Response and Action Taken by the Ministry of Health, Labour and Welfare of Japan on Radiation Protection at Works Relating to TEPCO's Fukushima Daiichi Nuclear Power Plant Accident

2nd Edition (Fiscal Year of 2014)

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Introduction

In response to the Fukushima Daiichi Nuclear Power Plant (NPP) accident that resulted from the Great East Japan Earthquake on 11 March 2011, the Tokyo Electric Power Company (TEPCO) undertook emergency work to which an emergency dose limit applied. The dose limit for the emergency work, which was originally 100 mSv, was temporarily increased to 250 mSv from 14 March to 16 December 2011, the day on which the Japanese Government declared that the affected plant had been stabilized as explained in Section 1.1.

During the emergency work, the Japanese Government observed various problems with the radiological protection of emergency workers. To regulate the implementation of radiological protection measures, the Ministry of Health, Labour and Welfare (MHLW) issued a series of compulsory directives and administrative guidance to TEPCO.

Based on the experiences and lessons learned, the MHLW recognized that to properly manage radiological exposure should a similar accident occur at another NPP, sufficient measures and systematic preparation for radiological management must be ensured, including the use of an exposure control system; implementation of an exposure data control system, and worker training and work planning; and maintenance of stockpiles of dosimeters, personal protective equipment and protective garments.

This document outlines the problems that occurred during the emergency response to the accident and the measures taken by the MHLW and TEPCO in Section 1.2. The recommendations to avoid the recurrence of similar problems are provided in Section 1.4.

Furthermore, the accident at the Fukushima Daiichi NPP released large amounts of radioactive materials. For rehabilitation of the contaminated areas, the Japanese Government decided to carry out decontamination work (e.g., clean-up of buildings and remediation of soils and vegetation) and to manage the waste resulting from decontamination and unmarketable contaminated goods.

For the radiological protection of the decontamination workers, the Japanese Government needed to establish new regulations because the existing regulations did not fit the “current exposure situations” in which radioactive sources have been scattered in wide areas around the plant. The new regulations aim to set the appropriate protection standards in accordance with the risk of the ambient dose rates, radioactivity concentrations, and types of radionuclides resulting from the NPP accident, which are equivalent to or more than the typical protection standards required in planned situations. This document explains the key issues of the new regulation and guidelines in Section 2, and the established regulations and guidelines are outlined in Section 3.

The second edition was updated with the information in (6) and (7) of Section 1.2.1 concerning governmental re-evaluation of internal exposure dose. The exposure dose distribution tables in Section 1.5 were thoroughly updated based on the latest information as of March 2015. Furthermore, Section 3.7 was newly created for explaining the establishment of the radiation dose registration system for decontamination work.

Regarding epidemiological studies targeting emergency workers for the accident, Section 4 was newly established for explaining the commencement of comprehensive epidemiological study. The section also mentioned the results of a cross-section study on thyroid gland examinations of emergency workers conducted in 2014.

Furthermore, Section 5 was newly created for explaining good practices in radiation dose control and exposure dose reduction by TEPCO and several primary contractors at the affected plant. The information was obtained from the workshop held on 11 December 2014.

1. Emergency Exposure Dose Control in the TEPCO Fukushima Daiichi NPP

Emergency work in response to the TEPCO Fukushima Daiichi NPP Accident associated with the Great East Japan Earthquake of 11 March 2011 was undertaken under high radiation levels and extreme conditions for which normal dose control facilities were ill-equipped to deal with, partially due to the station blackout after the tsunami. There were difficulties in recording the cumulative dose, and delays in monitoring of internal exposure due to insufficient exposure control personnel and equipment. Also, workers had to work under the brazing sun, while wearing protective clothing, and some suffered heat stroke. From the problems that occurred, MHLW issued a series of compulsory directions and administrative guidance to TEPCO and the primary contractors.

This section explains the lessons learned in exposure dose control at the TEPCO Fukushima Daiichi NPP, and shows necessary preparation for responding to future nuclear accidents that may necessitate emergency work. This section explains;

(a) Problems that occurred after the accident started and the responses by MHLW and TEPCO in Section 1.2,

(b) The status of the long term health care of emergency workers in Section 1.3, and

(c) Future actions based on the experience in Section 1.4.

1.1 Temporary raising of emergency dose limits

1.1.1 The increase of emergency dose limits by MHLW Ordinance 2011-23 (Exemption Ordinance)

At the time when the TEPCO Fukushima Daiichi NPP Accident occurred, emergency dose limits of 100mSv were in effect for the workers engaged in emergency work based on the Ordinance on the Prevention of Ionizing Radiation Hazards (hereinafter called Ionizing Radiation Ordinance) under the Industrial Safety and Health Act (Act No.57 -1972) for the prevention of health impairment.

After the start of accident, radiation protection of workers was implemented in accordance with the Ionizing Radiation Ordinance. However, consideration for the security of the general public and the prevention of expansion of nuclear disaster, led to the decision to raise the emergency dose limit in the affected plant to 250 mSv from 100 mSv. This was defined in the exemption ordinance of ionizing radiation corresponding to the situation derived by the 2011 Tohoku-Pacific Ocean Earthquake (Exemption Ordinance i.e. MHLW Ordinance 2011-23). This Exemption Ordinance was issued on 14 March 2011, and became effective on 15 March 2011.

Concerning the increase of the emergency dose limits, the points below were taken into consideration:

- According to the International Commission of Radiological Protection (ICRP) recommendation, the emergency dose limit for the "emergency exposure situations in the serious accident" should not exceed approximately 500 mSv, with the exception in the case of life saving actions.
- It is recognized that an exposure dose under 250 mSv may not cause acute radiation symptom.
- The Radiation Council under the Ministry of Education, Culture, Sports, Science and Technology (MEXT) agreed that the dose limit was appropriate.

1.1.2 Partial abolishment of increased emergency dose limits for new workers.

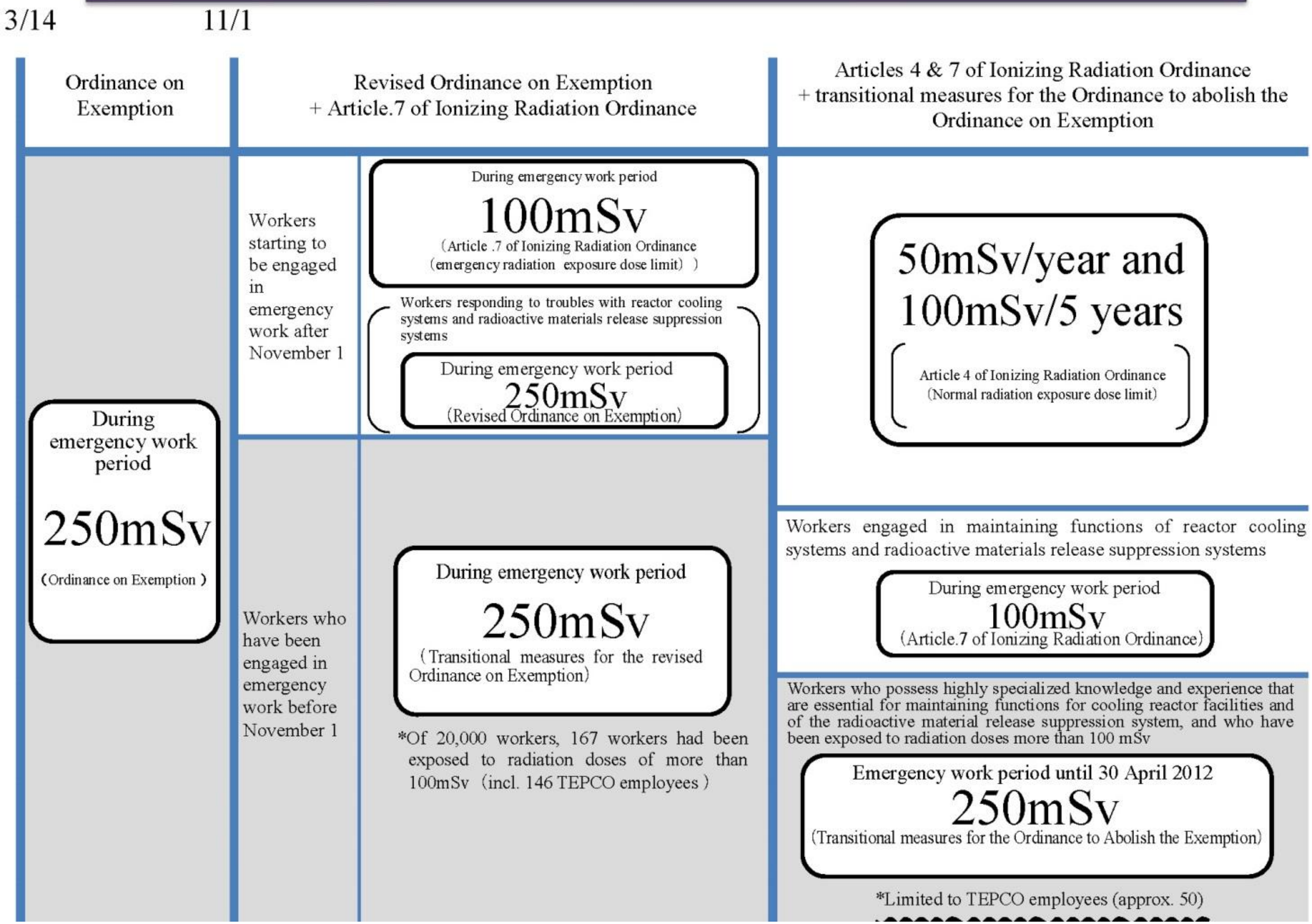
On 1 November 2011, the emergency dose limit for new workers was decreased to the original (100 mSv) with some exceptions designated by the minister of MHLW. Exempted work were listed as the emergency work related to responses for the prevention of the loss of cooling systems of nuclear reactors and for the loss of the function of the facilities to suppress the release of radioactive materials to offsite areas when engaged in the works in the reactor buildings and the immediate vicinity for a possible dose rate exceeding 0.1 mSv/h. For the exemptions, the dose limit for emergency work was set as 250 mSv.

1.1.3 The abolishment of the exemption ordinance

The exemption ordinance was abolished when Step 2 of the "Road Map towards the Restoration from TEPCO Fukushima Daiichi NPP Accident", which aimed to achieve long-term stability of the reactors was completed on 16 December 2011.

The dose limit exemption of 250 mSv was applied until 30 April 2012, for those specialists who are highly trained and experienced in operating the reactor cooling systems and in maintaining the facilities for suppressing the emission of radioactive materials (Approximately 50 TEPCO employees).For those 20,000 persons who had been engaged in the emergency work, 167 persons had exceeded 100 mSv (Including 146 TEPCO employees).

Figure.1 Application of the Radiation Exposure Dose Limit after the Completion of Step 2



1.2 Problems that occurred after the accident and the responses by MHLW and TEPCO

The problems that occurred with twenty cases are classified into the five categories shown below.

1) Personal identification and exposure dose control (6 cases)

(1) Insufficient exposure dose control system in the exposure dose control department
(2) Insufficient numbers of personal dosimeters
(3) Deficiencies in dosimeter-lending management
(4) Delay of radiation exposure doses notification to workers
(5) Delay of internal exposure monitoring
(6) Unexpected occurrence of workers who could not be contacted

2) Respiratory protective equipment and protective clothing (4cases)

(1) Exceeding emergency exposure dose limit
(2) Exceeding exposure dose limit for women
(3) Improper use of respiratory protective equipment
(4) Improper protective garments

3) Training for new workers (1 case)

(1) Insufficient training hours for workers

4) Health and medical care system (5 cases)

(1) Establishment of the medical care system at the affected plant
(2) Prevention of heat stroke
(3) Instruction to conduct special medical examinations
(4) Establishing patient transport systems from the affected plant
(5) Long-term health care program

5) Preliminary review of work plans (4 cases)

(1) Insufficient management systems for developing work plans
(2) Deficiencies of work plans
(3) Insufficient knowledge about contract conditions
(4) Improvement of the lodging and meals

The responses and actions to these twenty cases taken by MHLW and TEPCO are described in the following sections.

1.2.1 Personal identification and exposure dose control

(1) Insufficient exposure dose control system in the exposure dose control department

As the exposure control systems that were normally used became inoperable due to the tsunami, a significant amount of manual work was required, such as making dosimeter-lending records, inputting dose data and name-based collection and calculation of individual exposure doses. Although the work was eventually taken over by the corporate offices, its progress was delayed due to the many manual records that had to be input. These factors resulted in a substantial delay in the task to accumulate individual exposure dose.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW provided guidance for the consolidation of the exposure administration in the corporate offices (23 May).
・MHLW directed the primary contractors with a written notice to submit monthly reports on the status of notifying workers of their exposure doses as well as to consolidate the exposure administration (22 July).
・MHLW directed organization of a dedicated team to survey workers with whom contact had been lost (10 August).

[Actions taken by TEPCO]

・TEPCO increased the number of staff members in the radiation control department of the corporate offices, inputted data regarding the information in the dosimeter lending record managed at the NPP, and collected and calculated the dose data using spreadsheet software, in accordance with directions. TEPCO was able to submit a report on radiation exposure doses at the end of the subsequent month to MHLW, starting with the data from September.
・The primary contractors established a systematic control organization for exposure control in their corporate offices and reported to MHLW on the status of the exposure dose control on a monthly basis.

(2) Insufficient numbers of personal dosimeters

Many personal alarm dosimeters (hereinafter referred to as "PADs") became inoperable after the tsunami. Due to the shortage of PADs, only one PAD was given per work group during the period of 15–30 March. TEPCO said it had selected the groups working in areas where exposure was expected to be almost constant. However, using the dose of representative workers could have overlooked some extreme exposures of individual workers because highly radioactive contaminated waste was widely dispersed during this period.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW instructed TEPCO to provide each worker with a PAD (31 March).

[Actions taken by TEPCO]

・TEPCO obtained PADs from other NPPs and fitted every worker with a PAD (1 April).
・TEPCO obtained 4,100 PADs in total for management of the affected plant and 2,200 PADs were made available at J-Village for lending use (as of 17 November)

(3) Deficiencies in dosimeter-lending management

As the normal operating procedures to access controlled areas could not followed due to the tsunami, TEPCO implemented paper-based dosimeter-lending management, and workers were required to write down their names, affiliations, and radiation exposure doses into the paper-based lending records. However, deficiencies and incorrect information in the records made it difficult to identify individuals and compile name-based consolidated records of doses.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW demanded that TEPCO obtain basic information on workers, issue access permits with IDs, and conduct management of entry/exit (23 May).
・MHLW instructed TEPCO to attach a photo to the access

permit (7 July).

[Actions taken by TEPCO]

・TEPCO started issuing a "worker identification card" with an ID number at the seismically isolated building (14 April), and at the J-Village(8 June); it started writing ID numbers in the dosimeter-lending records.

・TEPCO started identifying individuals based on official documents at J-Village and issuing an access permit with photo ID (29 July).

・TEPCO started using workers' identification cards in combination with the access permit (8 August).

In addition to the above, MHLW additionally issued the instructions stated below on 29 October 2012, as a solution to the issue that the lower exposure dose was falsely recorded by covering the dosimeter with a lead plate:

(a) Check the management system of the exposure dose data.

(b) Use the protective garments (Tyvek coveralls) with a transparent chest pocket.

(c) Increase the accuracy of dose monitoring by limiting the wearing of glass badges solely during working hours.

(d) Record the higher reading of a PAD or a glass badges

(e) Set the alarm as close as to the reasonable estimated maximum doses as possible.

(f) Notify workers of their radiation exposure doses by providing written documentation.

(g) Exchange workers with a high cumulative radiation exposure in a job to workers with a low cumulative radiation exposure, and ensure close communication between the employers and the workers who had received radiation exposure close to the dose limit

(4) Delay of radiation exposure dose notification to workers

The normal dose notification system was inoperable due to the tsunami. It took time to manually input dose data which resulted in TEPCO falling behind notifying primary contractors. In addition, the receipts printing system of radiation exposure doses at the time of returning dosimeters was not functioning. Thus, it became difficult for workers to know their own cumulative exposure.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW demanded that TEPCO notify workers of their cumulative exposure doses once a week for external exposure and once a month for internal exposure (23 May).

・MHLW demanded that primary contractors submit a report once a month regarding the situation of notifying workers of their radiation exposure doses (22 July).

・MHLW demanded that workers should be issued receipts when returning their dosimeters, starting on 16 August (10 August).

[Actions taken by TEPCO]

・TEPCO were able to notify the primary contractors once a week (reported on 10 August). The receipt showing radiation exposure doses was issued to each worker when returning their dosimeters, starting on16 August.

(5) Delay of internal exposure monitoring

Whole-body counters (WBCs) in the NPP became unavailable, leading to their shortage and that delayed whole body measurements. It also took time to determine an estimation model according to the changes in the target nuclide to be measured as well as to identify the intake date. These factors created a significant delay in evaluation of the committed dose. In particular, precise measurements were conducted to identify the nuclides at the Japan Atomic Energy Agency (JAEA) and the National Institute of Radiological Sciences (NIRS) for the workers who received high radiation exposure doses, and that took time to determine their committed doses.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW demanded that TEPCO measure internal exposure for emergency workers on a monthly basis (23 May).

