit of exposure dose of 1 raditation worker who were in charge of emergency work. <3>On July 7 the exposure dose was confirmed, we reported to the Director-General of NISA from the President of TEPCO about the over limit of exposure dose of 3 raditation worker who were in charge of emergency work.				<1>Report about over limit exposure dose June 10 ● <2>Report about over limit exposure dose June 20 ●	<3>Report about over limit exposure dose July 7 ●			In case there are any events which violate laws, they will be reported in the same manner.					

Appendix 9

The report on cause analysis on exposure of radiation workers exceeding dose limit and development of measures on recurrence prevention at Fukushima Daiichi Nuclear Power Station

August 12, 2011

Tokyo Electric Power Company

1. Outline of the event

On June 10, 2011, it was confirmed that two TEPCO's male workers (Worker A and B) were exceeded radiation dose more than 250 mSv, i.e. Emergency Exposure Dose Limit, when TEPCO was examining the emergency radiation dose in the Fukushima Daiichi Nuclear Power Station (Reported on June 17, 2011, as "The report on cause analysis on exposure of radiation workers exceeding dose limit and development of measures on recurrence prevention at emergency work in Fukushima Daiichi Nuclear Power Station" (nuclear admin report to the government 23 No 153)).

Other than these two workers, other TEPCO's six male workers were exceeded 250mSv, when considering the combination of the tentative evaluation of the internal exposure at Onahama Coal Center or the Japan Atomic Energy Agency (hereinafter referred as JAEA) and the external exposure (effective dose). (Reported in the abovementioned report)

One out of the six workers (Worker C) was confirmed to exceed 250 mSv on June 20, 2011. (Reported on June 20, 2011 as "Site Workers' Exposure Doses during Emergency Work at Fukushima Daiichi Nuclear Power Station" (nuclear admin report to the government 23 No 155)).

After that, one more worker was suspected to exceed 250 mSv so that total six workers were further measured in detail. As a result of the detail measurement, the exposure doses of three workers were below 250 mSv, while it was confirmed that the exposure doses of other three (Worker D, E and F) were exceeded more than 250 mSv. (Reported on July 7 as "Site Workers' Exposure Doses during Emergency Work at Fukushima Daiichi Nuclear Power Station" (nuclear admin report to the government 23 No 199)).

Accordingly, cause analysis for the workers (Worker C, D, E and F) exceeding the exposure dose limit, 250 mSv, was implemented.

[four workers who were newly confirmed to exceed 250 mSv dose limit]

Worker C: 352.08mSv (external exposure 110.27mSv, internal 241.81mSv)
Worker D: 308.93mSv (external exposure 49.23mSv, internal 259.70mSv)
Worker E: 475.50mSv (external exposure 42.40mSv, internal 433.10mSv)
Worker F: 359.29mSv (external exposure 31.39mSv, internal 327.90mSv)

Note) The abovementioned amounts do not include the potential exposure during the stay in the Main Anti-Earthquake Building and during the transportation in May and June as those exposures are under evaluation. These amounts will be added after the completion of the evaluation.

Doctors diagnosed that there is no health impact on those four workers.

2. Survey result

(1) Survey of exposure dose

Survey of exposure dose was conducted for the exposure during the work at site, exposure during the stay in the Main Anti-Earthquake Building in March and April, exposure during the transportation from J-village which is the base camp for the access to power plant, to the Main Anti-Earthquake Building, and internal exposure. External exposure dose during the stay in the Main Anti-Earthquake Building and during the transportation in May and June will be evaluated and added afterwards.

(Attachment 1)

a. Exposure dose during the work at site

As workers wear Alarm Pocket Dosimeters (hereinafter referred as APD) during the work at site, exposure dose during the work at site was calculated by using the measured data by APD after March.

Worker C: 95.90mSv
Worker D: 34.86mSv
Worker E: 28.03mSv
Worker F: 17.02mSv

b. Exposure during the stay in the Main Anti-Earthquake Building

Exposure during the stay in the Main Anti-Earthquake Building for each month was calculated using the data from the integral dosimeter for the control purpose (dosimeter installed to grasp the background exposure dose).

March: 3.56 mSv
April: 2.06 mSv

Note) The exposure doses in May and June have not calculated yet.

c. Exposure during the transportation

Exposure during the transportation from J-Village to the Main Anti-Earthquake Building was calculated by multiplying the average radiation dose during a month (mSv/h) measured near the Main Anti-Earthquake Building and time needed for the transportation from the main gate to the Main Anti-Earthquake Building (approx. 30minutes) together.

March: 5.00 mSv
April: 3.75 mSv

Note) The exposure doses in May and June have not calculated yet

d. Internal exposure dose

Regarding Internal exposure dose, committed effective dose was calculated by measuring the radioactive materials remained inside body by whole body counter (hereinafter referred as “WBC”) and by estimating timing of each worker’s intake of radioactive materials based on the analysis of their activity.

< Worker C>

On April 13, worker C took the survey by WBC in the Onahama Coal Center. The committed dose at that time was 273.22mSV based on that March 12, which was his first working date according to his self-report, was assumed as the intake period.

As this amount was beyond standard (20mSv), which requires detail evaluation, JAEA was asked to conduct the evaluation further.

As a result of the detailed activity survey, the intake period of radioactive materials was specified as March 14. Based on such assumption, the exposure dose was calculated to be 210mSv, which indicated the possibility to exceed dose limit during the emergency work when combined with the external dose.

Accordingly, medical diagnosis was conducted by medical expert at National Institute of Radiological Sciences (hereinafter referred as “NIRS”) and intake period of radioactive materials was determined as March 12 with the expert’s knowledge.

Note) On March 12, radiation dose in the outside environment increased from the early morning. Also, ventilation in Unit 1 PCV was implemented and the explosion occurred in the upper part of Unit 1 reactor building on the same day.

With the WBC data measured at NIRS, committed effective dose of worker C was estimated as follows. No medical impact was observed as far as the medical diagnosis result.

Worker C: 241.8mSv

< Worker D>

On June 2, Worker D took the first survey by WBC in the Onahama Coal Center. The committed dose at that time was 1100mSV based on that March 12, which was his first working date according to his self-report, was assumed as the intake period.

As this amount was beyond standard, which requires detail evaluation, JAEA was asked to conduct the evaluation further.

As a result of the detailed activity survey, the intake period of radioactive materials was specified as March 13. Based on such assumption, the exposure dose was calculated to be 300.05mSv, which indicated the possibility to exceed dose limit during the emergency work when combined with the external dose.

Accordingly, medical diagnosis was conducted by medical expert at NIRS and intake period of radioactive materials was determined as March 12 with the expert's knowledge. With the WBC data measured at NIRS, committed effective dose of worker D was estimated as follows. No medical impact was observed as far as the medical diagnosis result.

Worker D: 259.7mSv

< Worker E>

On May 25, Worker E took the first survey by WBC in the Onahama Coal Center. The committed dose at that time was 465.6mSV based on that March 12, which was his first working date according to his self-report, was assumed as the intake period.

As this amount was beyond standard, which requires detail evaluation, JAEA was asked to conduct the evaluation further.

As a result of the detailed activity survey, the intake period of radioactive materials was specified as March 12. Based on such assumption, the exposure dose was calculated to be 368.1mSv, which indicated the possibility to exceed dose limit during the emergency work when combined with the external dose.

Accordingly, medical diagnosis was conducted by medical expert at NIRS and intake period of radioactive materials was determined as March 12 with the expert's knowledge. With the WBC data measured at NIRS, committed effective dose of worker E was estimated as follows. No medical impact was observed as far as the medical diagnosis result.

Worker E: 433.1mSv

< Worker F>

On May 21, Worker F took the first survey by WBC in the Onahama Coal Center. The committed dose at that time was 361.5mSV based on that March 12, which was his first working date according to his self-report, was assumed as the intake period.

As this amount was beyond standard, which requires detail evaluation, JAEA was asked to conduct the evaluation further.