・MHLW demanded that TEPCO promote internal exposure monitoring and report on the status (22 July).

・MHLW issued warnings of violation of the law to TEPCO and to the employers who had worked in March and had not had their internal exposure measured once within every three months (30 and 31 August).

[Actions taken by TEPCO]

・TEPCO determined the intake dose as that on 12 March in principle. TEPCO opened the WBC center at J-Village (10 July) and increased the number of WBCs by borrowing three "in-vehicle" type WBCs from JAEA, and purchased new ones. TEPCO secured 11 WBCs in total (18 October).

・TEPCO assessed and determined committed dose with the support of JAEA and NIRS. Monthly monitoring became possible from September.

MHLW identified that there were certain discrepancies between the dose evaluated by the primary contractors and the dose by TEPCO.

(6) Re-evaluation of Internal Dose Assessments

It was noticed that there were significant discrepancies between internal dose assessments of emergency workers made by TEPCO and those reported by primary contractors, doses which were reported to MHLW in April 2013.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW decided to re-evaluate the doses reported since May 2013, and some of the committed doses were re-adjusted based on the re-evaluation.

(a) MHLW readjusted committed doses based on the standardized method;

・Standardization of the estimation methodologies of internal dose assessments (intake date, intake scenario, and estimation of I-131 exposure, etc.) in accordance with TEPCO's methodologies as determined in August 2011.

・Readjustment of committed doses of 450 workers

1) Increased doses: 431 workers (Max. 48.9mSv, Ave. 5.0mSv)

2) Decreased doses: 19 workers (Min. 9.2mSv, Ave.

2.1mSv)

(b) MHLW corrected miscalculated committed doses (29 workers)

・Miscalculations and errors were found such as incorrect inputting of coefficients, mixing up of data, transmitting data to the wrong contractor, and omitting input of revised data transmitted from TEPCO, etc. into the database.

・Correction of 29 committed doses of workers among 7 contractors (corrections ranged from 3.5mSv to 18.1mSv)

・MHLW demanded that TEPCO and primary contractors employ the standardized methodologies for internal dose assessments; all parties were strictly instructed to prevent the recurrence of miscalculations and errors related to internal dose assessments (5 July 2013).

Detailed information is available at:
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/rp/pr_130705.html

(7) Additional re-evaluation of internal dose assessments

In addition to the above, it was found that TEPCO had data on committed effective doses assessed by a method other than the standard methods at the end of January 2014.

[Actions taken by MHLW]

・MHLW examined data on emergency workers' committed effective doses to ascertain whether there were any other similar cases since February 2014. Examined data were for 6,245 emergency workers, excluding those covered by the previous re-evaluation, from a total of 7,529 emergency workers (data for workers engaged in March and April 2011). This examination revealed that the data for 1,536 emergency workers were suspected to have been obtained by methods other than the standard assessment methods.

・MHLW instructed TEPCO and primary contractors to re-evaluate these data.

Consequently, the committed effective doses for 142 emergency workers were readjusted.

・MHLW provided TEPCO with guidance on the following matters.

(a) The internal audit sector should inspect the sector in charge of radiation dose control, check the workflow of its operations and data management, etc., and take necessary remedial actions.

(b) Before externally reporting or announcing radiation exposure doses, the data should be checked by a person in a quality assurance sector, in principle.

・MHLW instructed primary contractors that independently assess committed effective doses about thorough preservation of all the records, etc.

Detailed information is available at:
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/rp/pr_140325.html

(8) Unexpected occurrence of workers who could not be contacted

It was found that a number of workers could not be identified in the name-based consolidated record (174 individuals, a tentative maximum as of 29 July), during the time that the handwritten dosimeter-circulating record was used for management.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW demanded that TEPCO ask the primary contractors for cooperation and release the information about missing workers, by name, on the TEPCO's website (20 June).

・MHLW demanded that TEPCO correct the problem of the missing individuals, such as by verifying with other primary contractors groups and checking for overlaps of similar names (13 July).

・MHLW demanded the primary contractors consolidate exposure control and add a photo to each worker's identification card (22 and 29 July).

・MHLW directed TEPCO to organize a dedicated team to survey workers who could not be contacted (10 August).

[Actions taken by TEPCO]

・TEPCO, in cooperation with the primary contractors' office on site, found missing workers one by one by checking the original records, checking for an overlap in similar names, having them confirmed by the primary contractors, making use of professional investigation agencies, and making those missing individuals' names public. However, ten individuals are still missing.

1.2.2 Respiratory protective equipment and protective clothing

(1) Exceeding emergency exposure dose limit

The assessment of internal exposure revealed that 6 emergency workers exceeded the dose limit of 250 mSv (revealed on 10 June; 678 mSv was the highest). This presumably occurred because the workers did not use the charcoal filter cartridge in the respiratory protective equipment, and ate and drank in the main control room, where the concentration of radioactive materials had increased after the hydrogen explosion (12 March)

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・ MHLW instructed TEPCO to stop the workers who had worked in the main control room right after the hydrogen explosion, and those whose radiation exposure dose had tentatively exceeded 100 mSv from undertaking any radiation work until their doses were determined. TEPCO was also instructed to immediately exclude the 12 workers whose tentative doses had exceeded 200 mSv from emergency work (3 June, 7June, and 13 June).

・MHLW performed on-site inspections (7 June and 11 July) and demanded that TEPCO correct violations, these were making workers continue at their job when having a dose in excess of 250 mSv (10 June), and failing to require that workers use effective respiratory protective equipment and failing to prohibit them from eating and drinking in contaminated areas (14 July).

[Actions taken by TEPCO]

・TEPCO excluded the relevant workers from the work that might cause exposure until their doses were determined, and excluded those whose exposure dose exceeded 200 mSv from the work at Fukushima Daiichi NPP in accordance with instructions (reported on 13 June).

(2) Exceeding exposure dose limit for women

The assessment of internal exposure revealed that 2 female workers had exceeded the dose limit of 5 mSv in March (revealed on 27 April; 17 mSv was the highest). While the female workers had been engaged in support tasks in the seismically isolated building since the accident occurred (11-23 March), the flow of radioactive materials into the building could not be avoided due to the distortion of the entrance door caused by the hydrogen explosion. It should be noted that local exhaust ventilation equipment was later installed and the windows were shielded with lead.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW performed an on-site inspection (27 May) and demanded that TEPCO correct violations which had caused female workers to be exposed in excess of 5 mSv in March (30 May).

・MHLW also instructed TEPCO to ensure exposure dose control for all workers, monitor their health regularly at the site, and assess the internal exposure of female workers after excluding them from the work.

[Actions taken by TEPCO]

・TEPCO decided not to assign women to tasks in the area of the affected plant.

(3) Improper use of respiratory protective equipment

TEPCO failed to provide sufficient explanation with respect to instructions on how to wear respiratory protective equipment in the education of new workers. Thus, there still existed workers who received internal exposure, even in June.

(a) Improper fitting of respiratory protective equipment

The survey on fitting respiratory protective equipment conducted on 26 September indicated that the leakage rate of respiratory protective equipment was particularly high for those wearing glasses (56% at the highest, 17% on average).

(b) Neglecting to attach filters

One of the workers of a primary contractor was found working near Unit 2 without a charcoal filter cartridge on his full face mask (13 June). A similar case occurred on 29 June, suggesting that workers had not been well informed about the need to wear respiratory protective equipment.

(c) Contamination inside of respiratory protective equipment

Contamination was found on the inner surface of the mask filter in 4 workers (14 September). Several similar cases were subsequently found.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・Instructions were given to inform workers of the procedures for wearing respiratory protective equipment, to ensure that workers follow the rules regarding the correct way of wearing protective equipment, to provide education, and to post instructions on how to wear respiratory protective equipment (22 June).

・Instructions were given to establish work procedures for surveying contamination of respiratory protective equipment filters (5 October).

・TEPCO was instructed to:

1) Take necessary measures for workers wearing glasses such as giving them sealing pieces to attach to the frames of the eyeglasses to cut leakage;
2) Provide more masks so workers could choose one that was best suited to their own face;
3) Show workers how to perform fitting tests;
4) Introduce respiratory protective equipment with electric powered fans; and
5) Improve the contents of the training workers received, based on the results of leakage rate tests using a mask fitting tester (26 September).

[Actions taken by TEPCO]

・Respiratory protective equipment were sorted by their product makers and sizes in accordance with the instruction so that workers could choose masks suited to their faces more easily (27 September).

・TEPCO started to provide new workers with training about using fitting testers (17 November).

・Introduced masks with electric powered fans (25 August).

(4) Improper protective garments

(a)The case that a worker soaked his feet in highly contaminated water

A worker who was wearing short mid-calf boots soaked his feet in water (30 cm deep) during work. This caused the skin on both feet to become contaminated (beta ray exposure) (24 March) because the radiation dose in the work area had not been monitored before starting work, the worker did not wear high boots, and the worker continued to work although his dosimeter alarm was sounding.

(b)The cases that highly contaminated water was poured over workers

A worker was contaminated when contaminated water was poured over his head while he was working to discharge water in the tank of the contaminant removal plant. He was not wearing a hooded, waterproof garment. Another worker, also not wearing a hooded, waterproof garment, was engaged in handling hoses and became contaminated by water (both occurred on 31 August).

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW instructed TEPCO to conduct work after establishing a safety and health administration system (24 March).

・MHLW issued guidance to TEPCO and the primary contractors to:

1) Monitor the radiation doses in the work area before starting work in order to understand the contamination level and decide on work procedures,
2) Ensure that workers evacuate when dosimeters alarm and that workers wear effective protective garments and footwear according to the contamination level of the work

area (26 March).

- MHLW instructed TEPCO to make its best effort to determine the causes of the incidents and prevent their recurrence (1 September).
- MHLW performed on-site inspections (27 May and 28 September) and demanded violations be corrected by the employers who:
  1) had not made workers wear suitable footwear (high boots) (in the case of the beta ray exposure on 24 March) (30 May); and
  2) had not made workers wear effective protective clothing (hooded, waterproof protective clothing) (the cases on 31 August) (5 October).

[Actions taken by TEPCO]

- TEPCO ensured that workers put on rubber boots, and required workers who might be exposed to contaminated water to wear hooded, waterproof garments. No cases of exposure to contaminated water have occurred since then.

1.2.3 Training for new workers

(1) Insufficient training hours for workers

In the beginning (until around May), only 30 minutes were spent in worker education on the effects of radiation, how to control radiation dose, and the use of protective equipment; this was done at J-Village with instructional materials developed by TEPCO. In addition, the classroom where the worker education program was given was too small. The classroom accommodated only around 20 people per 30 minute session.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

- MHLW instructed TEPCO and the primary contractors to educate new workers on radiation hazards, the use of protective equipment, and the actions and evacuation methods to take in an emergency (13 May, 23 May and 22 July).

[Actions taken by TEPCO]

- TEPCO started a new worker education program in Tokyo from19 May and the special education program at the J-Village from 8 June to both TEPCO staff and contractors. Arrangements were made to secure sufficient classroom space.

1.2.4 Health and medical care system

(1) Establishment of the medical care system at the affected plant

TEPCO was able to provide physicians only intermittently at the affected plant. In the first month after the accident, 25 workers became sick or were injured, and 31 workers complained of poor health. One case of a worker suffering a heart attack was reported on 14 May, and this incident showed the urgent need for an emergency clinic that provides 24-hour medical services by physicians. However, securing a qualified staff of physicians, nurses, and radiological technologists has posed a great challenge, and establishing the emergency clinic turned out to be extremely difficult.

In response to the above, the following actions were taken.

[Actions taken by MHLW and relevant ministries (MEXT, etc.) and agencies]

- The Fukushima Prefectural Labour Bureau (PLB) demanded that TEPCO ensure workers' mental and physical health.
- The Fukushima PLB contacted and coordinated with the relevant ministers and sent hospitals a request letter for clinic staff under the name of the director of Occupational Safety and Health Department.
- The Fukushima PLB was allocated radiological technologists for the clinic, in cooperation with the Association of Radiological Technologists (September 2011).
- MEXT sent the PLB request to a wider range of radiation medicine institutions and was able to secure the dispatch of nurses.
- MHLW also asked the Japan Labour Health and Welfare Organization to steadily supply medical staffs from November 2011.
- The University of Occupational and Environmental Health has dispatched physicians who provide services mainly during the daytime (15 May). A system to ensure the 24-hour on-site presence of physicians was established on 29 May with the arrival of physicians dispatched from Rosai Hospitals (hospitals for labourers) managed by the Japan Labour Health and Welfare Organization. Subsequently, the plant site clinic was relocated to the J-Village (September 2011).
- The National Defense Medical College started dispatching teams of critical incident stress specialists (10 July). The team provides mental health services on a monthly basis.

[Actions taken by TEPCO]

- TEPCO opened the on-site makeshift medical clinic at Unit 5 and 6 in July. More physicians were allocated in September 2011 to the clinic in J-Village in order to provide the initial treatment and triage and routine preventative health care.

(2) Prevention of heat stroke

It has been a concern since May 2011 that emergency workers might be at risk of occupational hazards derived from heat stroke while working for long hours under the blazing sun while wearing heavy equipment, such as a full-face mask, Tyvek coveralls, and rubber gloves.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

- MHLW demanded that TEPCO undertake the following.
  a) Suspend work from 2 p.m. to 5 p.m. in July and August,
  b) Shift working hours to early morning, and specify the maximum number of consecutive working hours,
  c) Check workers' health prior to work, make available air-conditioned rest places where workers can remove their full face masks,
  d) Conduct education for the prevention of heat stroke
  e) Establish a medical care system (10 June 2011).
- MHLW demanded that TEPCO attach checklists for heat stroke prevention measures when they submit work plan to the inspection office.

[Actions taken by TEPCO]

・TEPCO took measures in addition to the instructions by the MHLW, including the following:
a) Distribution of Cool Vests (vests with attached refrigerant gel).
b) Provision of the wet bulb globe temperature (WBGT) through the internet.
c) Display the daily warning level for heat stroke at workplaces.
・TEPCO also required workers showing symptoms of mild heat stroke to take a break and a rest. As a result, although 40 patients with heat stroke symptoms were observed, no serious cases were reported.

(3) Instructions to conduct special medical examinations

Considering that exposure exceeding the normal exposure dose limit may cause acute radiation syndrome, special medical examinations conducted every six months would be too late to detect acute radiation damage. The more time that was spent on emergency work, the larger the numbers of workers who are subject to medical examinations. This made it difficult to collect information on the multiple-layered contractors, and the percentage of workers who undertook medical examinations was as low as 60% as of June 2011

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW issued compulsory instruction to TEPCO, under Item 4, Article 66 of the Industrial Safety and Health Act, to conduct special medical examinations including blood tests, skin test, and weight measurement, and specified the number of days after the completion of emergency work that the examinations must be taken within under the assumption of a short-term emergency work (16 March 2011)
・Additionally, MHLW re-issued instruction to TEPCO to conduct medical examinations for workers who were exposed to more than 100 mSv and who worked for more than 1month (25 April).
・In efforts to raise the implementation rate of medical examinations, MHLW regularly investigated the status of conducting the medical examinations and gave instructions to TEPCO and the primary contractors (May and June 2011).

(4) Establishing patient transport systems from the affected plant

In order to transport potentially seriously injured workers from the affected plant, a faster way to transport patients to a hospital was required, because it takes 1-2 hours to transport the patients via J-Village to hospitals. To shorten the transportation time, the MHLW tried to establish efficient patient transportation systems, including direct access of local ambulances to the plant and airlift by a helicopter to a hospital. The MHLW, however, faced difficulties in making arrangements with the hospitals expected to receive the patients.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW staff visited hospitals in Iwaki city and explained decontamination conditions that would allow the hospitals to accept direct patient transportation from the NPP. As a result, in August 2011, non-contaminated patients were allowed to approach hospitals directly from the plant.
・MHLW directed TEPCO to prepare a heliport to be used for an air ambulance, persuaded a helicopter operation company to join the work, and coordinated as a liaison regarding test flights to be conducted by a TEPCO affiliated company.

[Actions taken by TEPCO]

・TEPCO conducted direct transport of non-contaminated patients to hospitals without going through J-Village so that it was not necessary to decontaminate or transfer a patient to another vehicle (August 2011).
・An agreement was reached with the operation company to locate a heliport in the Fukushima Daini NPP, 13km from the affected plant, instead of using the Hirono playground near J-Village, 20km from the affected plant. (February 2012).

(5) Long-term health care program

In addition to the compulsory medical examinations, it became necessary to examine workers who exceeded normal dose limit of 50 mSv/y and those who exceeded the exposure dose limit of 100 mSv according to their exposure dose. It also became necessary to conduct health consultation for workers about their long-term mental and physical health.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW established Minister's guidelines pursuant to Item 2, Article 70 of the Industrial Safety and Health Act (11 October 2011). In the guidelines, the employers should basically be required to conduct long-term healthcare. However, the Government should conduct it for the workers who changed their jobs to those that were not related to radiation works, those who are continuously employed by the firms (small to midsize only) but not engaged in radiation work, and persons who are not currently employed.
・As additional medical examinations, MHLW decided to provide cataract eye examinations, for the workers who exceeded 50 mSv, and thyroid examinations and cancer screenings, (stomach, lung, and colon) for those who exceeded 100 mSv, in accordance with the report provided by the experts' meeting.

1.2.5 Preliminary review of work plans

(1) Insufficient management systems for developing work plans

During the first month from the start of receiving work plans, a large number of plans were summited from TEPCO in which many deficiencies were found. It took a lot of time to revise the work plans in spite of having provided correction instruction afterwards. As there was no other back-up organization to revise the work plans at that time, the persons in charge at the plant could not respond to reminder notices.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・The Tomioka Labour Standards Inspection Office developed a review standard and prepared instruction materials to be made available at its office, and continued to give instructions to the persons in charge at the plant.
・MHLW guided the corporate offices to improve the situation

by strengthening the organizations involved and increasing the numbers of staff members for the tasks at both the affected plant and corporate offices (30 June). MHLW provided the on-site review service at J-Village on a regular basis.

[Actions taken by TEPCO]

・TEPCO increased the number of staff members to prepare work plans, and defined the roles of the NPP and corporate offices (reported on 13 July).

(2) Deficiencies of work plans

MHLW directed the primary contractors conducting work activities associated with doses exceeding 1 mSv per day to submit a radiation work plan to the relevant inspection office(23 May 2011).A lot of deficiencies were found in the submitted requests such as excessive length of the work period, improper personnel in charge, unrealistic estimate of the maximum radiation exposure dose, improper use of dosimeters (glass badges, ring badges, and alarm setting), and lack of identification of the work location and work description.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・ MHLW developed review standards and prepared instruction materials to be made available at the office and continuously gave instructions to the staff in charge.

(3) Insufficient knowledge about contract conditions

Information obtained by TEPCO on the relationship among subcontractors, the number of subcontractors and workers, and whether training and medical examinations were provided at the time of employment were not sufficient.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW interviewed the primary contractors about the situation of exposure dose control (from late May to mid-June 2011).

・MHLW requested the primary contractors to report the current contract conditions (relationship among subcontractors, the number of subcontractors and workers, and whether education and medical examinations were provided at the time of employment) on a monthly basis (notified on 27 June 2011).

(4) Improvement of the lodging and meals

Many workers were unable to go back home or to their usual dormitories because the area within the 20 km radius from the affected plant was designated as the restricted area. Furthermore, many workers had to stay near the plant in preparation for any unexpected events. As a result, many workers were forced to sleep all crowded together on the floor in the seismically isolated building of the affected plant or the gymnasium of Fukushima Daini NPP, 13 km apart from the affected plant. In addition, the meals served were processed food in "retort pouches" in order to prevent internal exposure. Because workers were engaged in hard work without sufficient rest nor nutritious meals, there were concerns about worsening workers' health and occurrence of an accident caused by their operational errors.

In response to the above, the following actions were taken.

[Actions taken by MHLW]

・MHLW demanded that TEPCO undertake the following actions (20 April 2011):

(a) Reserve sleeping areas equipped with bedding and other required supplies.

(b) Take preventive measures against infectious diseases.

[Actions taken by TEPCO]

(a) TEPCO installed double-deck beds and supplied bedclothes for 240 workers in the gymnasium at Fukushima Daini NPP and installed equipment for 30 showers in the gymnasium and 42 double-deck beds in the seismically isolated building.

(b) TEPCO built a temporary dormitory at J-Village that accommodated 1600 workers.

(c) TEPCO changed meals from ready-made food in "retort pouches" to fresh boxed lunches in response to the decrease of radioactive materials and reopened the restaurant in J-Village.

(d) TEPCO reopened the restaurants in the main administration building at Fukushima Daini NPP (18 June 2012).

1.3 The status of long term health control at the TEPCO Fukushima Daiichi NPP

MHLW established "Guidelines on Maintaining and Improving Health of Emergency Workers at the TEPCO Fukushima Daiichi NPP" on 11 October 2011. The Guidelines describes "Actions for long-term health control", "Development of a database for workers who have engaged in emergency work" and "Support provided by the Government".

Based on the guidelines, MHLW and TEPCO are implementing the long term health control of cancer screenings etc. corresponding to the exposure dose values for the workers who had been engaged in the emergency work at TEPCO Fukushima Daiichi NPPs.

The implementation status as of 26 November 2014 is as follows;

(1) Status of registration card issuance

Out of 19,675 emergency workers, 19,383 workers (98.3%) were issued cards. For those 337 workers who had not received of the cards, confirmation of addresses was continuing.

(2) Status of handbook for recording radiation exposure doses (Handbook) issuance

Out of 904 designated emergency workers, 781 workers (86.4%) were issued handbooks. In February 2013, a document that recommended the handbook application was delivered to the employers of the designated workers. Recommendation for the application etc. will be continued in the future.

(3) Status of data base registration of the medical examination results

The implementation rate of the special medical examinations has reached 92.7% (the data registration is 77.9%), and that of general medical examinations has reached 91.9% (the data registration is 71.2%).

(4) Status of the data base registration of the cancer screenings results of designated emergency workers

(a)Recommendation to implement cancer screenings specified in the Guidelines (From June to November 2012 and November 2013)

Several recommendations to implement cancer screenings were delivered to the employers. The survey of current addresses for all designated workers should be conducted once a year. (June 2014)

(b)The results of the implementation status for cancer screenings (From October 2012 to September 2013)

Implementation rate for cataract screening was 67.4%, and that for cancer screenings was 96.78% respectively.

(c)Status of database registration of the cancer screenings results (From October 2012 to September 2013)

For current workers, data base registration for cataract screening was 54.7%, and that for cancer screenings was 63.6% respectively.

(5) Status of health consultation or guidance to emergency workers at the support desk (From April 2013 to March 2014)

There were 214 consultations cases, of which 91 cases were long term health control, and 53 cases were about radiation exposure and health effects.

1.4 Recommendations

On 10 August 2012, in response to the issues that were shown in previous sections, MHLW demanded the employers who operate nuclear facilities to prepare for nuclear accidents that may necessitate emergency work and also to prepare for the actions that may need to be taken when an accident occurred. This section shows accident preparations, and the actions to be taken at the time of an accident by the employers in response to the directions.

The guidance document is available at;
http://www.mhlw.go.jp/english/topics/2011eq/workers/ri/pr/pr_120810.html

1.4.1 Personal identification and exposure dose control

(1) Insufficient exposure dose control system in the exposure dose control department

(a)Preparations to be made by the employers

[Actions taken at the nuclear facilities including NPPs (hereinafter referred to as "the nuclear facility")]

・Develop a plan in preparation for emergency work to establish an organization to consolidate the radiation control of all the emergency workers (hereinafter referred to as "systematic control organization") in the nuclear facility (or the corporate offices if it is beyond the ability of the nuclear facility).

・Develop an emergency action plan for the case that the normally used systems become unavailable for exposure dose control, and prepare for increasing temporary staff members to be engaged in exposure dose control.

[Actions taken by the primary contractors]

・Establish the management system for dose control in emergency situations, as well as educate and train staff members to perform radiation control.

[Actions taken in the corporate offices or at the facilities with the functionality of the nuclear department in the corporate offices, excluding at the nuclear facilities (hereinafter "the corporate offices")]

・If necessary, develop a plan in advance to establish systematic control organization in the corporate offices.

・In preparation for supporting radiation control in the corporate offices and dispatching staff to help at the nuclear facility, make a staff list, provide required preliminary education and training to inexperienced staff members, and establish a system in the corporate offices for being able to increase the number of staff members temporarily.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Establish a system for exposure dose control such as by temporarily increasing the number of staff members in charge of dosimeter-lending for the case that the systems normally used are not available.

[Actions taken by the primary contractors]

・Ensure a system for exposure dose control such as by temporarily increasing the number of staff members carrying out radiation control in each primary contractor, and establishing an organization that can consolidate radiation exposure doses of workers under all the involved subcontractors.

[Actions taken in the corporate offices]

・Check the system for exposure dose control at the nuclear facility, and provide support such as by dispatching staff members from the corporate offices, as appropriate

・Check the situation in exposure data inputting work at the nuclear facility and, if there are any problems in the system for exposure dose control, obtain the administrative documents from the NPP and perform exposure dose control including the exposure data input and name-based dose consolidations directly in the corporate offices.

(2) Insufficient numbers of personal dosimeters

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Prepare sufficient numbers of extra PADs that can be used during emergency works (including battery chargers and emergency power generators, if non battery-powered (hereinafter all PADs and their auxiliary equipment are referred to as "PADs").

・Make agreements with other nuclear facilities in advance to supply sufficient number of PADs for all emergency workers (including those who are not engaged normally in radiation works).

[Actions taken in the corporate offices]

・Support the nuclear facility such as by discussing and making an agreement with other corporate offices for borrowing PADs.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Check whether or not sufficient PADs are available immediately after the occurrence of an accident.

・Once the shortage of PADs is found, borrow them immediately from other nuclear facilities in accordance with the agreement made in advance.

[Actions taken in the corporate offices]

・Check if a sufficient number of PADs are available at the nuclear facility, and if required, provide support to allow the nuclear facility to obtain PADs from other nuclear facilities, as appropriate.

(3) Deficiencies in dosimeter-lending management

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・In the case that the normally used system becomes unavailable, issue access permits with both personal identification numbers (hereinafter referred to as "ID number(s)") and photos, and build a backup system in advance that can control exposure dose by the ID number on mobile personal computers or computer systems that can be used in emergency situations (hereinafter referred to as "the backup system").

・In the case that the backup system is not operable, establish in advance an administrative list form to be filled in by hand and the administration method using the central registration number for each worker's radiation passbook and driver's license number (if it is difficult to use those, a combination of date of birth and name) as a temporary ID number (hereinafter referred to as "the temporary ID number").

・Conduct training on a regular basis so as to implement the management stated in (1) and (2) immediately in emergency situations.

[Actions taken in the corporate offices]

・In the case that the backup system is not operable at the nuclear facility, set up a backup system in the corporate offices as well. Note ,however, that this may not apply to the case that the backup system is installed in the seismically-isolated buildings located at a sufficient isolation distance and consisting of structures and equipment that can maintain internal radiation protective functions (hereinafter referred to as "the seismically isolated building") even if a hydrogen explosion occurs in a nuclear reactor or its vicinity.

(b) Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Make a backup system available.

・Use the hand-written administrative list to manage dosimeters using temporary ID numbers until the backup system is running.

・Once the backup system is running, verify individuals based on official documents, issue access permits, lend dosimeters based on the ID number, and record radiation exposure doses.

[Actions taken by the primary contractors]

・Ensure proper management of the access permit to prevent its use by anyone except the registered worker.

[Actions taken in the corporate offices]

・Check the situation of the dosimeter lending administration in the nuclear facility, and provide support such as by making a backup system in the corporate offices operable, as appropriate

(4) Delay of radiation exposure dose notification to workers

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Ensure that the backup system prepared for unavailability of the normally used system provides the function of issuing receipts to workers providing them with a written notice of their daily radiation exposure doses.

・Specify in advance the procedures for immediately informing the primary contractors of the input data when it is necessary for the corporate offices to undertake inputting of doses.

[Actions taken in the corporate offices]

・Plan in advance the procedures for immediately informing the nuclear facility of the dose data at the corporate offices, if the corporate offices are required to do so after the accident.

・For the case that the backup system is not operable at the nuclear facility, set up a backup system with a function to issue receipts in the corporate offices. Note, however, that this may not apply to the case that the backup system is located in the seismically isolated building. (Repeated notice was given for this action.)

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Make a backup system operable, and issue receipts of radiation exposure doses to workers.

・While the backup system is unavailable, issue a written notice of radiation exposure doses to workers at the time of returning dosimeters (hand-written memos are acceptable).

・Immediately inform the primary contractors of the radiation exposure doses data inputted.

[Actions taken by the primary contractors]

・Immediately notify all the workers under the involved subcontractors through the involved subcontractors of the dose data obtained from the nuclear facility.

[Actions taken in the corporate offices]

・Check the situation in dose data input and notification among employers at the nuclear facility, and perform the tasks such as data input in the corporate offices, as appropriate.

・If the data input task is performed in the corporate offices, provide the input data to the nuclear facility immediately.

(5) Delay of internal exposure monitoring

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・In order to measure internal exposure, specify in advance the places to locate mobile WBCs which will be borrowed in case of an accident under the prior agreements made by the relevant corporate offices.

・Develop in advance the method for evaluating internal exposure in emergency situations, such as identifying the date of ingestion or inhalation through a study of worker behavior.

[Actions taken in the corporate offices]

・For the agreements stated in (1) above, provide support such as by negotiating and concluding agreements with the corporate offices of other utilities and organizations, as appropriate.

・Develop in advance an assessment model to evaluate exposure to radionuclides of cesium and/or radionuclide of iodine after accidents in cooperation with JAEA and NIRS (hereinafter referred to as "the Advanced Radiation Expert Institutes").

・Develop in advance a plan for responding to an accident including the method for positioning WBCs outside a nuclear facility for the case that they cannot be located inside it. Also, make an agreement with other utilities and the Federation of Electric Power Companies of Japan to make mobile WBCs available for transport in emergency situations.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Ask other nuclear facilities in accordance with the agreement concluded in advance, to obtain mobile WBCs and transport them to a proper location when the normally used WBCs become unavailable.

・Immediately establish an internal exposure assessment model suitable for the released nuclides, in cooperation with the Advanced Radiation Expert Institute.

・Immediately determine the nuclides and the date of ingestion or inhalation for the workers who may exceed their normal exposure dose limit, by making use of WBCs in the Advanced Radiation Expert Institute, and determine the committed dose.

・Immediately consolidate the committed doses and external radiation doses by name and calculate the sums to ensure workers do not exceed the exposure limit.

[Actions taken by the primary contractors]

・Check the situation of internal exposure measurement by the involved subcontractors, and guide or support them to provide the measurement to all their workers.

[Actions taken in the corporate offices]

・Check the situation of internal exposure measurement at the nuclear facility, and if the normally used WBCs become unavailable, provide support so that the nuclear facility can obtain transferable WBCs from other nuclear facilities, and can measure internal exposure at other nuclear institutions.

・Provide technical support in cooperation with the Advanced Radiation Expert Institutes to identify the specific nuclides causing internal exposure, develop an exposure model, and identify the date of ingestion or inhalation.

(6) Unexpected occurrence of workers who could not be contacted

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Specify the procedures to successfully identify individuals until the backup system is up and running, such as by recording temporary ID numbers and names on the hand-written dosimeter lending list.

・For the case that contact is lost with any individual workers, specify in advance the investigation methods including checking the original records, checking for overlap of similar names, having them confirmed by other primary contractor groups, asking employers' office in site for investigation, making use of professional investigation agencies, and making those individuals' names known in public places.

[Actions taken in the corporate offices]

・Provide support when the nuclear facility develops survey methods, as appropriate.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Conduct the dosimeter-lending administration for emergency situations in the manner specified in advance.

・In the case that contact is lost with any individual workers, immediately check for overlap of similar names and ask the employers' office in site for reconfirmation, in cooperation with the primary contractors' office in site.

[Actions taken by the primary contractors]

・In the case that contact is lost with any individual workers, immediately check for overlap of similar names and ask the employers' office on site for reconfirmation.

[Actions taken in the corporate offices]

・Check the dosimeter lending procedures at the nuclear facility, and if contact is lost with any individual workers, reconfirm the dose records in the corporate offices, as required.

1.4.2 Respiratory protective equipment and protective clothing

(1) Exceeding emergency exposure dose limit

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Prepare required measurement instruments and establish measurement procedures so as to measure radiation dose in air at any time in places inside of the nuclear facilities where workers work or are on standby in emergency situations (hereinafter referred to as "the standby areas") (including places where air is considered to be not contaminated under normal conditions).

・In the case standby areas are contaminated, based on the breakthrough time, prepare a sufficient number of charcoal filters for workers to allow them to stay for several days at the standby areas, and store spare filters in the seismically isolated building.

・Train emergency workers (particularly focusing on such workers as drivers who do not generally wear respiratory protective equipment very often, and those wearing glasses) on how to wear respiratory protective equipment in an appropriate manner, and re-educate them at proper intervals.

・Conclude agreements with other nuclear facilities in advance to lend WBCs that can be transferred in emergency situations so as to measure internal exposure of all the emergency workers. (Repeated notice was given for this action.)

[Actions taken in the corporate offices]

・Provide support to allow the nuclear facility to take the actions, as appropriate.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Make all the workers in the standby areas wear charcoal filter respiratory protective equipment immediately after an accident, until it is verified that the air is not contaminated based on the concentration of radioactive materials in the air.
・Distribute a sufficient number of charcoal filters in every standby area, based on the breakthrough time.
・In the case that workers need to standby in a work area where air contamination is uncertain, give them some rest at a proper interval in a work area where it is verified that the air is not contaminated.
・Measure the concentrations of radioactive materials in the air and ambient dose rates in the standby areas continuously.
・Immediately measure internal exposure for all the workers in the standby areas where air contamination is uncertain.

[Actions taken in the corporate offices]

・Check the situation of radiation measurement in the standby areas of the nuclear facility, and provide support such as by dispatching staff members of the radiation control departments in other nuclear facilities, as appropriate.