As a result of the detailed activity survey, the intake period of radioactive materials was specified as March 12. Based on such assumption, the exposure dose was calculated to be 358.5mSv, which indicated the possibility to exceed dose limit during the emergency work when combined with the external dose.

Accordingly, medical diagnosis was conducted by medical expert at NIRS and intake period of radioactive materials was determined as March 12 with the expert's knowledge. With the WBC data measured at NIRS, committed effective dose of worker F was estimated as follows. No medical impact was observed as far as the medical diagnosis result.

Worker F: 327.9mSv

e. Result of survey of exposure dose

Combining external exposure dose (during the work at site, at the Main Anti-Earthquake Building and the transportation from J-village to the Main Anti-Earthquake Building) and internal exposure, the total exposure dose during the emergency work was confirmed to have exceeded the dose limit stipulated in the law.

(2) Investigation on the situation exceeding the dose limit

The figure of internal exposure dose of the four male workers was high. Therefore, internal exposure dose was investigated.

a. Survey of work at site

Worker C was a shift worker (an operator) of Unit 3 and 4 who was engaged in collecting data in Main Control Room, operating equipment inside the plants and working outside at site from March 11 when the earthquake occurred.

(Attachment 2)

Worker C	Mar. 11	Tried to resolve the situation in Main Control Room
	Mar. 12	Tried to resolve the situation in Main Control Room

Mar. 13	Tried to resolve the situation in Main Control Room At around 4:00 pm, moved to Main Anti-Earthquake Building (thereafter, data collection at Main Control Room was conducted by rotation)
Mar. 14	Moved from Main Anti-Earthquake Building to Main Control Room to collect data Refueled generators
Mar. 15-16	Worked in Main Anti-Earthquake Building
Mar. 17-18	Moved from Main-Anti Earthquake Building to Main Control Room to collect data Searched for missing persons
Mar. 19-21	Worked in Main Anti-Earthquake Building
Mar. 22	Moved from Main Anti-Earthquake Building to Main Control Room to collected data there Searched for missing persons
Mar. 23	Day-off

Afterwards, he was engaged in collecting data (30 min- 1 hour/ time) at Main Control Room of Unit 3 and 4 in Fukushima Daiichi Nuclear Power Station, based in Fukushima Daini Nuclear Power Station. (Final date of working outside at site was on March 31.)

Since May 26, he had not worked at Fukushima Daiichi Nuclear Power Station any more.

Worker D, E and F were belonging to Maintenance Group. In order to settle plant situation, they were engaged in operation to secure power supply and restore instruments at Main Control Room, inside plants and outside at site.

Worker D	Mar. 11	Secured batteries outside (within the site)
	Mar. 12-13	Worked for restoration of instruments at Main Control Room of Unit 1 and 2 Carried batteries
	Mar. 14	Transshipped batteries outside (within the site)

Mar. 15-16

Worked for restoration of instruments at Main Control Room of Unit 1 and 2

Carried batteries

Mar. 17 Worked in Main Anti-Earthquake Building

Mar 18-26 Day-off

Afterwards, he worked for restoration of instruments at Main Control Room of Unit 1 and 2 since March 27. (final date of working outside at site was on June 15)

Since June 16, he had not worked at Fukushima Daiichi Nuclear Power Station any more.

Worker E Mar. 11 Secured batteries outside (within the site)

Mar. 12-14

Worked for restoration of instruments at Main Control Room of Unit 1 and 2

Mar. 15 Moved to Fukushima Daini Nuclear Power Station

Mar. 16-17 Worked at Fukushima Daini Nuclear Power Station

Mar. 18-20 Day-off

Afterwards, he worked for restoration of instruments at Main Control Room of Unit 1 and 2 from March 21. (final date of working outside was one June 4)

Since Jun.5, he had not work at Fukushima Daiichi Nuclear Power Station any more..

Worker F Mar. 11 Secured batteries outside (within the site)

Mar. 12 Worked for restoration of instruments at Main Control Room of Unit 1 and 2

Mar. 13 Worked in Main Anti-Earthquake Building

Mar. 14 Worked for restoration of instruments at Main Control Room of Unit 1 and 2

Mar. 15 Moved to Fukushima Daini Nuclear Power Station

Mar. 16-17 Worked at Fukushima Daini Nuclear Power Station

Mar. 18-21 Day-off

Afterwards, he worked for restoration of instruments at Main Control Room of Unit 1 and 2 from March 22. (final date of working outside was June 7)

Since Jun.8, he had not work at Fukushima Daiichi Nuclear Power Station any more.

b.Category for cause and assumption

Investigation has been carried out on workers C~F regarding the facts that are assumed to be the cause for the intake of radioactive materials by workers A and B as well as other cause.

<1> Under the rapidly developing situation, it was extremely difficult to take appropriate protective measures like choosing, wearing and distributing appropriate mask, deploying iodine tablets as well as instruction to take them, etc.

As for the investigation carried out on workers C~F, worker C was working in Main Control Room for Unit 3 and 4 from the occurrence of the event and the worker was wearing dust mask until the explosion of upper part of reactor building for Unit 1 since there were few mask with charcoal filter available.

However, this issue has been resolved since adequate number of the mask with charcoal filter was replenished by the evening of March 12.

*At the time when we reported “The report on cause analysis on exposure of radiation workers exceeding dose limit and development on recurrence prevention at emergency work in Fukushima Daiichi Nuclear Power Station” (Genkanhakkan 23, No 153) on June 17, it was not clear whether there was a replenishment of the mask with charcoal filter. However, as a result of extensive hearing investigation as a part of the internal accident investigation, we confirmed that there were 20 masks with charcoal filter replenished on request from Main Control Room.

As for Unit 1 and 2, the mask with charcoal filter was procured and replenished from the entrance of controlled area in the morning of March 12.

Workers D~F were not wearing mask at the time of battery securing work on March 11.

However, worker E was in Main Control Room for Unit 1 and 2 when there was instruction for wearing mask (4:50 am on March 12). And the worker wore mask according to the instruction given by the shift supervisor.

Also, worker D and F were on their way to Main Control Room from Main Anti-Earthquake Building and were wearing the mask with charcoal filter immediately after the instruction.

<2> In order to bring this extraordinary situation under control, workers had to work for a long time in Main Control Room. There for, they had to eat in Main Control Room (room for night shift).

All the workers C~F had to continue their work for a long period of time. Therefore, they had to eat in Main Control Room (room for night shift).

<3> As for worker A, there was a space between the mask and temple arm of the glasses.

Worker C, D and E were wearing glasses. According to the hearing investigation, there were times when contamination on worker E's hair near temple arm was confirmed.

<4> Worker B was working near the emergency door at Main Control Room(door to the outside), the area that was assumed to have had high density of aerial radioactive substances. Therefore, it was not possible to response to the unforeseeable event such as the explosion at roof part of reactor building for Unit 1.

Worker C's working range is extensive since the worker uses Main Control Room for Unit 3 and 4 as office space. However, the worker mainly stayed in central part of Main Control Room to understand intensively the condition of facilities.

All the workers D~F were working near the emergency door at Main Control Room for Unit 1 and 2.

In addition, as is the case with emergency door at Main Control Room for Unit3 and 4, the door at Main Control Room for Unit 1 and 2 was slightly open since cables were laid into Main Control Room from a generator for power loss installed at west side of Main Control Room.

Therefore, after the explosion at roof part of reactor building for Unit 1, those unclosed doors were damaged. Because it was not possible to shut those doors, workers were curing space using materials (plastic sheets, etc.) that were available in Main Control Room.

However, according to the hearing investigation, worker E felt air flowing from emergency door on the way to Main Control Room. Therefore, considering the fact that curing work had to be conducted with what was available at that time, it is assumed that isolation from the outside was defective.

c.Confirming specific cause

In order to investigate validity confirmation for making above <1>~<4> as the cause as well as other causes, hearing was conducted on worker A and B in addition to workers C~F.

As a result, it was found out worker A and B were both working near the emergency door.

Also, as is the case for worker A and B, worker C was working at Main Control Room for Unit 3 and 4. As a result of the hearing investigation from worker C, testimonies regarding deployment of the mask and situation in the Main Control Room were consistent with those of worker A and B.

* Deployment of mask
Using the masks deployed at the entrance of controlled area in service building for Unit 3 and 4 by transferring them to Main Control Room, etc.
* Situation of Main Control Room
Emergency doors were damaged by explosion at roof part of reactor building for Unit 1, etc.

Also, worker C was engaged in refueling of generators and search for missing workers as outside work, both for once. However, as indicated by the analysis conducted for workers A and B, the possibility of radioactive material intake at those occasions is considered to be low.

* Internal exposure radiation dose for workers engaged in work similar to those of worker A and B were in range from approx. 1.6% to 9.7% (Total 7 workers: worker α~η) of radiation dose for worker A and B.
Total number of workers working together outside with Worker C is 9, including worker A and B.

In addition, workers α~η who were engaged in outside work together with worker

A, B and C were engaged in the work at Main Control Room for Unit 3 and 4 at the occurrence of the event together with them as well. Especially, worker α and γ were working by teaming up with worker A and B, and worker C was managing the team.

Internal exposure radiation dose for worker θ, ι, κ and λ who were engaged in similar work with worker C at Main Control Room are 14.1%, 4.7%, 58.7% and 10.9% respectively against that of worker C and the radiation dose for worker κ was high.

What is common between worker C and κ is that worker C had been engaged in work prior to the occurrence of the event and worker κ had been engaged in work at earlier than other workers after the occurrence of the event.(wearing dust mask at first)

Moreover, even though worker κ does not wear glasses, worker κ was eating and drinking in Main Control Room (room for night shift) as with worker C.(Worker λ was eating and drinking as well but starting time for work was late)

For this reason, the intake of radioactive materials is most likely to have taken place at Main Control Room including a room for night shift.

Worker D~F were working in Main Control Room for Unit 1 and 2 at the beginning time when radiation dose was high. 25.6% of workers, whose internal exposure radiation dose were over 100mSv, were engaged in similar works as worker D-F. The percentage grows up to 61.5%, if shift operators who were working in Main Control Room for Unit 1 and 2 are added. Thus, there is a high possibility that intakes of the radioactive materials by the workers occurred, through slight leaks from masks or while being unguarded when drinking and eating, by the increase of density of radioactive materials in the Main Control Room caused by radioactive materials blown in the air by explosion at the roof of Unit 1 reactor building and damage of the emergency door.

Also, workers D~F were working together but worker μ, ν and ξ were working together as well. Their internal exposure radiation dose are respectively 24.9%、24.7 and 40.4% against the average radiation dose for workers D~F. Since these numbers are relatively high, it can be considered that above assumptions are verified.

In addition to the above, hearing results are shown in Fig.-1 matrix.

Figure-１　Factor and radiation dose

	Internal exposure mSv	Appropriate Mask	Food and drink	Glasses	Work near door
Worker A	590.0	×	○	on	○
Worker B	540.0	×	○	nil	○
Worker C	241.8	×	○	on	×
Worker D	259.7	○	○	on	○
Worker E	433.1	×	○	on	○
Worker F	327.9	○	○	Nil	○
Worker α	57.4	×	○	on	○
Worker β	9.5	○	○	nil	×
Worker γ	35.7	×	○	on	○
Worker δ	13.4	×	○	nil	×
Worker ε	15.8	○	○	nil	×
Worker ζ	17.7	×	○	on	×
Worker η	25.6	×	○	nil	○
Worker θ	34.0	○	nil	on	×
Worker ι	11.4	×	nil	nil	×
Worker κ	141.9	×	○	nil	×
Worker λ	26.4	×	○	nil	×
Worker μ	84.6	○	nil	on	○
Worker ν	84.1	○	nil	nil	○
Worker ξ	137.3	○	nil	on	○

* Hatchings for internal exposure line represents 50mSv and above.

This matrix shows main working area for worker with high internal exposure radiation dose is near the door. Therefore, it is assumed that those areas are the cause for intake of radiation materials.

On the other hand, even though Worker D and F were wearing the mask with charcoal filter from the occurrence of the event, internal exposure radiation dose for them are high.

According to the another hearing carried out for investigation of the causes, both of the workers made small space between their face and mask for a while to have air to remove their fog on the glasses, because they felt it unsafe to deal with detailed works such as restore of measurement equipment with glasses being fogged after wearing long time.

Same situation was confirmed with regard to Worker ξ, who was in charge of same task.

In addition, workers α and γ were engaged in works with workers A and B near the emergency door, their internal exposure radiation dose are smaller than workers A and B while they conducted same actions to be considered as causes for intake of radioactive materials such as inappropriate wearing of masks, drinking and eating, removal of fog on eyeglasses.

Regarding this, according to investigation of the workers' place in Main Control Room, according to hearing from worker E, some open air flew into the room from emergency door. And as there was a place being considered to be out from the main route for open air to blow in at the working position for 3~4 workers in a group (please see (3) b.), hearing was made to worker A, B, α and γ to clarify if workers α and γ were engaged in their work at the place. Since the workers did not remember well and were not be able to identify, workers α and γ mainly deal with work at the place, and they did not exposure to radiation material flew into the room so much.(please see ☆ in Attachment 4)

In addition , workerη was engaged in works near emergency door too, but internal exposure radiation dose of the worker is smaller than worker A,B.

Regarding this, according to behavior survey to worker η, on March 12, the worker was engaged in investigation in accordance with stop of Reactor Core Isolation Cooling System (RCIC) and composition of the line for vent, and after the worker returned to the works in the Main Control Room. As the worker η was not engaged in works at the same time as workers A~C, α, γ and κ, so the atmosphere surrounded worker η was different from above mentioned workers, and it may cause less internal exposure radiation dose of worker η.

According to the investigation above, in addition to <1>~<4>, gap for the air between mask and face, even if for short time, was considered to be a new causes for intake of radiation materials.

For all cases, it is likely that intake was occurred near door of the Main Control Room or near emergency door, therefore, from the next section, investigation and verification are made for situation of the Main Control Room.

(3) Verification of causes

The assumed causes in the above were verified as follows.

a. Survey of working places

Arrangement of equipment in main control rooms of Unit 1&2 and Unit 3&4 were confirmed.

As a result, the emergency doors were installed at the side of Unit 1 and Unit 3 in the control rooms. From this reason, it was observed that radioactive materials coming from the emergency doors were diffused into the whole main control room of Unit 1 and partially diffused into the main control room of Unit 3.

(Attachement-3, 4)

It is assumed that main control rooms of Unit 1 and Uni3 indicated high radioactive material density compared with that of Unit 2 and Unit 4 respectively.

According to interviews from workers A-F, contamination survey meter (GM pipe type) indicated high density in Unit 1 side in main control rooms of Unit 1&2 and in Unit 2 in main control rooms of Unit 3&4, and they took a rest in Unit 2 side and Unit 4 side during working. This fact can explain the result of interviews.

Table-2 showed the results of trend of airborne radiation measured by contamination survey meter (GM pipe type) in main control room of Unit 3&4 on March 13.

The desk of the main control room was positioned at the center of the room. When radiation value at the desk, the door of the room and the emergency door were compared, values at the both doors were high. A route that radioactive materials came from and went out can be assumed.

In addition, it was observed that there was a time that desks of Unit 3 and Unit 4 indicated higher value than that of doors. It is assumed that outside air was accumulated and diffused around the center of the main control room of Unit 4 and then went out from the door of main control room with dilution.

According to the interviews from workers A-F, airborne dose of Unit 3 was higher than Unit 4. It is assumed that increase of density was local.