(2) Exceeding exposure dose limit for women

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Prepare the required measurement instruments and establish measurement procedures so as to measure radiation dose in the air at any time in the standby areas. (Repeated notice was given for this action.)
・Prepare charcoal filter respiratory protective equipment at each standby area, and store spare equipment in the seismically isolated building in advance. (Repeated notice was given for this action.)
・Prepare a sufficient number of personal dosimeters such as PADs for all the emergency workers (including those who are not engaged normally in radiation works). (Repeated notice was given for this action.)

[Actions taken in the corporate offices]

・Provide support to allow the nuclear facility to take the necessary actions, as appropriate.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Measure the concentrations of radioactive materials in the air and ambient dose rates in the standby areas continuously, putting a higher priority on those areas where female workers are present. Evacuate female workers immediately if there are any possibilities that the doses may exceed the exposure limit.
・Make all the workers in the standby areas wear charcoal filter respiratory protective equipment and PADs immediately after an accident, until it is verified that air is not contaminated by measuring the concentration of radioactive materials in the air. (Repeated notice was given for this action.)

[Actions taken in the corporate offices]

・Check the situation of measurement in stand-by areas of the nuclear facility, and provide support regarding the management of female workers, as appropriate.

(3) Improper use of respiratory protective equipment

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Group masks by size (or product makers if multiple products are used) in order to have workers easily choose the one best suited to their faces.
・Promote introduction of masks with an electric powered fan.
・Provide new workers with education regarding the performance and usage of masks focusing on the following points, and re-educate them at proper intervals.

1) How to verify of proper fitting using fitting testers
2) Taking preventive measures against leak-in, especially having use sealing pieces on their glasses
3) Instructing workers how to wear masks, and how to verify operation of fitting filters
4) Instructing workers how to handle masks properly to prevent contamination inside them

[Actions taken in the corporate offices]

・Provide support such as by preparing education materials and training instructors to be dispatched in emergency situations, so that the nuclear facilities can take the necessary actions, as appropriate.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Immediately educate new workers regarding the points shown in (3) of the previous section, namely ” (a) Preparations to be made by the employers”.

[Actions taken in the corporate offices]

・Check the situation of education for new workers in the nuclear facility, and provide support such as by dispatching instructors to assist in the education sessions and providing education materials, as appropriate.

(4) Improper protective garments

(a)Preparations to be made by the employers

[Actions taken at the nuclear facility]

・Prepare a sufficient number of rubber boots, chemical protective suits, and waterproof protective clothing (hereinafter referred to as "the protective clothing") for emergency situations.
・Prepare a sufficient number of dosimeters including PADs for emergency situations (Repeated notice was given for this action.).

[Actions taken in the corporate offices]

・Provide support to allow the nuclear facility to take action in an appropriate manner.

(b)Post-accident actions to be taken by the employers

[Actions taken at the nuclear facility]

・Prepare a sufficient amount of protective clothing and ensure workers wear them in an appropriate manner.
・Develop work instructions for the activities handling contaminated water, and provide appropriate education and training using the instructions.

[Actions taken in the corporate offices]

・Check the status of worker instruction on wearing protective clothing in the nuclear facility, and provide support, as appropriate.

1.4.3Training for new workers

(1) Insufficient training hours for workers

(a) Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Prepare a large enough classroom sufficient instructional materials for the sessions, and train instructors so as to provide sufficient sessions in emergency situations to all of those who need the education as new workers.
・In addition to the special education program conventionally offered in nuclear reactor/nuclear fuel handling, develop instructional materials regarding the evacuation methods, emergency responses and radiation dose control methods at the time of an accident, and provide education and re-education at proper intervals, to workers doing these works.
・Educate workers engaged in radiation works (particularly focusing on those such as drivers who do not generally wear respiratory protective equipment and workers wearing eyeglasses) on how to wear respiratory protective equipment in an appropriate manner, and re-educate them at proper intervals (Repeated notice was given for this action.).

[Actions taken in the corporate offices]

・Support the nuclear facility to develop education and training materials.
・Train a sufficient number of instructors to train workers, in order to dispatch them to the nuclear facility in emergency situations.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Provide education to emergency workers who require education as new workers and according to the curriculum, prepared in advance.
・Check if the classroom size, the materials and the number of instructors are sufficient, and ask the corporate offices for support otherwise.

[Actions taken by the primary contractors]

・In cooperation with the nuclear facility, support the education for new workers for all the workers under the involved subcontractors.

[Actions taken in the corporate offices]

・Check the situation of educating workers in the nuclear facility, and provide support such as by dispatching instructors to assist in the education sessions and provide education materials, as appropriate.

1.4.4 Health and medical care system

(1) Establishment of the medical care system in the affected plant

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Coordinate with the relevant agencies under the support of the District Labour Bureau to establish a council consisting of prefectural health care and medical offices, fire departments, nearby medical centers, nuclear facilities and prefectural labour bureaus, and other relevant agencies (hereinafter referred to as "the council for medical care system") which aims at establishing a proper medical care system for workers in nuclear facilities.
・In the case that the normally used medical center becomes unavailable after an accident has occurred, reserve a place which can accommodate materials and equipment for medical centers in a building of the nuclear facility (or an appropriate building located within several kilometers from the nuclear facility if no such building exists in the NPP) with a sufficient distance to ensure safety, even if hydrogen explosion occurred at a nuclear reactor or its vicinities.
・Consider the health and medical care system required to ensure mental and physical health of workers engaged in emergency work, and make the required preparations.

[Actions taken in the corporate offices]

・Participate in the council for the medical care system to support the nuclear facility in securing a medical care system in emergency situations.

(b)Post-accident actions to be taken by the employers

[Instructions to the nuclear facility]

・Request the dispatch of medical care workers considering the number of emergency workers, based on the medical care system developed in advance.
・Launch operation of an emergency medical center at the location prepared in advance, in the case that the normally used medical center became unavailable.
・Immediately establish the required medical care system to ensure mental and physical health of workers engaged in emergency work.

[Actions taken in the corporate offices]

・Check the status of the medical care system in the nuclear facility, and provide support, as appropriate

(2) Prevention of heat stroke

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Take preventive measures against heat stroke in advance including determining the suppliers of cooling vests and cooler boxes; building a rest area equipped with the required functions; developing procedures for actions to be taken when heat strokes occurs; forecasting conditions likely promote heat stroke occurrence using WBGT; and obtaining educational materials regarding heat stroke, on the assumption that workers work wearing heavy equipment under the brazing sun.
・Establish in advance a framework to share information among the employers engaged in construction work in the plant.

[Actions taken in the corporate offices]

・Provide the nuclear facility with support to take proper preventive measures against heat stroke, as appropriate.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Take the planned preventive measures against heat stroke in a proper manner for workers working in hot and humid place.
・Check physical conditions frequently, making use of medical questionnaires.
・When heat stroke occurs, analyze the causes, and reflect the results in measures to prevent recurrence, and share them through the council consisting of the primary contractors.

[Actions taken by the primary contractors]

・Provide required guidance or support in cooperation with the nuclear facility to ensure that the involved subcontractors can take proper preventive measures against heat stroke.

[Actions taken in the corporate offices]

・Check the status of taking preventive measures against heat stroke in the nuclear facility, and provide support, as appropriate.

(3) Instructions to conduct special medical examinations

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Build a consensus with the relevant parties in the council for the medical care system to immediately conduct special medical examinations in case that emergency work leads to a high-level of exposure.

[Actions taken in the corporate offices]

・In the case that the nuclear facility cannot conduct the special medical examinations during emergency work, consider and make required preparations to directly conduct and manage them.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Conduct special medical examinations in accordance with the inspection items in the examinations as instructed.

・Obtain correct information on the primary contractors, and provide special medical examinations to workers under the involved subcontractors.

・Check the situation of special medical examinations conducted by the primary contractors.

[Actions taken by the primary contractors]

・Obtain the correct number of workers under the involved subcontractors, and provide the required guidance or support to ensure that the workers under the involved subcontractors can undertake the special medical examinations.

・Check the situation of the special medical examinations conducted by the involved subcontractors.

[Actions taken in the corporate offices]

・Check the situation of the special medical examinations in the nuclear facility, and provide support such as by dispatching medical care workers to assist, as appropriate.

(4) Establishing patient transport systems from the affected plant

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Build a consensus with the relevant parties in the council for medical care system on the emergency transport systems.

・Prepare a heliport near the nuclear facility to be used by a helicopter ambulance after the occurrence of an accident.

[Actions taken in the corporate offices]

・Participate in the council for the medical care system to support the nuclear facility in providing transport systems.

(b)Post-accident actions to be taken by the employers

[Instructions to the nuclear facility]

・Request emergency transport systems based on the consensus reached in the council for the medical care system.

・Prepare the pre-arranged heliport for an air ambulance according to the severity of the accident, and request the operation of the air ambulance in accordance with the consensus in the council for the medical care system.

[Actions taken in the corporate offices]

・Check the transport systems in the nuclear facility, and provide support such as by consulting with medical care institutions, fire authorities and aviation authorities, as appropriate.

(5) Long-term health care program

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Make advance preparations to take actions for emergency workers, conforming to the Minister's guidelines.

[Actions taken in the corporate offices]

・Support the nuclear facility to make the required preparations for properly conducting long-term health care in emergency situations.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Take actions for emergency workers, in accordance with the Minister's guidelines.

[Actions taken in the corporate offices]

・Check the situation of the long-term health care conducted by the nuclear facility to provide support, as appropriate.

1.4.5 Preliminary review of work plans

(1) Insufficient management system for developing work plans

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・In the case that emergency work is required, establish an organizational system at both the nuclear facility and the corporate offices to develop and review the emergency work plans.

[Actions taken in the corporate offices]

・Formulate an organizational system in advance that allows the corporate offices to review the emergency work plans directly in the case of an emergency.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Formulate and review details of emergency work under the predetermined organizational system, in order to prepare and submit work plans that include proper actions to mitigate exposure.

[Actions taken in the corporate offices]

・Check the situation of preparing work plans at the nuclear facility, and provide support such as by reviewing the details at the corporate offices and dispatching the staffs for help, as appropriate.

(2) Deficiencies of work plans

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Reflect the summarized typical findings indicated by the Labour Standard Inspection Office having jurisdiction over the nuclear facility when developing work plans in normal situations in addition to emergency work.

[Actions taken in the corporate offices]

・Plan the organizational system in advance to allow the corporate offices to review the details of works directly, in the case that the NPP cannot do the task properly in case of emergency.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Develop and review the details of emergency work plans, and prepare and submit work plans that include proper actions to mitigate exposure, based on the findings indicated in advance.

[Actions taken in the corporate offices]

・Check the situation of the work plans prepared by the nuclear facility, and provides support such as by directly reviewing them at the corporate offices, as appropriate.

(3) Insufficient knowledge about contract conditions

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Arrange in advance the system for collecting information on workers under the involved subcontractors through the primary contractors in the case of an emergency.

[Actions taken by the primary contractors]

・Establish in advance the system for obtaining correct information on workers engaged in emergency work under the involved subcontractors.

[Actions taken in the corporate offices]

・Provide support to allow the nuclear facility to take the necessary actions in an appropriate manner.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Collect information on subcontractors through the primary contractors, and check if education and medical examinations are provided in an appropriate manner.

[Actions taken by the primary contractors]

・Be sure to obtain information on workers under the involved subcontractors who are engaged in emergency work, and provide guidance or support appropriately to ensure that education and medical examinations are provided in a proper manner.

[Actions taken in the corporate offices]

・Check the situation of collecting the information on contract conditions at the nuclear facility, and provide support appropriately.

(4) Improvement of the lodging and meals

(a)Preparations to be made by the employers

[Actions taken at nuclear facilities]

・Prepare temporary sleeping equipment with bedclothes, and plan in advance where to locate them for an emergency.

・Prepare a sufficient volume of emergency meals with good nutritional balance for an emergency.

[Actions taken in the corporate offices]

・Provide support to allow for the nuclear facilities to take the necessary actions in an appropriate manner.

(b)Post-accident actions to be taken by the employers

[Actions taken at nuclear facilities]

・Make temporary sleeping areas available and provide meals based on the pre-determined plan.

[Actions taken in the corporate offices]

・Check the conditions of temporary sleeping areas and meals in the nuclear facility, and provide support, as appropriate.

1.5 Exposure dose distribution of workers at the TEPCO Fukushima Daiichi NPP

The status of the radiation exposure dose is shown on the URL of the MHLW (English)
http://www.mhlw.go.jp/english/topics/2011eq/workers/irpw/index.html

Exposure dose distribution of the workers at Fukushima Daiichi NPP (provided by TEPCO)

[Table.1 Cumulative Effective Dose (by year)]

As of 31 December 2014

March 2011 - March 2012

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	6	0	6
200 < E <= 250	1	2	3
150 < E <= 200	26	2	28
100 < E <= 150	117	20	137
75 < E <= 100	186	65	251
50 < E <= 75	257	258	515
20 < E <= 50	630	2,660	3,290
10 < E <= 20	491	2,892	3,383
5 < E <= 10	376	2,557	2,933
1 < E <= 5	589	4,621	5,210
<E <= 1	737	4,632	5,369
Total	3,416	17,709	21,125
Maximum (mSv)	678.80	238.42	678.80
Average (mSv)	25.14	10.06	12.50

April 2012 - March 2013

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	0	0	0
200 < E <= 250	0	0	0
150 < E <= 200	0	0	0
100 < E <= 150	0	0	0
75 < E <= 100	0	0	0
50 < E <= 75	1	0	1
20 < E <= 50	62	675	737
10 < E <= 20	129	2,000	2,129
5 < E <= 10	266	1,875	2,141
1 < E <= 5	579	3,326	3,905
<E <= 1	588	4,240	4,828
Total	1,625	12,116	13,741
Maximum (mSv)	54.10	43.30	54.10
Average (mSv)	4.49	5.90	5.74

April 2013 – March 2014

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	0	0	0
200 < E <= 250	0	0	0
150 < E <= 200	0	0	0
100 < E <= 150	0	0	0
75 < E <= 100	0	0	0
50 < E <= 75	0	0	0
20 < E <= 50	31	629	660
10 < E <= 20	95	2,067	2,162
5 < E <= 10	195	1,897	2,092
1 < E <= 5	670	3,739	4,409
<E <= 1	701	4,722	5,423
Total	1,692	13,054	14,746
Maximum (mSv)	41.90	41.40	41.90
Average (mSv)	3.24	5.51	5.25

April 2014 – December 2014

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	0	0	0
200 < E <= 250	0	0	0
150 < E <= 200	0	0	0
100 < E <= 150	0	0	0
75 < E <= 100	0	0	0
50 < E <= 75	0	0	0
20 < E <= 50	5	604	609
10 < E <= 20	17	1,651	1,668
5 < E <= 10	130	2,340	2,470
1 < E <= 5	573	5,015	5,588
<E <= 1	898	6,954	7,852
Total	1,623	16,564	18,187
Maximum (mSv)	24.18	39.85	39.85
Average (mSv)	1.74	4.27	4.05

*The exposure dose is subject to change due to the replacement of the PAD-measured dose by the glass badge-measured dose. The number of workers is also subject to change due to the addition of workers who wore only glass badges (e.g., workers who work only indoors).