Table-2 Trend of airborne dose in main control room of Unit 3&4 (Unit: cpm)

	Door of main control room	Emergency door of main control room	Desk of main control room of Unit 3	Desk of main control room of Unit 4
10:00	15,000	98,000	12,000	12,000
10:30	12,000	100,000	17,000	17,000
11:00	13,000	40,000	20,000	20,000
12:00	33,000	50,000	60,000	63,000
12:30	47,000	110,000	67,000	83,000
13:00	43,000	105,000	110,000	132,000
13:30	120,000	100,000	70,000	70,000

* Hatching columns means the value of door or emergency door of main control room was higher than the vale of desk of main control room.

The trend that airborne dose of Unit 2 and Unit 4 side was lower than that of Unit 1 and Unit 3 respectively was endorsed by distribution of exposure of workers of Daiichi maintenance division and Daiichi operation division (operator) who mainly worked in main control rooms. It is assumed that the main control room of Unit 3&4 indicated the density rapidly increased (Table-3).

* In Unit 1 and Unit 2, a share of persons who has high exposure was high. In Unit 3 and Unit 4, a share of persons who has low exposure was low.

* Regarding maximum internal exposure of operators who mainly worked in main control rooms, Unit 1 and Unit 2 was 117,3 mSv and Unit 3 and Unit 4 was 590.0 mSv.

Table-3 Distribution of exposure of workers in main control rooms of Unit 1&2 and Unit 3&4 (internal exposure)

Exposure(mS		0≦X<10	10≦X<20	20≦X<50	50≦X<100	100≦X
Unit 1 and Unit 2 (persons)	Measurement and Control G	5	1	4	3	6
	Electric Equipment G	5	4	3	2	0
	Turbine G	9	9	2	1	0
	Reactor G	15	7	1	0	0
Total of Maintenance Division of Unit 1 and Unit 2 (persons)		34	21	10	6	6
Ratio to all Maintenance division workers of Unit 1 and Unit 2 (%)		44.2	27.3	13	7.8	7.8
Unit 1 and Unit 2 (persons)	Operator	5	8	21	20	5
Ratio to operators of Unit 1 and Unit 2 (%)		8.5	13.6	35.6	33.9	8.5
Ratio of Unit 1 and Unit 2 (%)		28.7	21.3	22.8	19.1	8.1
Unit 3 and Unit 4 (persons)	Measurement and Control G	3	5	7	0	0
	Electric Equipment G	4	8	2	5	1
	Turbine G	5	4	3	1	0
	Reactor G	7	10	3	0	0
Total of Maintenance Division of Unit 3 and Unit 4 (persons)		19	27	15	6	1
Ratio to all Maintenance division workers of Unit 3 and Unit 4 (%)		27.9	39.7	22.1	8.8	1.5
Unit 3 and Unit 4 (persons)	Operator	18	14	20	9	4
Ratio to operators of Unit 3 and Unit 4 (%)		27.7	21.5	30.8	13.8	6.2
Ratio of Unit 3 and Unit 4 (%)		27.8	30.8	26.3	11.3	3.8

b. Flow line survey

A flow line survey to workers A-F was conducted.

As a result, worker A and B mainly took data at the back side of main control room of Unit 3. From workers positioning, 3-4 persons made one team and worked in turn.

Three (3) teams were established on a 4-hour shift basis. We reshuffled the team members depending on what they ought to do. Worker C, together with other counterparts, supervised these teams.

Looking at the line-of-work they took, the team to which Worker A and B belonged and which were near the emergency door of Unit 3 showed a high level of radiological dosage. Where they worked, except one location, was located on the flow line of outer air which we thought moved in from the outside.

Worker C might have worked on that location too. After interviewing Worker “κ” who started the work on the location earlier than Worker C, we found that Worker “κ” was also exposed to radiological dosage

These workers took rest at Main Control Room of Unit 4 while they were not working.

Worker D, E, and F covered the whole area on Central Operation Room. Where they worked was relatively near the emergency door.

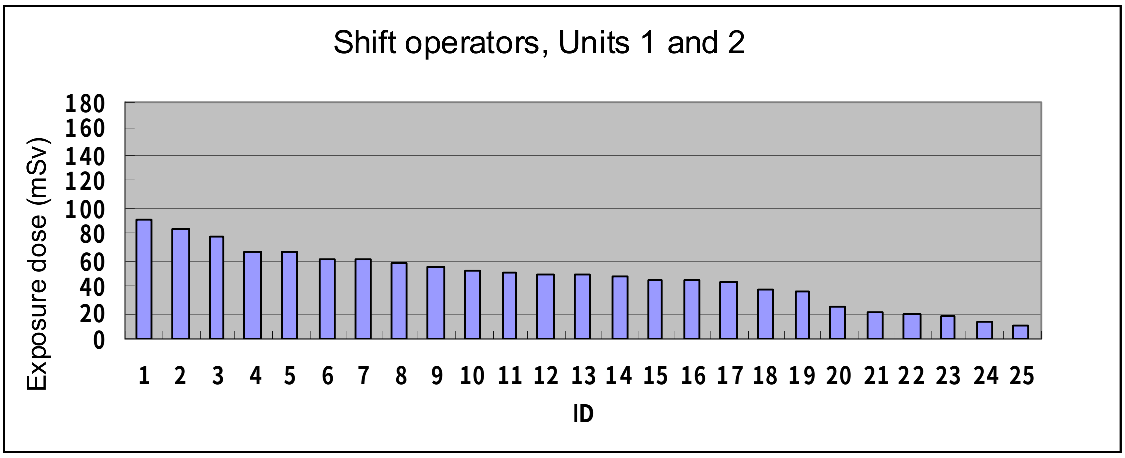
For this reason, we thought they worked on the flow line of outer air moving in from the outside.

To examine this estimation we checked where they worked and what they did regarding the following workers who worked at the same time inside Main Control Room on March 12 as Worker A to F.

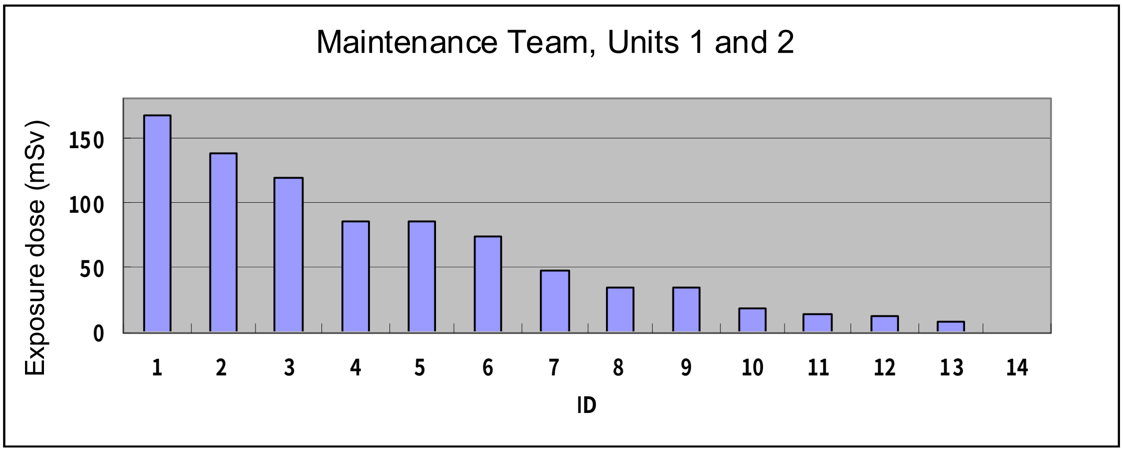
- 25 night shift workers of Units 1 & 2, and 22 of Units 3 & 4
- 14 workers of Units 1 & 2, and 15 of Units 3 & 4 (Maintenance Dept.)

The diagrams below show the amount of radiological dosage by each worker.

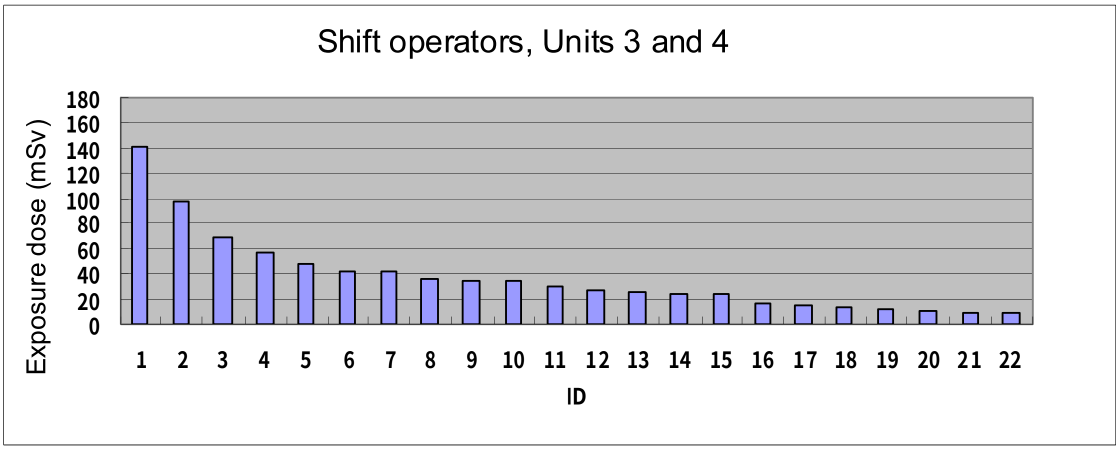
Graph – 1 Radiological dosage of night shift workers for Units 1 and 2



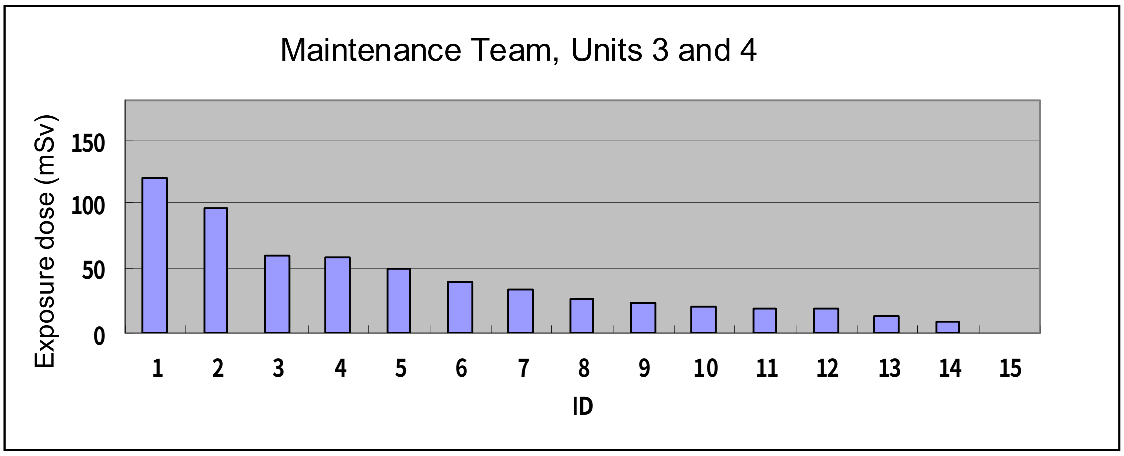
Graph – 2 Radiological dosage of Maintenance Dept. workers for Units 1 and 2



Graph – 3 Radiological dosage of night shift workers for Units 3 & 4



Graph – 4 Radiological dosage of Maintenance Dept. workers for Units 3 and 4



Maintenance Team, Units 3 and 4

We can see from Graphs 1 to 4 that the slope for the density level of radioactive materials is larger in Units 3 & 4 than in Units 1 & 2.

Though we had assumed in the previous (2) that Worker “α” and ”γ” did their work where the radiological dosage was lower, we estimate from the Graphs that the difference of density level between Workers A, B and Workers “α”, ”γ” is reflected in that of internal exposure dosage among them.

The dosage level of workers who belong to Maintenance Department is larger in Units 1 & 2 than in Units 3 & 4.

We think the reason is because Maintenance Department workers for Units 1 & 2 had more opportunity to be exposed to outer air than those for Units 3 & 4 during such work as curing the emergency door after the explosion. They had to start their work before the explosion of Reactor Building of Unit 1 and they had to move back-up battery equipment from the emergency door of Main Control Room.

As a result of behavioral survey, all the workers from Maintenance Department (ID: 1 to 6) who were engaged in carrying in the batteries were exposed to large amount of radiological dosage. Also, night shift workers of Units 1 & 2 (ID: 1, 2, 4, 5, and 6) who worked near the emergency door were exposed to relatively large amount of radiological dosage.

A night shift worker of Unit 2 (ID-3) who did an administrative work, like Worker C who worked near the emergency door, was also exposed to large amount of internal radiological dose.

It was found the amount of radiological dosage was small for the night shift and Maintenance Department workers who worked inside Main Control Room of Unit 2. On the other hand, the amount of radiological dosage was relatively large for the night shift workers at Main Control Room of Units 3 & 4 because they worked near the emergency door even after the explosion that occurred on the upper part of

Reactor Building of Unit 1. As a result from behavioral survey, it was revealed that night shift workers for Units 3 & 4 (ID-1 & 2), as like Worker A, B, and C, showed the larges amount of radiological dosage because they worked on the flow line of outer air or they continued their work even after the explosion that occurred on Reactor Building, Unit 1.

The night shift workers for Units 3 & 4 of Maintenance Department worked near the emergency door too.

We can say from this result that the workers at Main Control Room of Units 1 & 2 and 3 & 4 might have taken relatively large amount of radiological materials because they were on the flow line of outer air that moved in from the outside.

Although the density level of the radiological materials could not be measured, we can presume they have absorbed them due to the performance degradation of charcoal filters.

(4)Probable cause and countermeasures

On a design basis, radiological exposures are lower in Main Control Room than in Ventilation System even in an emergency. However, the ventilation systems did not work this time due to loss of all AC power. Because of this, night shift workers and the workers of Maintenance Department were busy restoring the damaged facilities and stabilizing the situation. They were working fervently with regards to radiological protection measures while at the same time responding to stabilize the station.

This was the utmost efforts they could make. Consequently, we think the fallowing combined causes made the workers take radiological materials.

<1> The rapid progress of the event made it difficult for the workers to prepare and wear radiological protection gears such as masks.

<2>Since they had to work for a long time to stabilize the accident at Main Control Room, they had no choice but to eat and drink in it.

<3> Worker E might have had a space between the mask and his glasses, while we can not deny that Worker C and D are thought to have done the same.

<4> Worker D to F were dedicated to a work near the emergency door of Main Control Room where we estimate the radioactivity density were high. Therefore, they could not respond to unpredictable events such as the explosion that occurred on the upper part of Reactor Building of Unit 1.

<5>Worker D and F had enough time to wear masks in order to work in a safe manner. However, they made space between their faces and masks.

Especially, the cause <4> is thought to be common between Main Control Rooms for Units 1 & 2 and Units 3 & 4. We think this cause can be applied to Worker A, B and C who took radiological materials.

These causes were the same as reported on June 17, 2011 to NISA, "Cause analysis on exposure of radiation workers exceeding dose limit and development of measures on recurrence prevention at emergency work in Fukushima Daiichi Nuclear Power Station". We will implement the countermeasures described in the report, and we think we will prevent recurrence by conducting what is written in "Improvement instruction regarding the exposure of radiation workers exceeding dose limit at emergency work in Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company (instruction)" (July 12, 2011 NISA No.6).

Moreover, based on a possibility it was needed to respond to the degradation of charcoal filters, we revised the standard for wearing the charcoal filters on June 23.

* The countermeasures reported in "Report to NISA regarding the improvement of radiation exposures by workers who have exceeded dose limit while engaged in emergency works at Fukushima Daiichi Nuclear Power Station" (Excerpt)

As for "<1> The rapid progress of the event made it difficult for the workers to prepare and wear radiological protection gears such as masks", we will follow up as follows:

a. Information sharing
We decided that we will share the information owned by emergency response teams by taking such as opportunity as meetings so that we will check from the multifaceted viewpoint.

b. Enhancement of materials and equipment for a effective use
From the lessons learned this time, we will prepare such materials as masks and iodine to promptly respond to the unexpected emergencies at our plants.