[Table2. Radiation Exposure Dose Distribution (by month)]

As of 31 December 2014

Month/ Year		<E <= 1	1 < E <= 5	5 < E <= 10	10 < E <= 20	20 < E <= 50	50 < E <= 75	75 < E <= 100	100 < E <= 150	150 < E <= 200	200 < E <= 250	250 < E	Total	Maximum (mSv)	Average (mSv)
March 2011	TEPCO	40	66	238	529	539	119	77	65	16		6	1695	670.36	31.54
	Contractors	406	524	397	460	371	65	34	17	2	2		2278	238.42	14.16
	Total	446	590	635	989	910	184	111	82	18	2	6	3973	670.36	21.57
April 2011	TEPCO	228	323	857	186	62	1						1657	59.60	6.66
	Contractors	1556	1466	624	433	128							4207	49.61	4.34
	Total	1784	1789	1481	619	190	1						5864	59.60	5.00
May 2011	TEPCO	437	782	171	73	14							1477	33.42	3.14
	Contractors	2216	2369	805	350	80							5820	48.80	3.37
	Total	2653	3151	976	423	94							7297	48.80	3.32
June 2011	TEPCO	513	723	85	30								1351	16.29	2.12
	Contractors	2548	2648	768	350	65	1	1					6381	89.50	3.08
	Total	3061	3371	853	380	65	1	1					7732	89.50	2.91
July 2011	TEPCO	653	626	53	17	3							1352	31.13	1.69
	Contractors	2893	2758	587	200	37	3						6478	61.97	2.44
	Total	3546	3384	640	217	40	3						7830	61.97	2.31
August 2011	TEPCO	545	666	57	19	1							1288	23.33	1.72
	Contractors	2814	2727	485	162	25	2						6215	66.50	2.20
	Total	3359	3393	542	181	26	2						7503	66.50	2.12
September 2011	TEPCO	534	634	38	2								1208	11.35	1.45
	Contractors	2840	2583	399	140	23							5985	33.40	2.02
	Total	3374	3217	437	142	23							7193	33.40	1.92
October 2011	TEPCO	564	553	45	15	3							1180	36.35	1.57
	Contractors	2812	2350	337	103	8							5610	23.50	1.85
	Total	3376	2903	382	118	11							6790	36.35	1.80
November 2011	TEPCO	853	280	37	10								1180	13.40	1.07
	Contractors	3349	1911	227	82	5							5574	23.03	1.46
	Total	4202	2191	264	92	5							6754	23.03	1.39
December 2011	TEPCO	868	282	26	13	3							1192	23.20	1.10
	Contractors	3336	1729	258	76								5399	19.20	1.44
	Total	4204	2011	284	89	3							6591	23.20	1.38
January 2012	TEPCO	762	284	37	13								1096	17.00	1.18
	Contractors	3235	1434	203	72	1							4945	21.90	1.36
	Total	3997	1718	240	85	1							6041	21.90	1.33
February 2012	TEPCO	845	231	25	8								1109	17.63	0.91
	Contractors	2944	1578	221	100	2							4845	20.91	1.50
	Total	3789	1809	246	108	2							5954	20.91	1.39
March 2012	TEPCO	874	220	23	2								1119	12.10	0.83
	Contractors	3029	1464	206	53	3							4755	21.83	1.36
	Total	3903	1684	229	55	3							5874	21.83	1.26
April 2012	TEPCO	870	179	19	3								1071	13.00	0.75
	Contractors	2836	1304	151	75	3							4369	23.90	1.30
	Total	3706	1483	170	78	3							5440	23.90	1.19
May 2012	TEPCO	853	177	10	1								1041	10.20	0.66
	Contractors	2898	1406	246	49								4599	18.22	1.41
	Total	3751	1583	256	50								5640	18.22	1.28
June 2012	TEPCO	829	162	20	3								1014	12.10	0.78
	Contractors	3086	1652	220	29								4987	14.94	1.29
	Total	3915	1814	240	32								6001	14.94	1.21

Month/ Year		<E <= 1	1 < E <= 5	5 < E <= 10	10 < E <= 20	20 < E <= 50	50 < E <= 75	75 < E <= 100	100 < E <= 150	150 < E <= 200	200 < E <= 250	250 < E	Total	Maximum (mSv)	Average (mSv)
July 2012	TEPCO	854	150	9									1013	6.60	0.62
	Contractors	3065	1621	222	38								4946	17.33	1.34
	Total	3919	1771	231	38								5959	17.33	1.21
August 2012	TEPCO	835	144	7									986	7.20	0.62
	Contractors	3299	1341	120	4								4764	11.64	1.04
	Total	4134	1485	127	4								5750	11.64	0.97
September 2012	TEPCO	850	123	9									982	8.20	0.57
	Contractors	3272	1274	163	29	1							4739	20.50	1.15
	Total	4122	1397	172	29	1							5721	20.50	1.05
October 2012	TEPCO	826	145	7									978	6.30	0.61
	Contractors	3307	1325	136	31								4799	16.00	1.11
	Total	4133	1470	143	31								5777	16.00	1.03
November 2012	TEPCO	812	149	7									968	9.50	0.61
	Contractors	3306	1222	145	27								4700	18.70	1.09
	Total	4118	1371	152	27								5668	18.70	1.01
December 2012	TEPCO	846	149	10									1005	7.50	0.58
	Contractors	3489	1363	180	10								5042	15.00	1.10
	Total	4335	1512	190	10								6047	15.00	1.01
January 2013	TEPCO	870	96	3									969	7.39	0.42
	Contractors	3768	1310	115	7								5200	12.90	0.96
	Total	4638	1406	118	7								6169	12.90	0.88
February 2013	TEPCO	870	105	2									977	5.43	0.45
	Contractors	3916	1415	263	35								5629	18.50	1.21
	Total	4786	1520	265	35								6606	18.50	1.09
March 2013	TEPCO	845	140	10	2								997	11.03	0.60
	Contractors	3907	1706	335	35								5983	19.30	1.35
	Total	4752	1846	345	37								6980	19.30	1.24
April 2013	TEPCO	948	108	4									1060	5.90	0.49
	Contractors	4029	1165	111	5								5310	14.40	0.88
	Total	4977	1273	115	5								6370	14.40	0.81
May 2013	TEPCO	896	100	4									1000	8.60	0.45
	Contractors	3920	1141	92	5								5158	15.80	0.85
	Total	4816	1241	96	5								6158	15.80	0.78
June 2013	TEPCO	931	87	6									1024	7.40	0.42
	Contractors	3731	1182	85	7								5005	17.50	0.87
	Total	4662	1269	91	7								6029	17.50	0.79
July 2013	TEPCO	891	96	1									988	5.50	0.43
	Contractors	3752	1128	107	9								4996	14.80	0.89
	Total	4643	1224	108	9								5984	14.80	0.81
August 2013	TEPCO	834	118	4									956	6.10	0.49
	Contractors	3665	1211	142	40								5058	19.89	1.03
	Total	4499	1329	146	40								6014	19.89	0.94
September 2013	TEPCO	933	102	3									1038	5.60	0.44
	Contractors	3525	1420	247	61	1							5254	20.58	1.28
	Total	4458	1522	250	61	1							6292	20.58	1.14
October 2013	TEPCO	893	146	8									1047	9.50	0.55
	Contractors	3460	1556	343	47								5406	19.36	1.43
	Total	4353	1702	351	47								6453	19.36	1.29

Month/ Year		<E <= 1	1 < E <= 5	5 < E <= 10	10 < E <= 20	20 < E <= 50	50 < E <= 75	75 < E <= 100	100 < E <= 150	150 < E <= 200	200 < E <= 250	250 < E	Total	Maximum (mSv)	Average (mSv)
November 2013	TEPCO	954	120	5									1079	9.20	0.48
	Contractors	3700	1533	303	32								5568	16.91	1.28
	Total	4654	1653	308	32								6647	16.91	1.15
December 2013	TEPCO	968	116	2									1086	5.40	0.44
	Contractors	3852	1627	199	23								5701	16.81	1.13
	Total	4820	1743	201	23								6787	16.81	1.02
January 2014	TEPCO	997	84										1081	4.50	0.37
	Contractors	4112	1505	221	53								5891	15.80	1.16
	Total	5109	1589	221	53								6972	15.80	1.04
February 2014	TEPCO	1018	56	4									1078	6.50	0.34
	Contractors	4611	1611	168	30								6420	17.29	1.02
	Total	5629	1667	172	30								7498	17.29	0.92
March 2014	TEPCO	1012	85										1097	4.80	0.36
	Contractors	4940	1867	227	23								7057	18.49	1.07
	Total	5952	1952	227	23								8154	18.49	0.98
April 2014	TEPCO	999	94	1									1094	5.70	0.38
	Contractors	5449	1743	234	19								7445	16.00	0.98
	Total	6448	1837	235	19								8539	16.00	0.91
May 2014	TEPCO	1053	65	1									1119	5.60	0.31
	Contractors	5974	1794	209	47	1							8025	20.70	0.95
	Total	7027	1859	210	47	1							9144	20.70	0.87
June 2014	TEPCO	1056	66	1									1123	6.80	0.32
	Contractors	6774	1790	329	26								8919	16.89	0.95
	Total	7830	1856	330	26								10042	16.89	0.88
July 2014	TEPCO	1092	39	1									1132	5.40	0.27
	Contractors	7292	1728	258	49								9327	18.69	0.89
	Total	8384	1767	259	49								10459	18.69	0.82
August 2014	TEPCO	1062	39										1101	3.40	0.25
	Contractors	7818	1338	214	9								9379	17.13	0.71
	Total	8880	1377	214	9								10480	17.13	0.67
September 2014	TEPCO	1110	51	1									1162	6.00	0.27
	Contractors	8001	1634	288	36								9959	18.22	0.84
	Total	9111	1685	289	36								11121	18.22	0.78
October 2014	TEPCO	1112	62										1174	2.70	0.29
	Contractors	7935	1766	234	18								9953	14.92	0.80
	Total	9047	1828	234	18								11127	14.92	0.75
November 2014	TEPCO	1141	45										1186	3.00	0.21
	Contractors	8179	1644	269	19								10111	15.92	0.78
	Total	9320	1689	269	19								11297	15.92	0.72
December 2014	TEPCO	982	49										1031	3.91	0.23
	Contractors	7950	1870	245	21								10086	15.41	0.80
	Total	8932	1919	245	21								11117	15.41	0.75

*The exposure dose is subject to change due to the replacement of the PAD-measured dose by the glass badge-measured dose.
The number of workers is also subject to change due to the addition of workers who wore only glass badges (e.g., workers who work only indoors).

[Table.3 Radiation Exposure Dose Distribution (by age)]

As of 31 December 2014

Ages 18 to 19

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	0	0	0
200 < E <= 250	0	0	0
150 < E <= 200	0	0	0
100 < E <= 150	0	0	0
75 < E <= 100	0	0	0
50 < E <= 75	0	0	0
20 < E <= 50	0	1	1
10 < E <= 20	0	8	8
5 < E <= 10	0	9	9
1 < E <= 5	0	28	28
<E <= 1	0	33	33
Total	0	79	79
Maximum (mSv)	0.00	20.72	20.72
Average (mSv)	0.00	3.59	3.59

Ages 20 to 29

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	2	0	2
200 < E <= 250	0	0	0
150 < E <= 200	3	0	3
100 < E <= 150	11	0	11
75 < E <= 100	80	7	87
50 < E <= 75	52	59	111
20 < E <= 50	78	472	550
10 < E <= 20	91	535	626
5 < E <= 10	63	486	549
1 < E <= 5	69	833	902
<E <= 1	72	909	981
Total	521	3301	3822
Maximum (mSv)	477.01	99.25	477.01
Average (mSv)	33.19	9.73	12.93

Ages 30 to 39

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	1	0	1
200 < E <= 250	1	2	3
150 < E <= 200	0	1	1
100 < E <= 150	28	2	30
75 < E <= 100	78	19	97
50 < E <= 75	86	259	345
20 < E <= 50	148	1021	1169
10 < E <= 20	148	925	1073
5 < E <= 10	109	843	952
1 < E <= 5	165	1584	1749
<E <= 1	193	1850	2043
Total	957	6506	7463
Maximum (mSv)	310.97	238.42	310.97
Average (mSv)	25.33	11.47	13.25

Ages 40 to 49

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	2	0	2
200 < E <= 250	0	0	0
150 < E <= 200	10	0	10
100 < E <= 150	32	4	36
75 < E <= 100	74	53	127
50 < E <= 75	83	384	467
20 < E <= 50	199	1564	1763
10 < E <= 20	215	1463	1678
5 < E <= 10	181	1381	1562
1 < E <= 5	336	2471	2807
<E <= 1	437	3155	3592
Total	1569	10475	12044
Maximum (mSv)	678.80	133.24	678.80
Average (mSv)	19.21	11.00	12.07

Ages 50 to 59

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	1	0	1
200 < E <= 250	0	0	0
150 < E <= 200	12	0	12
100 < E <= 150	43	10	53
75 < E <= 100	56	62	118
50 < E <= 75	91	374	465
20 < E <= 50	172	1526	1698
10 < E <= 20	122	1304	1426
5 < E <= 10	120	1270	1390
1 < E <= 5	224	2315	2539
<E <= 1	397	3051	3448
Total	1238	9912	11150
Maximum (mSv)	353.12	147.90	353.12
Average (mSv)	22.04	11.35	12.54

Ages 60 to 69

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	0	0	0
200 < E <= 250	0	0	0
150 < E <= 200	1	1	2
100 < E <= 150	3	4	7
75 < E <= 100	2	32	34
50 < E <= 75	15	176	191
20 < E <= 50	21	744	765
10 < E <= 20	4	701	705
5 < E <= 10	13	655	668
1 < E <= 5	13	1451	1464
<E <= 1	32	1940	1972
Total	104	5704	5808
Maximum (mSv)	197.00	176.00	197.00
Average (mSv)	24.22	9.87	10.13

Ages 70 and over

Effective dose (E) mSv	TEPCO	Contractors	Total
250 < E	0	0	0
200 < E <= 250	0	0	0
150 < E <= 200	0	0	0
100 < E <= 150	0	0	0
75 < E <= 100	0	2	2
50 < E <= 75	0	1	1
20 < E <= 50	0	14	14
10 < E <= 20	1	22	23
5 < E <= 10	1	23	24
1 < E <= 5	0	52	52
<E <= 1	1	79	80
Total	3	193	196
Maximum (mSv)	16.19	89.50	89.50
Average (mSv)	8.37	6.72	6.74

Number of workers

	TEPCO	Contractors	Total
Ages 18 to 19	0	79	79
Ages 20 to 29	521	3301	3822
Ages 30 to 39	957	6506	7463
Ages 40 to 49	1569	10475	12044
Ages 50 to 59	1238	9912	11150
Ages 60 to 69	104	5704	5808
Ages 70 and over	3	193	196
Ages unknown*	0	7	7
Total	4392	36177	40569
Maximum (mSv)	678.80	238.42	678.80
Average (mSv)	23.11	10.85	12.17

* Seven people, who cannot be contacted, are treated as “ages unknown”, because it is impossible to put them into any group.

2. Decontamination works resulting from the TEPCO Fukushima Daiichi NPP Accident and necessary radiation protection measures

2.1 Radiation protection of workers involved in decontamination works

The accident at the Fukushima Daiichi Nuclear Power Plant (NPP) released large amounts of radioactive materials. For rehabilitation of the contaminated areas, the Japanese Government has decided to carry out decontamination works (e.g., clean-up of buildings and remediation of soil and vegetation) and to manage the wastes resulting from decontamination works and clean-up of unmarketable contaminated goods. Prevention of radiological contamination of the workers has required that the Government ensure sufficient radiological protection is provided to them.

2.1.1 Radiation protection for workers engaged in decontamination works

The Act on Special Measures Concerning the Handling of Radioactive Pollution (Act. No.110, 2011, hereinafter referred to as "Act on Special Measures") was passed into law in August 2011, and fully implemented starting from 1 January 2012.

(1) The regulations established by the Act are as follows:

a) Treatment of wastes contaminated with radioactive materials; and

b) Actions such as decontamination of soil contaminated with radioactive materials.

However, the Act does not include measures for protecting workers engaged in these tasks from health hazards caused by exposure to ionizing radiation.

(2) In addition, in the current Ordinance on Prevention of Ionizing Radiation Hazards (Ordinance No. 41 of the Ministry of Labour, 1972, hereinafter referred to as "the Ionizing Radiation Ordinance"), measures are established on the premise that the radioactive sources are located at a certain place, such as at medical facilities or at NPPs, where workers mainly work indoors (planned exposure situations).

Measures for responding to the types of decontamination work that involves collection of waste stipulated in the Act on Special Measures are not included. Furthermore, the Act was not established on the premise that the radioactive sources are dispersed over wide areas and that workers mostly work outdoors (existing exposure situations).

(3) Further, under the fundamental policies based on the Act on Special Measures approved by the cabinet on 11 November 2011, it is stated that "ensuring the safety of workers is the highest priority when handling environmental decontamination. Therefore, the employers should take great care regarding the safety and health of workers engaged in duties concerning decontamination of the environment, for example, by providing radiological protection guidance. In addition, they should manage the radiation doses received by the workers and provide workers with opportunities to enhance their knowledge of safety and health."

Considering the situation, a new ordinance was formulated that regulates measures to properly protect workers from health hazards caused by ionizing radiation based on the nature of the works such as decontamination works and waste collection works ; this is the "Ordinance on Prevention of Ionizing Radiation Hazards at Works to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works" (hereinafter referred to as "the decontamination ordinance." This Ordinance was formulated separately from the current Ionizing Radiation Ordinance.

2.1.2 Radiation protection for workers engaged in restoration and reconstruction works

The Nuclear Emergency Response Headquarters and the National Reconstruction Agency revised the classification of the evacuation areas around the TEPCO Fukushima Daiichi NPP (restricted areas and deliberate evacuation areas) into 3 types of areas on 1 April 2012: (1) Areas for which evacuation orders are ready to be lifted; (2) Areas in which the residents are not permitted to live; and (3) Areas where it is expected that the residents will have difficulties in returning for a long time.

In the "Areas in which evacuation orders are ready to be lifted", activities can be started for:

(1) Restoring local infrastructures other than those requiring decontamination;

(2) Restarting businesses such as manufacturing industries;

(3) Preparing to reopen hospitals and welfare facilities;

(4) Restarting agriculture and forestry industries; and

(5) Restarting transportation services associated with these activities.

The "Decontamination Ordinance" which came into force on 1 January 2012 was applicable only for decontamination operations (decontaminating soil, and collecting, transporting and storing waste). For application of the above activities, revision of the other Ordinance was required.

Therefore, the expert meeting originally organized to discuss decontamination operations was reorganized to discuss measures to protect workers from radiation hazards in the evacuation areas. The committee compiled their discussions and issued a second report on 27 April 2012.

Based on this report, the Decontamination Ordinance was amended and guidelines were prepared that summarize relevant laws and regulations comprehensively and in an easy way to understand manner.*[1)]

*[1)] Under the amended Decontamination Ordinance definitions were given for: "specified contaminated soil handling work (tasks handling soil with a cesium concentration exceeding 10,000 Bq/kg)" and "work under a designated dose rate (tasks performed in the areas where the average ambient dose rate exceeds 2.5 μSv/h" (excluding decontamination operation, etc.)