Concerning "<2> Since they had to work for a long time to stabilize the accident at Main Control Room, they had no choice but to eat and drink there." we will follow up as follows:,

c. Food restriction

We will restrict eating food not only when we are in Main Control Rooms at Units 1 to 4 of Fukushima Daiichi, but also when in radiation controlled areas, the radiological density of which is higher than previously defined.

Regarding “<3> Worker A might have had a space between the mask and his glasses”, we will follow up as follows:

d. Enlightenment activities about protecting gears

We have posted an instruction for attention at J-Village that is a kind center to enter the site, as well as at Main Anti-Earthquake Building. (May 21 and June 6)

e. Education on protecting gears

For those who entered the grounds of Fukushima Daiichi Nuclear Power Station, we will instruct them on how to use wear the protecting gears at J-Village that is a kind of center to enter the site.

We notified within Fukushima Daiichi Nuclear Power Station and to partner companies (contractors) about the necessity and effectiveness of the protection equipments and how to use them.

f. Consistent wearing of protection gears

Team Leaders / Assistant Leaders must make sure that all the workers wear protection gears and they will be fully reminded of that.

g. Employment of new type masks

Taking into account the space between worker’s glasses and faces, we will consider the employment of new type masks to make it better to adhere or to cover the entire face.

Relating to “<4>Worker D to F were dedicated to a work near emergency door of Main Control Room which are we estimate the radioactivity density were high. They could not respond to unpredictable event such as the explosion that occurred on the upper part of Reactor Building of Unit 1.” we will follow up as follows:

h. Improvement of pre-work survey and information sharing

As reported in “Investigation of causes and development of preventive measures regarding exposure exceeding dose limit to radiation workers at Fukushima Daiichi Nuclear Power Station to NISA”, we will have a radiation map notified on the common bulletin board to mitigate radiation exposure by sharing information, in addition to the enhancement of preliminary survey.

i. Wearing protecting clothes

Based on a survey before works, all the workers will have to wear protecting gears in accordance with the work environment.

3.Appendices

(1)Individual exposure dose

(2)Chronology

(3)Main Control Room of Units 1 & 2

(4)Main Control Room of Units 3 & 4

END

Evaluation Result of Individual Exposure Dose

Attachment 1

[Worker C]50's

External Exposure Dose	Value of APD	95.9mSv	110.27mSv
	Exposure Dose at Main Anti-Earthquake Building	5.62mSv (March 3.56mSv、April 2.06mSv)	
	Exposure Dose on the move	8.75mSv (March 5.00mSv、April 3.75mSv)	
Internal Exposure Dose			241.81mSv
Total Exposure Dose			352.08mSv

[Worker D]20's

External Exposure Dose	Value of APD	34.86mSv	49.23mSv
	Exposure Dose at Main Anti-Earthquake Building	5.62mSv (March 3.56mSv、April 2.06mSv)	
	Exposure Dose on the move	8.75mSv (March 5.00mSv、April 3.75mSv)	
Internal Exposure Dose			259.70mSv
Total Exposure Dose			308.93mSv

[Worker E]20's

External Exposure Dose	Value of APD	28.03mSv	42.40mSv
	Exposure Dose at Main Anti-Earthquake Building	5.62mSv (March 3.56mSv、April 2.06mSv)	
	Exposure Dose on the move	8.75mSv (March 5.00mSv、April 3.75mSv)	
Internal Exposure Dose			433.10mSv
Total Exposure Dose			475.5mSv

[Worker F]20's

External Exposure Dose	Value of APD	17.02mSv	31.39mSv
	Exposure Dose at Main Anti-Earthquake Building	5.62mSv (March 3.56mSv、April	
	Exposure Dose on the move	8.75mSv (March 5.00mSv、April	
Internal Exposure Dose			327.90mSv
Total Exposure Dose			359.29mSv

Attachment 2

< Time Series >

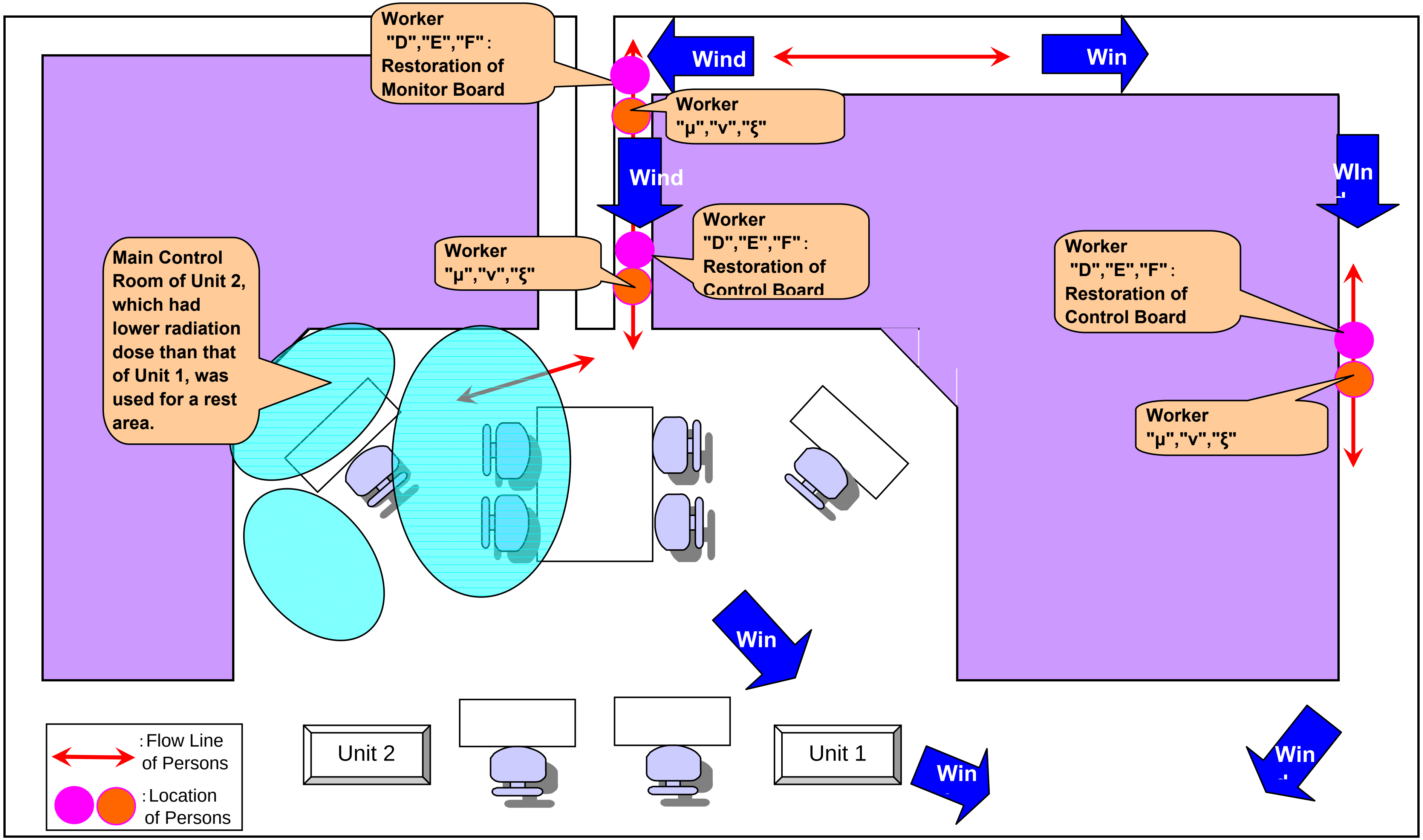
	Exposure dose control implemented	Actions taken by Worker C	Actions taken by Worker D	Actions taken by Worker E	Actions taken by Worker F
2011 March 11 2:46pm	Tohoku-Chihou-Taiheiyou-Oki Earthquake occurred	Tried to resolve the situation in Main Control Room of Unit 3 and 4	Secured batteries outdoors (within the site)	Secured batteries outdoors (within the site)	Secured batteries outdoors (within the site)
March 12 round 4:00 am	Prepared masks against the impacts from ventiration	Tried to resolve the situation in Main Control Room of Unit 3 and 4	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2
round 4:50 am	Instructed outdoor workers to wear charcoal masks (emergency headquaters)		Carried batteries		
5:04 am	Instructed to wear dust masks at Main Control Room and charcoal masks outdoors (shift supervisor)				
orund 2:30 pm	Conducted ventilation of Unit 1 (PCV pressure decreased)				
3:36 pm	Upper part of reactor building of Unit 1 exploded.				
5:57 pm	Instructed to wear charcoal masks (security supervisor)				
March 13 round 9:20 am	Conducted ventilation of Unit 3 (PCV pressure decreased)	Tried to resolve the situation in Main Control Room of Unit 3 and 4 Moved to Main Anti-Earthquake Building at around 4:00 pm (thereafter, data collection at Main Control Room was conducted by rotation)	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2 Carried batteries	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2	Worked in Main Anti-Earthquake Building
March 14 11:01 am	Upper part of reactor building of Unit 3 exploded.	Moved from Main Anti-Earthquake Building to Control Room of Unit 3 and 4 and collected data there Refueled generators	Replaced batteries outdoors (within the site)	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2
March 15 aound 6:30 am	Plant General Manager instructed emergency workers to evacuate temporarily.	Worked in Main Anti-Earthquake Building	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2 Carried batteries	Moved to Fukushima Daini Nuclear Power Station	Moved to Fukushima Daini Nuclear Power Station
March 16					

March 17		Worked in Main Anti-Earthquake Building	Worked for restoration of indicators at Main Control Roon of Unit 1 and 2 Carried batteries	Worked at Fukushima Daini Nuclear Power Station	Worked at Fukushima Daini Nuclear Power Station
		Moved from Main Anti-Earthquake Building to Control Room of Unit 3 and 4 and collected data there Searched for missing persons	Worked in Main Anti-Earthquake Building	Worked at Fukushima Daini Nuclear Power Station	Worked at Fukushima Daini Nuclear Power Station
March 18		Moved from Main Anti-Earthquake Building to Control Room of Unit 3 and 4 and collected data there Searched for missing persons	Day off	Day off	Day off

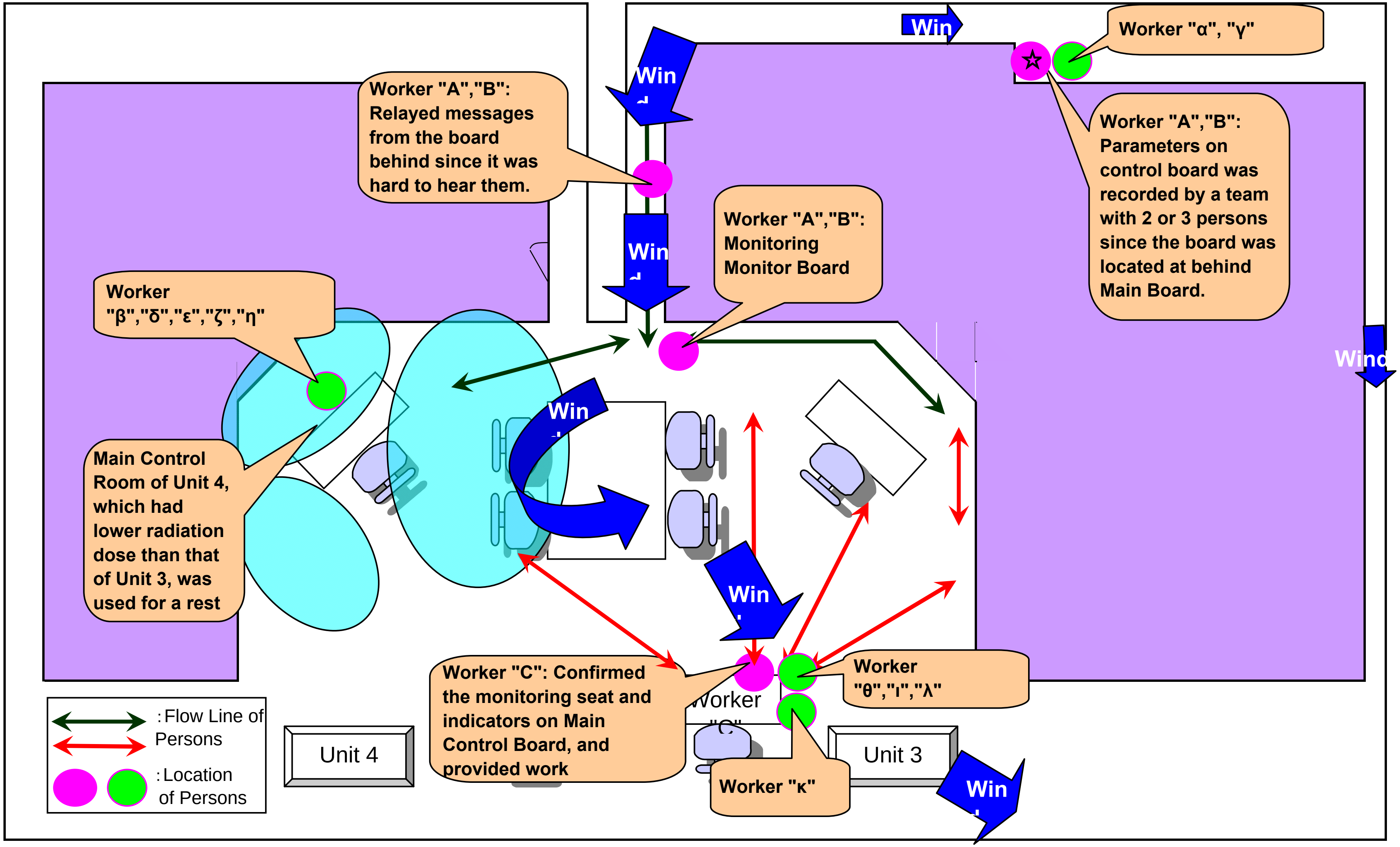
March 19		Worked at Main Anti-Earthquake Building	Day off	Day off	Day off
March 20		Worked at Main Anti-Earthquake Building	Day off	Day off	Day off
March 21		Worked at Main Anti-Earthquake Building	Day off	on duty	Day off
March 22	Installed JAEA's WBC at Onahama Coal Center	Moved from Main Anti-Earthquake Building to Control Room of Unit 3 and 4 and collected data there	Day off		on duty
		Searched for missing persons			
March 23		Day off	Day off		
March 24	Started confirming measurement results of the density of radioactive materials in the air in Main Anti-Earthquake Building （conducted every day,	Worked at Main Anti-Earthquake Building	Day off		
March 25		Searched for missing persons	Day off		
March 26		Worked at Main Anti-Earthquake Building	Day off		
March 27		Day off	on duty		
March 28		Day off			
March 29		Day off			
March 30		on duty			
March 31		Final day of working outdoors			
around April 1 - 10	Conducted hearing of the emergency workers' duration of stay				

around April 10 -	Considered the evaluation way of exposure dose during the stay	May 26: Final day of working in Main Anti-Earthquake Building	June 15: Final day of working outdoors and in Main Anti-Earthquake Building	June 4: Final day of working outdoors and in Main Anti-Earthquake Building	June 7: Final day of working outdoors and in Main Anti-Earthquake Building
April 25	Completed the evaluation of exposure dose during the stay at Main Anti-Earthquake Building				

Main Control Room of Unit 1 and 2



Main Control Room of Unit 3 and 4



Appendix 10

Failure of our workers to fit charcoal filters in a full-face mask

1. Preface

On July 26, 2011, one of our workers of the corporate affairs team at Fukushima Daiichi Nuclear Power Station ("Worker") moved from Fukushima Daini Nuclear Power Station ("2F") to Fukushima Daiichi Nuclear Power Station ("1F"), drove a car and transferred other workers, wearing a full-face mask without charcoal filters.