2.1.3 Radiation protection for workers engaged in disposal of accident-derived waste

The Ministry of the Environment estimated that approximately 15 - 31 million tons of soil and wastes had been generated from decontamination works and clean-up of unmarketable contaminated goods had reached approximately 0.56 million tons in Fukushima Prefecture alone. The Ministry was expected to start deploying full-scale activities to dispose of those wastes in the summer of 2013.

Activities for accident-derived waste disposal*[2)] were subject to the Ordinance on Prevention of Ionizing Radiation Hazards (the Ionizing Radiation Ordinance); however, the ordinance did not contain sufficient regulations for employers involved in disposal work.

The expert meeting on radiation protection and waste disposal was held to consider measures to prevent radiological hazards. The report of the expert meeting was published on 14 February 2013.

Based on the report, the Ionizing Radiation Ordinance was amended and the new guidelines were developed that summarize relevant laws and regulations.

*2) These include e.g., final disposal (landfill), interim storage, and interim treatments (incineration, crushing, etc.)

2.2 Outline of ordinances which provide radiation protection during decontamination works and restoration and reconstruction works, etc.

Measures to prevent ionizing radiation hazards for each step are outlined below.

2.2.1 Outline of radiation protection measures during decontamination works

The Decontamination Ordinance specifies actions to be taken by the employer to prevent radiation exposure of workers engaged in decontamination of soil, collection of removed soil/waste in the areas contaminated by radioactive materials released from the accident in the Fukushima Daiichi NPP. Actions are largely divided into three types as follows:

(1) Actions to reduce exposure

- The dose limit for the workers shall be 100 mSv for five years, and not exceed 50 mSv for any one year (it shall not exceed 5 mSv for three months for potentially pregnant workers)
- In areas where dose rates shall be higher than 2.5 µSv/h (equivalent to 5 mSv/y)*[3)], the external dose shall be measured with a personal dosimeter (it should be noted that, in areas where dose rate is in the range of 0.23 µSv/h -2.5 µSv/h (1 mSv - 5 mSv/y), simple methods of measurement may be acceptable.)
- Measured data should be kept for 30 years*[4)], as well, workers should be notified of their doses.
- The decontamination should be started after measuring dose rates, and conducted under the direction of an operation leader in accordance with the work plan. The decontamination in areas where the dose rate is higher than 2.5 µSv/h in particular, requires submitting a work plan to the relevant Labour Standards Inspection Office.

*3) This approximately corresponds to the areas that cover the deliberate evacuation areas and the restricted areas.

*4) After 5 years, the stored data may be transferred to the organization designated by the MHLW.

(2) Actions to prevent spread of contamination

- When dust containing a high concentration of radioactive cesium may be generated, dispersion of soil should be prevented by moistening the soil. When works are involving soil with a high radioactivity concentration or the possibility that a high concentration of dust may be generated, workers should wear proper respiratory protective equipment and protective clothes.
- Removed soil should be stored in a container that meets a certain requirement*[5)] and access to the containers should be restricted.
- Smoking, drinking or eating in working areas that may have a risk of ingestion or inhalation of radioactive material should be prohibited.
- Set up a contamination inspection area where contamination surveys are conducted for body and clothes of workers.

*5) The requirements are: no risk of dispersal or leaking of container contents; and the 1 cm dose equivalent rate at 1 m from the container surface should be 0.1 mSv/h or less.

(3) Education and health care of workers

- Education should be provided to workers who will be engaged in the decontamination works with respect to radiation effects, radiation dose control, working methods, etc.
- Special medical examinations should be provided to workers when they are employed, their jobs are changed, and once every six months. The records of the medical examinations implemented for each worker should be kept for 30 years*[6)] and notified to each worker. When any radiological hazards should be found in the medical examination, some consideration in their work should be made, such as a change of workplace.
- When the workers leave the job or the companies terminate their decontamination business, the records of radiation doses of the workers and their individual medical examination sheets should be delivered to the organization designated by the MHLW, and copies should be given to the workers.
- The results of periodical special medical examinations should be reported to the relevant Labour Standards Inspection Office.

*6) After 5 years, the data may be transferred to the organization designated by the MHLW.

2.2.2 Outline of radiation protection measures during restoration and reconstruction work

The MHLW published the ministerial ordinance which partially revises the "Ordinance on Prevention of Ionizing Radiation Hazards at Works to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works" (hereafter referred to as "the Ionizing Radiation Ordinance for Decontamination"). It was put into effect on 1 July 2012.

The revision was made anticipating the start and resumption of "restoration of life infrastructures (excluding decontamination works) and manufacturing industries"*[7)] in "special decontamination areas"*8) in response to the readjustment of the evacuation areas.

*7) This includes preparations for restarting hospitals and welfare facilities, agriculture and forestry operations, and associated transportation services.

*8) Specified by Article 25, Paragraph 1, of the Special Measures concerning Environmental Contamination with Radioactive Materials Released from the Accident of the Nuclear Power Plant Associated with the Tohoku-Pacific Ocean Earthquake on 11 March 2011 (Law No.110, 2011)

The revision focuses on the following points:

1. Work involving contaminated soil with radioactivity higher than 10,000 Bq/kg (designated contaminated soil handling work) should also be included in the decontamination operation, and
2. The Ionizing Radiation Ordinance for Decontamination should also be applied to work other than decontamination at areas with an average ambient dose rate higher than 2.5 µSv/h (works under a designated dose rate).

Employers are required to take radiological protection measures for the types of works described above.

In conjunction with the above, the "guidelines on decontamination works, etc." was also revised, and "guidelines on work under a designated dose rate" were newly formulated. These guidelines summarized the content of the Ionizing Radiation Ordinance for Decontamination in a comprehensive manner and described provisions specified in the Industrial Safety and Health Act and other relevant regulations; as well they described recommended actions for employers to take in order to prevent radiological hazards for workers. Specifically, the guidelines summarize the following items:

1. Identification of personnel for whom radiation dose needs to be controlled, and prescribe methods to control the radiation dose;
2. Measures to reduce radiation exposure;
3. Measures to prevent spread of contamination and internal exposure;
4. Worker education programs;
5. Actions for health care; and
6. Safety and health control system.

It should be noted that the guidelines are also expected to be useful for local residents or volunteers who are in the special decontamination areas, though their original purpose was to ensure safety of workers engaged in decontamination works or works under a designated dose rate. In addition, a textbook for special education of workers as specified in the Ionizing Radiation Ordinance for Decontamination was also prepared, and is available from the MHLW website.

2.2.3 Outline of radiation protection measures during disposal of accident-derived waste

The MHLW published a ministerial ordinance to revise the Ionizing Radiation Ordinance for Decontamination on 12 April 2013, and put the revised ordinance into effect on 1 July 2013.

This revision was made in light of the fact that disposal of wastes contaminated with radioactive materials discharged by the NPP accident associated with the 11 March 2011 earthquake and tsunami is expected to in scale with the progress of decontamination project.

Five revised points shown below were recommended to disposal business employers to take radiological hazard prevention measures. It should be noted that definitions of controlled area, dose limits, dose measurement and recording and measures for health care should follow the provisions in the current Ordinance on Preventing Ionizing Radiation Hazards.

1. Requirements to be satisfied by such facilities as incineration plants and landfills where the disposal of accident-derived wastes will be performed.
2. Measures to prevent the spread of contamination, such as the use of dust masks and protective clothing, as well as making contamination inspection.
3. Operation management by, for example, preparing operation manuals.
4. Special education for workers engaged in disposal work.
5. Exemptions when the disposal facility is constructed in special decontamination areas.

In parallel with the revision, "guidelines on prevention of radiation hazards for workers engaged in the accident-derived waste disposal "were also prepared. The guidelines summarize the provisions specified in the Industrial Safety and Health Act and other relevant regulations, including the Ordinance for Preventing Ionizing Radiation Hazards, as well as recommended actions that employers should implement in order to prevent radiological hazards for workers. Specifically, the following subjects were included:

1. Methods for defining radiation controlled areas and controlling radiation doses
2. Education of workers
3. Dose limits in facilities
4. Actions for health care
5. Requirements for facilities to prevent contamination
6. Safety and health control framework
7. Measures to prevent contamination
8. Exemptions in the special decontamination areas
9. Work management, etc.

A textbook for special education of workers engaged in the disposal works, as specified in this revision, was also prepared. This textbook is available from the MHLW website. The MHLW is making public the textbook so that it will be widely utilized by employers and workers in taking appropriate measures at work sites.

2.3 Status of the implementation of radiation protection corresponding to decontamination works

2.3.1 Current status of inspections and instructions provided to employers engaged in decontamination works, etc.

Current status of inspections and instructions provided to employers engaged in decontamination etc. in Fukushima Prefecture are summarized below.

(1) Current status of inspections (Preliminary report)

The Fukushima Prefectural Labour Bureau (PLB), via Labour Standards Inspection offices, has conducted inspections and given instructions to 242 employers (as of 31 December 2012) in order to ensure proper conditions of employment and the safety and health of workers engaged in decontamination etc.

Among those employers, 108 employers were recognized as being in violation of applicable laws such as the Labour Standards Act or the Industrial Safety and Health Act (percentage of employers in violation: 45%). Instruction to correct the said violations was given accordingly.

(2) Actions other than inspection/instruction to employers engaged in decontamination, etc.

1. Guidance was collectively provided for employers engaged in decontamination works regarding the content of the Decontamination Ordinance.* (The said guidance was provided a total of 5 times for 500 persons during the period from June to August 2012.)
2. The Fukushima Prefectural Labour Bureau (PLB) conducted lectures on legal aspects for instructors of the special education for decontamination employers to disseminate rules and regulations in detail. (These lectures were given a total of nine times for 1,613 persons during the period from December 2011 to February 2012.)
3. The textbook for special education of decontamination workers, instructional movies that support the practical training of handling equipment and tools in the special education, and Q&A were made available through the MHLW website. In addition, leaflets for workers and employers were distributed to relevant employers.

2.3.2 Results of inspection and instructions provided to employers engaged in decontamination works, etc. (January - June, 2014) and requests to the employers

The Fukushima Prefectural Labour Bureau (PLB) has conducted inspections and given instructions within the jurisdiction of the Labour Standards Inspection Offices to 313 employers during the period from January to June 2014 in order to ensure proper conditions of employment and safety, and the health of workers engaged in decontamination works, etc.

The investigations were focused on conditions of employment such as clear indications of conditions of employment, payment of wages, and working hours, reflecting the circumstances that some inquiries were raised about wages and other conditions of employment such as the special duty (decontamination) allowance.

Among those employers, a total of 186 (percentage of employers in violation: 59.4%) were recognized as being in violation of applicable laws such as the Labour Standards Act or the Industrial Safety and Health Act. Corrective recommendations were issued to these employers to correct the said violations accordingly.

3. Overview of Guidelines and Notifications

3.1 Overview of the Guidelines on Maintaining and Improving Health of Emergency Workers at the TEPCO Fukushima Daiichi NPP

These guidelines were issued on 11 October 2011. The purpose of the guidelines is to support appropriate and effective implementation of measures to maintain and improve the health of workers who have engaged or had engaged in the emergency work or radiation work at the TEPCO Fukushima Daiichi NPP (hereinafter referred to as "emergency workers."). The guidelines require that the following measures are implemented appropriately to maintain and improve the health of emergency workers.

(1) Actions for long-term health care

- An on-site health care system should be established, appropriate to the scale of each workplace to implement the relevant medical examinations.
- The following examinations should be performed for those workers whose exposure doses (effective doses) during emergency work fall in the following ranges:
  (a) Higher than 50mSv, a cataract examination once a year.
  (b) Higher than 100mSv, a cancer screening once a year.
- Health guidance should be provided to all emergency workers

(2) Development of a database for workers who have engaged in emergency work

- The employer who assigns their emergency workers to be engaged in the emergency work or radiation work should report to the Japanese Government the results of their medical examination and provide the status report on their radiation dose control.
  The same rule on the reporting requirement should apply to employees who had been emergency workers but were transferred to radiation works.
- A registration card for the database established by the Japanese Government should be issued to emergency workers. The emergency workers should be able to obtain transcripts of their records for exposure doses and medical examination results by presenting the card at the national support service.
- The emergency workers whose exposure doses are higher than 50 mSv are eligible to receive a record book describing the doses.

(3) Support provided by the Japanese Government

- Recommendations for cancer screening and other examination to emergency workers.
- Health consultations and guidance to emergency workers at the support services.
- Full or partial financial support for the expenses incurred by emergency workers who fall into the categories described in Section 2 of "Actions for long-term health care".

Information on these topics and others are available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/lhc/pr_111011_a01.pdf
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/lhc/pr_111011_a02.pdf (Overview)

3.2 Overview of the Ordinance on Prevention of Ionizing Radiation Hazards at Works to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works

The Ordinance on Prevention of Ionizing Radiation Hazards at Works to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works, was released to the press on 12 December 2011, and it specifies the actions below to be taken by employers to prevent radiation exposure of workers engaged in decontamination works.

(1) Fundamental principles and definitions

- Employers shall strive toward minimizing worker exposure to ionizing radiation.

(2) Measuring doses and monitoring the maximum dose levels

- The exposure doses shall not exceed 100 mSv per five years and 50 mSv per one year.
- The exposure doses received by workers shall be monitored, recorded, and the records kept for 30 years.
- The external exposure doses shall be monitored.
- The workers handling contaminated soil shall receive examinations for internal exposure doses.

(3) Measures for implementation of decontamination works

- Exposure doses in workplaces shall be surveyed and recorded before commencing works.
- A work plan shall be established and disseminated to every worker.
- An operation leader shall be appointed to lead the project.
- The work plan shall be submitted to the Head of the relevant Labour Standards Inspection Office.
- When the radiation doses exceed the maximum standardized levels, employers shall promptly consult a physician and report the case to the relevant office.

(4) Prevention of contamination

- For suppression of dust, measures shall be taken to keep contaminated soil and wastes in a wet condition.
- Contaminated soil and wastes shall be stored in containers.
- When workers leave their workplaces, their bodies and belongings shall be screened for contamination.

・When workers are engaged in some designated work, they shall wear protective equipment.
・When protective equipment is contaminated, it shall not be used until it is decontaminated.
・In the workplaces, eating, drinking, and smoking shall be prohibited.

(5) Education

・Workers engaged in decontamination works shall receive special education.

(6) Health care

・Special medical examinations for workers engaged in decontamination works shall be conducted.
・The medical examination cards shall be created, and the examination results recorded on them and the cards kept for 30 years.
・Opinions of physicians shall be received and recorded on the medical examination cards.
・Workers shall be informed the results of the special medical examinations and the results shall be submitted to the Head of the relevant Labour Standards Inspection Office.
・Based on the medical examination results, workers shall receive needed measures to protect their health.

(7) Others

・Radiation dosimeters, which are indispensable to abide by the ordinance, shall be provided.
・When employers terminate their business, the records of radiation dose measurements and medical examination cards shall be transferred to the organization designated by the MHLW.
・When workers leave their jobs, such records shall be issued to the workers.
・Exposure doses shall be added to those received during other decontamination works.

Information on these topics and others are available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/dr/dr/pr_111212_a03.pdf

3.3 Overview of the Guidelines on Prevention of Radiation Hazards for Workers Engaged in Decontamination Works

The guidelines specify actions to be taken by the employers to prevent radiation exposure for workers engaged in decontamination works. The guideline was issued on 22 December 2011, partially revised on 15 June 2012 and on 18 November 2014.

(1) Objectives

・These guidelines aim at collectively providing the essence of the actions that employers should take and the provisions specified in the Industrial Safety and Health Act (Act No. 57, 1972) and other relevant laws and regulations, in addition to the provisions specified in the revised Ionizing Radiation Ordinance for Decontamination.

(2) Scope

・"Decontamination works" refers to the works in performing decontamination of soil, etc., handling of designated contaminated soil, and wastes and collecting wastes, etc.
・Employers should follow applicable matters from each sections of the guidelines, as needed.

(3) Targets and methods for radiation exposure dose control

・Employers for decontamination works, etc., should conduct effective exposure dose monitoring during decontamination works.
・Employers for decontamination works, etc., should ensure that the individual total effective dose does not exceed the limits defined in the guidelines. The records of exposure data should be kept for 30 years.

(4) Measures to Reduce Radiation Exposure

・Employers for decontamination works, etc., should make surveys of workplaces in advance and formulate a work plan, according to which works should be conducted, based on the information from the preparatory survey.

(5) Measures for Preventions of Contamination Spreading and Internal Exposure

・Control of dust generation by wetting soil, contamination screening for workers when leaving the controlled area, use of dust mask or other protective equipment etc., are required.

(6) Education for Workers

・Education for operation leaders and special education for the workers are defined.

(7) Measures for Health Care

・Employers for decontamination works, etc., should provide workers with the special and general health examinations once every 6 months. The examination results should be recorded in medical examination cards and the cards kept for 30 years.

(8) Safety and Health Management System

・The safety and health management system should be established by the primary contractors, by appointing a general safety and health manager and a radiation administrator to conduct radiation dose control, and related activities.

Information on these topics and others are available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/dr/dr/pr_120615_a03.pdf

3.4 Overview of the Guidelines on Prevention of Radiation Hazards for Workers Engaged in Works under a Designated Dose Rate

The guidelines specifies actions to be taken by the employers to prevent radiation exposure for workers engaged in works, such as restoration and reconstruction works, under a designated dose rate.

(1) Purpose

The Ionizing Radiation Ordinance was partially revised to regulate measures for appropriately protecting workers from health hazards caused by radiation, according to the types of restoration and reconstruction works.

(2) Application

These guidelines apply to employers who provide services other than the decontamination works at the sites where the average ambient dose rate exceeds 2.5μSv/h.

(3) Recipients of radiation dose control and methods

The total effective exposure doses should not exceed 100 mSv per five years and 50 mSv per year for male workers, 5 mSv per three months for female workers having the possibility to become pregnant. The dose records should be preserved for 30 years.

(4) Measures for reducing radiation exposure

The employers should measure the average ambient dose rate of the work sites to determine the appropriate measures for radiation exposure dose control. The appropriate health services and consultations by physicians should be provided to the workers.

(5) Worker Education

The employers should provide special lectures intended to enhance workers' knowledge and understanding in the following areas before assigning them to the high risk operations: the effects of ionizing radiation, radiation measurement methods, relevant laws and regulations, etc.

(6) Health care measures

The employers of workers under a designated dose rate should provide general medical examinations to the workers and should seek advice from a physician about the results of the medical examinations.

(7) Safety and health control system

Primary contractors who conduct operations under a designated dose rate should appoint a radiation manager who is responsible for consolidated management of dose control. Employers should appoint health managers or safety and health promoters, who are expected to oversee technical issues associated with measuring radiation exposure doses and recording the measurement results.

Information on these topics and others are available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/dr/dr/pr_120615_a04.pdf

3.5 Overview of the Improvement of the Safety and Health Management System of Radiation and Emergency Works at Nuclear Facilities

On 10 August 2012, the MHLW issued a circular notice ("Improvemnt of safety and health management measures of radiation works and emergency work at nuclear facilities", Labour Standard Bureau Notification No. 0810-1, issued on 10 August 2012) to the directors of the relevant Prefectural Labour Bureaus with a directive to enhance instruction to the employers with respect to safety and health measures in preparation for emergency work at nuclear facilities (nuclear power plants, reprocessing facilities and fuel fabrication facilities).

MHLW has provided instructions via circular notices since 2000 regarding safety and health management of radiation works in nuclear facilities, including radiation exposure dose control. In consideration of the lessons learned from the accident in the TEPCO Fukushima Daiichi NPP associated with the Great East Japan Earthquake, measures in preparation for emergency work to be taken by the employers are also considered important. Accordingly, the Ministry decided to improve the instructions thoroughly.

Points where instructions are improved:

(1) Provisions in preparation for emergency work should be taken not only at nuclear facilities, but also at corporate offices and primary contractors,

(2) In making prior preparations for emergency work, nuclear facility operators, etc. are required to conduct the voluntary inspections listed below. The facilities will be instructed to implement those matters that are difficult to implement immediately in a step-by-step manner.

(a) Radiation dose control

Improvement of the framework of the dose management system, including securing availability of dosimeters by making advance borrowing agreements with other facilities, managing dosimeter-lending records of workers, and notifying of their doses and measurements of internal exposure, etc., should be undertaken.

(b) Protective equipment and clothing

Protective equipment and clothing should be made available and workers should be shown the correct wearing of respiratory protective equipment. Employers should measure airborne concentration at waiting stations (stand-by areas) and other places

(c) Safety and health education

Textbooks should be prepared and rooms for educating new workers should be provided.

(d) Health care and medical care system

The medical care system should be established, measures against heat stroke should be implemented, special medical examinations should be conducted, and a patient transportation system should be established.

(e) Work plan and others

A work planning system should be established, preparation of proper work plans should be promoted, the actual status of contracted work should be assessed, and arrangements for proper accommodations (lodging) and meals, etc. should be made in advance.

(3) The Ministry will clarify the items for the relevant Prefectural Labour Bureaus to ensure that nuclear facilities are properly instructed in the case of implementing emergency work.

Information on these topics and others are available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/ri/pr/pr_120810.html

3.6 Overview of the Guidelines on Prevention of Radiation Hazards for Workers Engaged in Accident-derived Waste Disposal

The guidelines, prepared for disposal of accident-derived waste, summarize the provisions specified in the Industrial Safety and Health Act and other relevant regulations, including the Ordinance for Preventing Ionizing Radiation Hazards.

(1) Scope

The guidelines aim at collectively providing the actions that the disposal operator handling accident-derived waste should take.

(2) General Principles

The disposal operator should strive to minimize the amount of ionizing radiation. The disposal operator should strive to decontaminate the area around the disposal site in advance in order to reduce radiation exposure to workers.

(3) Methods on setting radiation controlled areas and radiation dose control

The disposal operator should clearly specify the radiation controlled areas with posted signs and prohibit access to the area. The dose measurements should be recorded basically every three months, every year, and every five years, and the records should be kept for 30 years.

(4) Dose limit at facilities

The disposal operator should ensure that the dose rate is restricted so that the sum of the external dose and committed effective dose from radioactive materials in air should not exceed 1mSv per week.

(5) Requirements on equipment for preventing contamination

The disposal operator should use materials and structures that prevent spread of contamination, and ensure that workers in the facilities are not exposed to radiation.

(6) Measures to prevent spread of contamination

The disposal operator should use containers in order to prevent spread of contamination, should create an inspection area to check the contamination levels of workers, and should make available effective respiratory protective equipment and protective clothing for workers to prevent body contamination.

(7) Work management

The disposal operator should define rules on work methods and procedures, etc. that should be disseminated to the workers. The disposal operator should submit a "work permit" to the head of the relevant Labour Standards Inspection Office.

(8) Education for workers

The disposal operator should provide workers with special education consisting of the following categories; what accident-derived waste is and how they should be disposed.

(9) Measures for health care

The disposal operator should provide workers with special and general medical examinations once every 6 months. The examination results should be recorded on medical examination cards and the cards kept for 30 years.

(10) Safety and health management system

The safety and health management system should be established by the primary contractor by assigning a general safety and health manager, a responsible person for safety and health management by involved subcontractors, and so on. Safety and health coordinating meetings consisting of all of the involved subcontractors will be held once a month.

Information on these topics and others are available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/dr/wd/pr_130412_a04.pdf
http://www.mhlw.go.jp/english/topics/2011eq/workers/dr/wd/pr_130412_a03.pdf (Overview)

3.7 Overview of the Establishment of Radiation Exposure Doses Registration Systems for decontamination and related works

The primary contractors of decontaminator works came to an agreement on establishing the Organization for registration control of radiation exposure doses for decontamination and related works from April 2014 as follows:

(1) Objectives

The Registration System aims to achieve the following:
Establish a registration system in coordination with the existing system for nuclear facilities to verify past exposure doses when decontamination workers are successively employed by different employers.

(2) Systematic operation of the radiation passbook control

- Obtaining the radiation passbook
- Control of radiation passbooks and notification of exposure doses
- Obtaining the result of medical examinations and

recording it in radiation passbooks

- Obtaining implementation status of special education and recording it in radiation passbooks

(3) Methods for dose registration and past record inquiry

- Registration of work sites
- Periodical registration of exposure doses
- Inquiry and registration of past records prior to 2014
- Cross-reference of data with system for nuclear facilities

(4) Transfer of records of exposure dose and medical examination

- Statutory transfer of exposure dose records
- Statutory transfer of medical examination records

(5) Operation of dose control system

- Expense for participating in dose control system
- Development of work procedures and manuals
- Establishment of governance council to maintain the system

Further information is available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/ors/oi/pr_131115.html

4. Results of Epidemiological Studies on Emergency Workers

4.1 Overview of the Report of the Expert Meeting on Epidemiological Studies Targeting Emergency Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant

MHLW compiled a report of the expert meeting series held since February 2014 in which discussions were made about how to make plans for epidemiological studies targeting emergency workers concerning radiation effects on human health.

The purpose of the report is to compile the basic concept and matters of note in establishing the abovementioned plans.

(1) Study targets and method

・Around 20,000 emergency workers should be covered with the study period lasting throughout their respective lifetimes.

・Follow-up for the target group should be done and the current-state survey conducted by the MHLW should be utilized and maintained in the course of the long-term health care database management.

・Health and psychological effects to be examined should cover cancers (tumors), leukemia and non-cancerous diseases.

・The cumulative dose should be set as an exposure factor. Dose-response relationships of health effects are to be examined, and classification by exposure conditions should be done.

・The prospective cohort study method should be employed.

・When compiling study results, analysis results that show both presence and absence of statistically significant differences using a suitable statistical test should be reported.

(2) Health effects examinations

・The abovementioned diseases, for which radiation effects have been previously suspected, should be covered broadly. In addition to health checkups, other systems and data should also be referred to.

・Examination items and frequencies should be determined based on the MHLW Minister's guidelines, while referring to the examinations targeting WWII atomic bomb survivors. However, these may be changed or added to in accordance with technological advancement.

・Questionnaires to ascertain psychological effects should be used.

(3) Ascertaining cumulative doses

・Primary source materials for both internal and external exposures should be preserved as original documents where possible for data verification in the future.

・A chromosomal test to biologically measure exposure doses should be conducted for workers whose effective doses exceed 100mSv.

(4) Control of confounding factors

・As the epidemiological studies take time and cover cancers and various other diseases, it is important to control confounding factors.

・In addition to examinations of items adopted in previous studies in Japan, examinations of each worker's history of exposure to toxic substances and work details should be collected.

(5) Implementation system of the studies

・A controlling research institute should first be designated and cooperative research institutions in respective sectors should be selected thereunder.

・Consigned health check organizations should be selected.

(6) Study period, evaluation and publication of study results

・As the studies will take time, research institutions should be evaluated by an international third-party panel at 5-year intervals.

・Research institutions should regularly report their results to the MHLW and publicize them in the controlling research institute's publications, and compile and publish achievements in international academic journals.

Further information is available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/lhc/pr_140604.html

4.2 Overview of the Results of the Research on Thyroid Gland Examinations, etc. of Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant (Sobue et. al. 2014)

A report was compiled regarding the Research on Thyroid Gland Examinations, etc. of Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant (chief researcher: Tomotaka Sobue (Professor, Environmental Medicine and Population Sciences, Graduate School of Medicine, Osaka University)).

This research funded by the Health and Labour Science Research Grants aims to epidemiologically analyze radiation effects on the thyroid gland by setting an exposed group (emergency workers exposed to radiation exceeding a thyroid equivalent dose*1) of 100 mSv) and a control group (thyroid equivalent dose of 100 mSv or less), performing ultrasonic examinations for both groups and comparing the results. The results of the analysis are to be evaluated from the viewpoint of clinical medicine in terms of radiation effects on the thyroid gland. Major findings and discussion was as follows.

*1) Thyroid equivalent dose: Dose only focusing on thyroid exposure, which is calculated as the total of internal exposure and external exposure (including exposure prior to the accident); 1/20 of the whole-body exposure dose (effective dose)

(1) No difference was found in the percentages of workers assigned as level B (a secondary examination was recommended) and level C (secondary examination was necessary) between the exposed group and the control group, and there was no correlation with thyroid equivalent doses. However, the percentage of workers assigned as level A2 (a secondary examination was unnecessary) was relatively high for people with high doses, and the same trend was observed in analysis using re-evaluated thyroid equivalent doses.

(2) While no correlation was found between nodule size and thyroid equivalent dose, the incidence of relatively larger cysts*2) was high for workers with high doses.

*2) Cysts themselves need not be treated. However, as large cysts may cause neck symptoms, a cyst 20.1mm or larger is judged as level B (only one case).

(3) This is an interim report based only on the ultrasonic examination and prepared before definite diagnoses have become available. Conclusions drawn based only on the results of this research could be faulty due to the following uncertainties.

・According to the research results, the percentage of workers who received ultrasonic examinations before the present ultrasonic examinations was high for the exposed group while that for the control group was low, and the percentage of workers who received the present examination was low for the exposed group. This suggests the possibility of considerable bias in cyst and nodule incidence among workers with high doses.

・Namely, there is a possibility that workers judged as level A2 in earlier ultrasonic examinations selectively participated. Also, workers judged as level B or level C in their ultrasonic examinations might have selectively dropped out of the research program.

・For workers whose internal exposure evaluation results are considered less reliable, quantitative evaluation of internal exposure should be conducted.

(4) Efforts need to be made to collect and analyze the detailed examination results where abnormalities were detected in the examination and for past thyroid gland ultrasonic examinations for the exposed group.

・ The ultrasonic examination results and secondary examination results have not been collected.

Further information is available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/ort/pr_140805.html

5. Good Practices in Radiation Exposure Control at the Fukushima Daiichi Nuclear Power Plant

This Section introduces good practices implemented by TEPCO and primary contractors related to radiation exposure dose management, exposure reduction and health management at TEPCO's Fukushima Daiichi NPP.

To amass and facilitate the sharing of good practices, the Workshop on Radiation Exposure Control at the Fukushima Daiichi Nuclear Power Plant was held in cooperation with TEPCO and primary contractors at J-Village in Futaba County, Fukushima Prefecture on 11 December 2014.

The workshop consisted of three sessions: (i) working environment improvement activities, (ii) radiation exposure reduction, and (iii) technological research and development. Presentations were given by primary contractors, followed by an exchange of opinions between participants and experts.

The details of the presentations are compiled and introduced below.

1. Good Practices in Working Environment Improvement

The Tokyo Electric Power Company has been trying to improve the working environment at the Fukushima Daiichi NPP from various perspectives, such as enhancing the convenience for the relevant workers, reducing exposure doses and otherwise improving the working environment and preparing countermeasures against heat illness.

Specifically, the following are now being implemented.

○ Reduction of radiation doses on-site

The sites of NPP are divided into Area I to Area IV. Activities to reduce radiation doses are carried out from areas where many workers are engaging in work and areas with less interference to achieve targeted dose rates in stages.

Area I: Areas in the vicinity of surrounding Units 1-4 where radiation dose equivalent rates are particularly high
Area II: Planting areas and areas with remaining woods
Area III: Areas where facilities are installed or are to be installed
Area IV: Already paved areas, such as streets and parking lots
Scope of the implementation policy for reducing on-site dose

○ Control of radiation exposure dose

On-site workers go through health checkups and receive education on radiation protection in advance as legally required, and are registered as radiation workers with the dose management system to commence control of individual radiation doses.

Radiation work is managed based on plans set up for each type of work, and workers are required to wear an Alarmed Personal Dosimeter (APD) and their doses are controlled strictly.

○ Designation of non-full (half)-face mask required area

With the aim of reducing work load and improving work efficiency, efforts have been made to expand the areas where workers can wear DS2 (disposable half-face respiration mask with collection efficiency of 95%). Such area now accounts for around two-thirds of the premises.

○ Expansion of the work area of women

On 23 March 2011, immediately after the accident, TEPCO prohibited work of all female workers. Later, in accordance with the improvement in the working environment within the premises, such measure was eased in stages and areas to allow female workers to work freely were expanded. In November 2014, they became able to work on site in its entirety. However, they are not allowed to engage in work for which emergency dose limits apply or work in which they may be expose to radiation exceeding 4mSv at one time.

○ Construction of a large rest house

In response to workers' requests for a place for taking a rest, a large rest house is now under construction. The rest house being constructed in a non-radiation controlled area will accommodate 1,200 workers and be equipped with an eating space with tables and chairs as requested by workers.

○ Countermeasures against heat illness

Workers need to wear a coverall and full-face mask in the premises and are at risk of heat stroke during summer. Therefore, work management based on the wet bulb globe temperature (WBGT) is adopted and work under the blazing sun is prohibited in principle. Furthermore, mobile rest stations are installed and other countermeasures are promoted in a comprehensive manner to eliminate risks of heat illness by encouraging workers to stay well hydrated and wear a cool vest.

[Major measures]

- Use of the Wet Bulb Glob Temperature (WBGT) (change in work time and work intensity, etc.)
- Work under the blazing sun is prohibited in principle in hot season (Jul. and Aug.)
- Appropriate rest and frequent intake of water and salt are encouraged
- Physical management using check sheets

- Wearing cool vests (Work vests attached with refrigerant)
- Early diagnosis of a worker with poor health condition at the medical room
- Development of rest stations (preparation of cooling boxes and drinking water)
- Use of mobile rest stations
- Dissemination of the WBGT forecast level
- Education and instruction on heat illness measures

[Good practices by each contractor]

- Making the shade by using tents
- Using spot coolers
- Having a break every 30 minutes by using mobile rest stations/ preparation of cold retainers
- Having a break in the rest station within one hour/ supply of water and salt supplementation/ exchange of cold retainers of cooling vests
- Using coolant sprays
- Preparation of drinking water at rest stations
- Installation of air-conditioned container houses
- Appointment of management representatives in charge of heat illness prevention
- Deployment of appointed patrol personnel to each working area/measuring a WBGT level every 30 minutes/ ensuring alertness

Making the shade by using a tent

Using a heat stroke meter

Using a spot cooler and large electric fan

○ Countermeasures against flu, etc.