Despite this event, the internal exposure of the Worker is below the recording level.

2. Time sequence of events

Please refer to the attachment 1

3. Contents of investigation

(1) Investigation status of leak check of the Worker

Similar events happened in the past and therefore we had already announced and implemented to our workers the following preventive measure.

- In each of the working groups workers have to appoint a "Checker of wearing" and based on the instructions of the responsible checker, workers have to do leak check in pairs whether the equipment is sufficient, pointing and saying the name of each of piece of equipment or with the mirror placed in the gateway of main anti-earthquake building before leaving for the working site.

The Worker understood the measure and usually did leak check but when he moved from 2F to 1F at that day as he was talking about the scheduled work for the day, and when he transferred other workers from 1F main anti-earthquake building as he was in a hurry with heavy wastes, he forgot to do the leak check.

(2) Checking status of the equipment of working groups

Similar events happened in the past and therefore we had already announced and implemented to our workers the following preventive measure.

- In each of the working groups, a "Checker of wearing" has to be appointed and based on the instructions of the responsible checker workers have to do leak check in pairs whether the equipment is sufficient, pointing and saying the name of each of piece of equipment or with the mirror placed in the gateway of main anti-earthquake building before leaving for the working site.

In this event, since moving from 2F to 1F was just an action of transfer, no "Checker of wearing" was arranged.

When he transferred other workers, "Checker of wearing" was one of corporate affairs team ("Worker A"), who left 1F main anti-earthquake building together with the Worker in the above, and the Worker A was aware of the mentioned measure and therefore usually he checked the equipment of each working team. However, when the Worker transferred other workers from 1F main anti-earthquake building, as the burden (a sampling bottle containing about 10 liters of some liquid) was heavy and downward, the Worker A forgot to check the equipment of the Worker. The picture of the mask that the Worker wore at the time was as shown in the attachment 2, and you can see if one wears a mask with charcoal filters or not from the appearance.

(3) Distribution and stock status of masks in the visitor's hall in 2F

The safety and security team at 1F distributed and maintained full-face masks to the visitor's halls in 2F but there was no one who hand masks to each of the workers. In addition to that, face parts of the masks were reused and the masks without charcoal filters were distributed and new charcoal filters were kept in bags separately from the masks, in order to avoid them from deterioration.

(4) Confirmation of workers' status of wearing masks by controllers of workers' going in and out

The safety and security team at 1F opened and closed the doors in the control area of going in and out of the main anti-earthquake building, but it was not supposed to check the wearing status of the equipment such as masks.

4. Causes

We presume that causes for this event are as follows;

-the Worker was aware of the rule of the leak check on the mask, but he forgot it because he was concentrating on other things;

-the Worker A was aware of the rule to check each worker's equipment, as a member of working group, but he also forgot it because he was concentrating on other things;

-charcoal filters were not attached to the full-face masks distributed in the 2F visitor's hall, and;

-in the control area of going in and out, there was no one to check the status of wearing equipment.

5. Countermeasures

The countermeasures taken now are as follows;

-We have notified all the members including the Worker that they have to make sure that they do leak check, check and point out each piece of equipment in pairs, and check the equipment in the mirror placed in the gateway of main anti-earthquake building, and the Worker himself reflected on his behavior concerning the checking the equipment and confirmed the necessary process, again.

-We have notified that before leaving for the site they do leak check and confirm the equipment as working group.

> We announced to our workers and partner companies' workers in a meeting at the day the event occurred.

> We announced to the prime contractor's responsible person in a safety implementation liaison meeting and radiation control liaison meeting.

- Now, in the visitor's hall of 2F and the gymnasium of 2F, controllers hand full-face masks with charcoal filters. With this procedure, in all the places (J-Village, visitor's hall of 2F and the gymnasium of 2F) from which workers leave for 1F including main anti-earthquake buildings and rest stations in which controllers exchange the charcoal filters with new ones, all the workers receive full-face masks with charcoal filters (attachment 3)
- In the going in and out area of main anti-earthquake buildings and rest stations in which workers exchange charcoal filters of masks with new ones by themselves, controllers talk to the workers and do leak check and confirm their equipment. With this procedure, in all the places in which workers could take off the charcoal filters by themselves, a third party checks the status of the equipment (attachment 4).
- We have made posters to remind the workers of fitting charcoal filters in a full-face mask

and have posted in the front gate, each of the rest stations and buses for moving, which the workers can easily find (attachment 5).

6. Attachments
(1) Temporal sequence of events
(2) Picture of a full-face mask with charcoal filters
(3) Picture of the mask circulation desk at the visitor's hall in Fukushima Daini Nuclear Power Station
(4) Picture of the control area of the main anti-earthquake building
(5) Poster to remind the workers of fitting charcoal filters in a full-face mask

END

Attachment 1

Temporal Sequence of Events

* July 25, 2011

Around 1:00 pm : The Worker moved to 2F from J-Village. As he was supposed to work from July 25 to July 28 but his work in 1F was only for 2 days (July 26 and 27), he was going to borrow 1F equipment (including a full-face mask with charcoal filters) and therefore he wore only 2F equipment (a surgical mask and cotton gloves) in J-Village.

Around 1:30 pm : He arrived at the office of 2F and after that worked there for tasks of internal and clerical affairs (answering phone calls. paying out for office supplies, answering questions, preparing and distributing lunch, etc.)

Around 11:00 pm : He rested at the office of 2F

* July 26, 2011

Around 6:00 am : He woke up at the office of 2F

Around 6:50 am : He walked to the visitor’s hall from the office of 2F (with a surgical mask and cotton gloves)

Around 7:00 am : He put on the equipment for 1F (tyvek suit, rubber gloves and rubber shoes) and left the hall, taking a full-face mask with no charcoal filter

Around 7:10 am : He got in a car with an corporate affairs team member and 2 welfare team members and moved to 1F. During the moving, he put on the mask but did not do leak check (the other 3 workers’ masks were given at J-Village and they did leak check themselves in the car)

Around 7:40 am : They arrived at 1F main anti-earthquake building and after that worked there for tasks of internal and clerical affairs (answering phone calls. paying out for office supplies, answering questions, preparing and distributing lunch, etc.). The workers were supposed to carry masks on their own and the Worker carried a full-face mask with no charcoal filter.

Around 2:30 pm : An corporate affairs team worker (Worker A) and the Worker left the 1F main anti-earthquake building. When they left, the Worker put on a full-face mask with no charcoal filters but did not conduct leak check. The Worker A did leak check but did not instruct the Worker to do so or mutually check with the Worker.

Around 2:30 pm ~ 2:45 pm : They conducted the following tasks together.

- Moved to the parking of the north of the main office by car and confirmed that the engine of a first private car of a partner company's worker still worked (the Worker confirmed it).
- Moved to the west parking of the main office by car and confirmed that the engine of a second private car of a partner company's worker (the Worker stayed and waited in the car).
- Confirmed that the engine of a third private car of a partner company's worker still worked (the Worker confirmed it). The Worker A drove the car and moved to J-Village.

The Worker conducted the following task by himself.

- Moved to the dump yard by car, disposed the garbage and moved to the main anti-earthquake building by car.

Around 2:45 pm : A commissioned worker who checks workers' going in and out found that the Worker did not take the full-face mask in charcoal filters.

Attachment 2

Picture of a full-face mask with charcoal filters

Mask with charcoal filters

Mask without charcoal filters

Attachment 3

Picture of the mask circulation desk at visitor's hall in Fukushima Daini Nuclear Power Station

Attachment 4

Picture of the control area of main anti-earthquake building

Attachment 5

Have you fit charcoal filters to your mask?

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