Ahead of the flu season and norovirus season, flu vaccinations are provided and other countermeasures are taken to prevent the spread of infection among workers and reduce those severely ill.

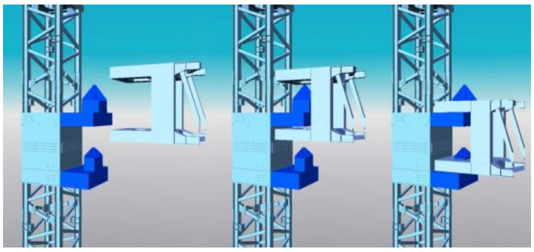
○ Emergency response for injured or sick workers

A doctor specialized in emergency medical service, an emergency life-saving technician, and a nurse are stationed on a 24 hour basis in the emergency room in the entrance control facility on site, thereby ensuring a system for taking prompt emergency response for any injured or sick workers.

Case: Radiation Exposure Reduction during Installation of a Reactor Building Cover at Unit 1

The installation of a reactor building cover at Unit 1 commenced late March 2011. However, radiation dose rates were extremely high at 5mSv/h on the road nearby and at 10mSv/h around the reactor building and workers could not work on a continuing basis. Under such an extremely severe radiation environment, the primary contractor aimed to secure the required quality and complete this project within about half a year, while making efforts to reduce workers' radiation exposure and ensure their safety. Preparatory work, deployment of cranes, was conducted to reduce radiation in order to enable workers to engage in work on crane routes around the reactor building and in the northwestern yard, and it was decided to adopt automated and remote-controlled installation work, focusing on the following three measures.

1. Employment of the structure and joint parts of steel frames of the covering building (fitting by applying the Japanese traditional wood frame construction methods)



Joint part of a column and a girder

2. Development of a remote-controlled system using remote-controlled hoisting devices and an automatic measuring and guiding system

Lifting/swinging gear

Remote slinging/unslinging device

3. Preparing and properly operating facilities for reducing workers' radiation exposure and alleviating their fatigue at each stage from the preparatory work to the main installation work

In order to fulfil these three measures in carrying out this project, the following concrete measures were taken in each process of designing, procurement and construction:

- Designing and planning on the premise of adopting automated and remote-controlled installation work
- Early commencement of the work through procuring steel frames, assembling, and installing membrane structure at the fastest pace
- Verification of and improvements to plans and mastering of work procedures through training for tentative assembly and remote control at Onahama
- On-site preparatory work such as removal of rubble of the reactor building and other radiation sources and covering of the ground with crushed stone and steel plates
- Development and installation of infrastructure for enabling remote-controlled work and for providing workers with shelters and shields
- Efficient management of working hours by utilizing the operation room and waiting rooms at the site

The project seemed impossible at first as it would be difficult to secure enough workers if adopting conventional construction methods under the working environment with high radiation dose rates. However, through the abovementioned measures, workers' radiation exposure was minimized as follows.

[Radiation exposure reduction effect through proper planning and improvements in working environment]

(i) Automated joining work of the covering structure
Estimated required hours for tightening approximately 20,000 bolts and for welding × Radiation doses at the site (Reduction of 7,600 mSv)

(ii) Shielding at transit routes
Shielding effect × Total transit and stay hours during the period (Reduction of 15,100mSv)

(iii) Preparation and use of operation rooms and waiting rooms at the site
Cumulative doses after the opening of waiting rooms × Reduced travel time for taking a rest before the introduction of relevant measures / 2.5 hours (Reduction of 500mSv)
Estimated exposure reduction through (i) to (iii) (Reduction of 23,200mSv)

Total cumulative dose was 7,324mSv (0.324mSv/worker-day × 22,582 workers in total) and the effect of relevant measures was a reduction of 23,200mSv. Through the use of automated joining technology for remote-controlled work and thorough radiation shielding, the total radiation exposure was reduced to one-quarter compared with the case where no reduction measures were taken.

As a result, it became possible for a small number of selected personnel as a team to master work procedures in an unusual environment without being restricted working hours. The company thus succeeded in balancing safety and high quality and completed the installation of the reactor building cover as early as October 14.

Case: Radiation Exposure Reduction Using Box Culverts and Shielding Hutches

Work to install sub-drain catchment facilities for Unit 1 to Unit 4, related demolition work, and the work to excavate a new pit aim to control the groundwater level around the reactor buildings from the perspective of reducing inflow of groundwater into main reactor buildings. These operations consist of recovery of existing sub-drain facilities, excavation of a new pit, and installation of pipes from each of the sub-drains to water tanks. Excavation of the new pit was carried out on the west side (mountain side) of Unit 1 to Unit 4, where air dose rates were high. Therefore, it was decided to use box culverts and shielding hutches as a means to reduce doses to which workers were to be exposed. A box culvert is made of concrete and is 1.5m × 1.5m × 2m in the inner dimensions, with a thickness of 14cm at the walls and 16cm at the floor and the ceiling. The weight is approximately 5 tons. A shielding hutch is 1m × 1m × 2m in the inner dimensions, and framed with steel with 3mm-lead plate attached thereto. Box culverts and shielding hutches were used as operating rooms for drill operators or waiting areas for workers and vehicle guides. Air dose rates were reduced to 20% on average within box culverts and to 30% on average within shielding hutches.

Case: Radiation Exposure Reduction for Soil Improvement Work in a High-Dose Environment

The primary contractor conducted soil improvement work for preventing contaminated groundwater from leaking into the sea area around the bank near the water intakes for Units 1 to 4 during the period from July 2013 to March 2014. Radiation doses were very high in the relevant area, which is also close to the reactor buildings of Units 1 to 4 with seawater pipe trenches and power cable duct running underground. Therefore, measures for reducing radiation doses and careful radiation exposure control were required.

Prior to commencing soil improvement work, air dose rates at the work site were reduced to 0.2mSv/h or lower by laying crushed stone and installing L-shaped retaining walls and lead panels for radiation shielding.

Soil improvement was urgently needed and around 10 hours' work per day was necessary. Therefore, a double-shift system was adopted to keep individual workers' working hours below five hours per day.

Furthermore, preliminary exploratory digging revealed that there were some spots with high dose rates over several dozen mSv/h near the power cable duct and it was feared that conducting the soil improvement work might cause highly contaminated water to gush out to the ground surface, resulting in a sharp increase in air dose rates during work. Accordingly, the primary contractor assembled a work floor with scaffolding members at such spots to enable workers to work at a height of 1.5m from the ground surface. The floor and the side of the work floor were shielded with lead plates to ensure that air dose rates on the floor were 0.15mSv/h or lower, almost the same level as in other general places.

Careful radiation exposure control was indispensable under such an environment with high air dose rates and possible increases in air dose rates in the process of the work. Therefore, APD (Alarmed Personal Dosimeter) alarms were set to ring each time when an accumulated dose reaches 20% of the predetermined 0.8mSv, and the number of rings and the time were scribed on the surface of each worker’s protective coveralls so that workers themselves and supervisors would be able to ascertain radiation exposure at any time.

Case: Contamination Survey and Development of Remote-controlled Decontamination Vehicle, etc. for Commencing Removal of Nuclear Fuel Debris

Improving the working environment through reduction of ambient dose rates within the reactor buildings is indispensable for performing indoor works for the decommissioning of Fukushima Daiichi NPP from the perspective of alleviating workloads, reducing radiation exposure during work and minimizing the influence on the environment of the surrounding areas.

The following are the results of the contamination survey, the development of a remote-controlled decontamination vehicle and the decontamination work on the first floor of the Unit 2 reactor building, which the company has conducted for improving the labor environment.

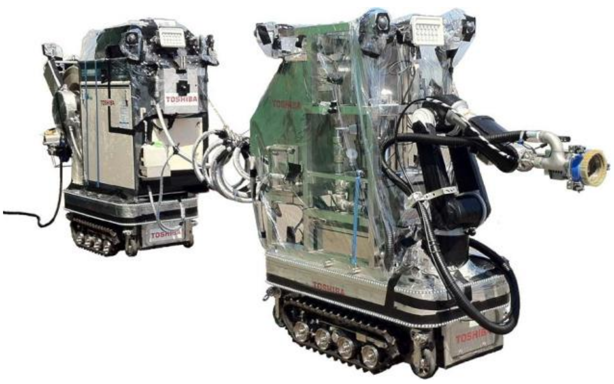
1. Contamination survey

Decontamination, shielding and removal of radiation sources are known as effective means to reduce ambient dose rates. When determining which means to adopt for each location and selecting suitable decontamination methods, it is necessary to understand the status of the contamination of the plant. Under the government project “Development of Remote Decontamination Technology for Reactor Buildings,” the company conducted a contamination survey within the reactor building and found that the surface contamination can be categorized into the following three types.

- Loose contamination: Easily movable contamination, such as dust piled up within the building, or concrete pieces or powder generated by hydrogen explosions to which radioactive material is attached
- Fixed contamination:Immovable contamination, such as that caused by radioactive material attached to the building itself or the surface of the machinery
- Penetrant contamination: Contamination by radioactive material penetrating into concrete

2. Development of remote-controlled decontamination vehicle

The contamination was categorized into six types depending on the aforementioned three types of surface contamination and whether or not the concrete surfaces of the building are coated with epoxy resin. The company classified decontamination techniques publicly sought from inside and outside of Japan by the applicable type of contamination and selected the dry ice blast method, which is effective for removing fixed contamination, to develop a remote-controlled decontamination vehicle. The dry ice blast method is removal of contamination by the use of the impact force generated by dry ice blasting and the expansive force of subliming dry ice, which characteristically generates little secondary waste. The remote-controlled decontamination vehicle the primary contractor has developed is equipped with decontamination equipment, collection equipment, compressors, electric arms, etc. on two crawlers and can be remotely controlled from the main seismic isolated building. A test of this vehicle was conducted on the first floor of the Unit 2 reactor building in April 2014 and the surface contamination was further reduced by 60% compared to the contamination level of the floor surface cleaned by spraying water.



A remote dry-ice blast vehicle consists of two crawler vehicles loaded with decontamination equipment, collection equipment, compressor, electric arm, etc. and can be remotely controlled from the important quake-proof building.

Decontamination work at Unit 2

While developing the aforementioned remote-controlled decontamination vehicle, the company also carried out decontamination work within the reactor building by using existing devices. Decontamination work was commenced at Unit 2 in October 2013. First, unnecessary objects that would hinder the decontamination work were removed, the floor surface and the lower part of the walls were cleaned by spraying water, and the middle part, etc. was vacuumed and wiped. Through these efforts, ambient dose rates decreased by around 50%. The company further installed temporary shields and it became possible to conduct a survey for a short time and perform simple works.

Middle-upper decontamination equipment
(remodeled small heavy equipment)

Acknowledgment

This report includes part of the outcome of the FY2011 project subsidized by the Ministry of Economy, Trade and Industry "Decontamination Work in Reactor Buildings" (subsidized entities: Toshiba Corporation, Hitachi-GE Nuclear Energy, Ltd., and Mitsubishi Heavy Industries, Ltd.), the FY2012 subsidized project "Integrated Dose Reduction Planning" (subsidized entity: ATOX Co, Ltd.) and the FY2013 subsidized project "Development of Remote Decontamination Technology for Reactor Buildings" (subsidized entity: IRID).

Case: Radiation Management for R/B Works at Unit 1 and Unit 4

1. Radiation management for works at the reactor building of Unit 1

Dose rates were extremely high both inside and outside the reactor building and the following measures were taken.

(1) Reduction of dose rates by installing a steel shield and shielding screens
(2) Introduction of remote controlled robots (boats and Telerunner, etc.) for surveys in the reactor building and the following measures for performing the relevant works
- Training and operation test using full-size facilities simulating the inside of the torus room
- Training for workers for putting on and off protective gear, such as Tyvek coveralls and masks
- Shielding of the vicinity of the boring area and ascertaining of dose rates with an area monitor
- Remote control of boring and other operations
- Measurement of dose rates upon retrieving robots and dissemination of measurement results to workers
- Ascertaining of exposure doses by having them wear APDs

(3) Installation of shielding for work within the reactor building and other work
(4) Removal of rubble within the reactor building by using remote controlled robots (ASTACO-SoRa)
(5) Introduction of gamma cameras that can measure dose rates by remote scanning
(6) Introduction of survey meters using optical fiber (D-phod) that can measure the vertical dose distribution

Remote-controlled removal of rubble in the R/B

Important quake-proof building Operation panel

2. Radiation dose management on the operation floor (R/B5FL) at the reactor building of Unit 4

The following measures were taken for the work to remove rubble scattered in the spent fuel pool.
- Training of workers who are to perform the relevant work by using full-size fake rubble at a plant facility
- Cleaning of rubble being removed with high-pressure water within and above the water of the spent fuel pool
- Check of dose rates of rubble being removed with a remote controlled survey meter
- Storage and shielding of the rubble storage area and ascertaining of dose rates with an area monitor
- Reduction of workload of workers by having them wear air

supplied hood and mask

3. Dose control/health management

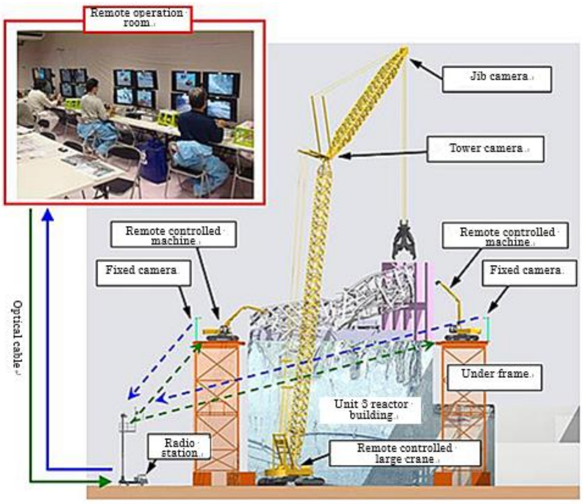
(1) The primary contractor receives data of individual exposure doses provided from TEPCO and incorporates them into its management system on a daily basis to check exposure doses and regularly provides workers with a dose control table that enables them to ascertain their accumulated doses.

(2) Industrial physicians provide health guidance at local offices to eliminate workers' health concerns.

Case: Radiation Exposure Reduction through Remote-controlled Work and Automation

In the process of endeavoring to stabilize TEPCO's Fukushima Daiichi NPP, the company set up its original dose control criteria (40mSv per year and 80mSv per five years; statutory dose limits are 50mSv per year and 100mSv per five years) with the top priority placed on the safety and health of employees and workers. Under the established dose control system, company-wide efforts have been made for controlling radiation doses of the primary contractor employees as a whole. In addition to setting up dose control criteria, the primary contractor has reviewed the frequency of ionizing radiation medical examinations and WBC tests as necessary, thereby trying to eliminate workers' anxiety over radiation exposure.

At present, the primary contractor is performing operations for covering the Unit 3 reactor building. As radiation doses are especially high around Unit 3, automation technology is indispensable. Therefore, the primary contractor developed a remote unmanned work system, which makes it possible to remotely operate ten construction machines at the same time from a remote operation room (below 10µSv/h) at a distance of around 500m, and is using the system for the construction of the reactor building cover of Unit 3. By utilizing this automation technology, removal of rubble and decontamination can be carried out without workers needing to work on the operation floor where dose rates are very high (removal of rubble completed in October 2013).

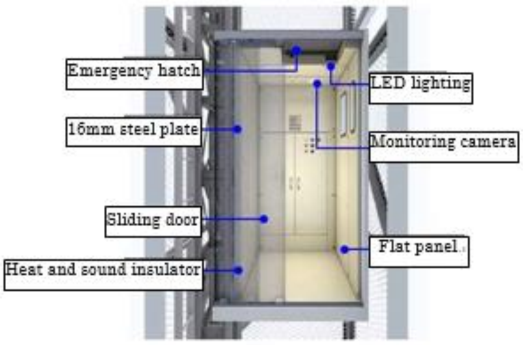


Destruction and removal of rubble from the top of a reactor building by using a remote-controlled system

Autonomous construction vehicles transport demolished rubble to storage facilities on-site. Concrete rubble and steel frames generated as a result of demolition work are stored in steel containers and are transported to storage facilities on-site by crawler dumps and forklift trucks. By adopting advanced information technology that the primary contractor accumulated through large-scale land formation projects and others, those autonomous construction vehicles each equipped with a GPS antenna, compass, monitoring camera, laser scanner, etc. can run, stop and turn while automatically detecting obstacles ahead and errors based on the predetermined route. Thanks to this technology, high dose rubble can be transported safely to the storage place without workers needing to directly handle such rubble.

Unmanned forklift for transporting high dose rubble

The primary contractors also developed an elevator with a radiological protection function and adopted it for the construction work at the reactor building of Unit 3. The elevators are used for workers going up and down between the ground of the site and the floor 30m above. The cage is covered with steel plating and is designed to halve radiation doses inside to reduce the radiation exposure of users. When installing the elevators, efforts were made to reduce the radiation exposure of workers by significantly reducing the assembly time through the adoption of the construction method of stacking units of the elevator shaft.



31 March 2015
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URL: http://www.mhlw.go.jp/english/topics/2011eq/workers/index.html