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

4th Edition (Fiscal Year of 2016)

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1) Exemption Ordinance

At the time the accident began at the TEPCO Fukushima Daiichi NPP, emergency dose limits of 100 mSv were in effect for the workers based on the Ordinance on the Prevention of Ionizing Radiation Hazards. However, after consideration of the security of the general public and the prevention of expansion of the nuclear disaster, the emergency dose limit in the affected plant was raised to 250 mSv on 14 March 2011 (Exemption Ordinance). 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. The exemption ordinance was abolished on 16 December 2011 when TEPCO completed step 2 of the road map.

2) Problems that occurred after the accident and the responses by MHLW and TEPCO

The responses and actions to the following 20 cases were taken by MHLW and TEPCO.

Related 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 dose notifications to workers, 5. Delay of internal exposure monitoring, 6. Unexpected occurrence of workers who could not be contacted.

Related respiratory protective equipment and protective clothing (4 cases): 1. Exceeding emergency exposure dose limit, 2. Exceeding exposure dose limit for woman, 3. Improper use of respiratory protective equipment, 4. Improper protective garments.

Related training for new workers (1 case): 1. Insufficient training hours for workers.

Related 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.

Related 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 lodging and meals.

3) 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 describe "Actions for long-term health control", "Development of a database for workers who have engaged in emergency works" and "Support provided by the Government". Based on the guidelines, MHLW and TEPCO are implementing long term health control such as cancer screenings etc., corresponding to the exposure dose values for the workers who had been engaged in the emergency works at the NPP.

4) Implementation status of measures against ionizing radiation hazards associated with decommissioning works

In order to ensure the working conditions as well as the industrial safety and health of workers engaged in decommissioning works at the NPP, the Fukushima Prefectural Labour Bureau provided employers with focused supervision and instruction.

5) Recommendations

On 10 August 2012, in response to the issues of 20 cases, MHLW demanded the employers who operate nuclear facilities to prepare for nuclear accidents that may necessitate emergency works and also to prepare for the actions that may need to be taken when such accidents 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.

6) Exposure dose distribution of workers at the TEPCO Fukushima Daiichi NPP

The status of the radiation exposure dose was summarized.

2. Decontamination Works Resulting from the Accident of the TEPCO Fukushima Daiichi NPP and Necessary Radiation Protection Measures

1) Radiation protection of workers involved in decontamination works

The Japanese Government has decided to carry out decontamination works 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.

The Act on Special Measures Concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District off the Pacific Ocean Earthquake was fully implemented starting from 1 January 2012.

The Nuclear Emergency Response Headquarters and the National Reconstruction Agency revised the classification of the evacuation areas around the TEPCO Fukushima Daiichi NPP into 3 types of areas: 1. Area 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.

Activities for accident-derived waste disposal were subject to the Ionizing Radiation Ordinance; however, this ordinance did not contain sufficient regulations for employers involved in disposal work. Therefore the Ionizing Radiation Ordinances was amended and the new guidelines were developed that summarize relevant laws and regulations.

2) Outline of ordinances which provide radiation protection during decontamination works and restoration and reconstruction 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 at the NPP. Actions are largely divided into three types, namely actions to reduce exposure, actions to prevent spread of contamination, and education and health care of workers.

The MHLW published the ministerial ordinance which partially revised the Ionizing Radiation Ordinance for Decontamination. It was put into effect on 1 July 2012. 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) shall also be included in the decontamination operation, and 2. the Ionizing Radiation Ordinance for Decontamination shall also be applied to works other than decontamination at areas with an average ambient dose rate higher than 2.5 μSv/h.

The MHLW published a ministerial ordinance to revise the Ionizing Radiation Ordinance for Decontamination and it was put into effect on 1 July 2013. This revision was made in light of the fact that disposal of waste contaminated with radioactive materials discharged by the NPP accident is expected to increase in scale with the progress of decontamination projects. In parallel with the revision, “Guidelines on Prevention of Radiation Hazards for Workers Engaged in the Accident-derived Waste Disposal” were prepared.

3) Status of the implementation of radiation protection corresponding to decontamination works

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

3. Overview of Guidelines and Notifications

The following guidelines and notifications were issued.

- “Guidelines on Maintaining and Improving Health of Emergency Workers at Nuclear Facilities”
- 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
- “Guidelines on Prevention of Radiation Hazards for Workers Engaged in Decontamination Works”
- “Guidelines on Prevention of Radiation Hazards for Workers Engaged in Works under a Designated Dose Rate”
- Improvement of the safety and health management system of radiation and emergency works at nuclear facilities
- “Guidelines on Prevention of Radiation Hazards for Workers Engaged in Accident-derived Waste Disposal”
- Radiation exposure doses registration systems for decontamination and related works
- “Guidelines on Occupational Safety and Health Management at the TEPCO Fukushima Daiichi Nuclear Power Plant”

4. Results of Epidemiological Studies on Emergency Workers

1) 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.

This report describes study target and method, health effect examinations, ascertaining cumulative doses, control of confounding factors, implementation system of studies, study period and evaluation and publication of study results.

2) A report was compiled regarding the Research on Thyroid Gland Examinations, etc. of Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant. The aim of this research was the epidemiological analysis of radiation effects on the thyroid gland by setting an exposed group (emergency workers exposed to radiation exceeding a thyroid equivalent dose 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 were to be evaluated from the viewpoint of clinical medicine in terms of radiation effects on the thyroid gland.

5. Good Practices in Radiation Exposure Control at the Fukushima Daiichi NPP

To collect and facilitate the sharing of information about good practices, the Workshop on Radiation Exposure Control at the Fukushima Daiichi NPP was held in cooperation with TEPCO and primary contractors. The workshop consisted of three sessions: (i) Current situation of the Fukushima Daiichi Nuclear Power Plant and the improvement in working environment, (ii) Radiation exposure reduction by improvement of work efficiency and mechanized measures, and (iii) Radiation exposure reduction by the management and improvement of working environment. Presentations were given by TEPCO and primary contractors, followed by an exchange of opinions between participants and experts.

Introduction

In response to the accident of the Fukushima Daiichi Nuclear Power Plant (NPP) that resulted from the Great East Japan Earthquake on 11 March 2011, the Tokyo Electric Power Company (TEPCO) undertook emergency works to which an emergency dose limit applied. The dose limit for the emergency works, 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 works, 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 guidances 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; the implementation of an exposure data control system, and worker training and work planning; and the 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 1.5.

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 works (e.g., clean-up of buildings and remediation of soils and vegetation) and to manage the wastes 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 from 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 fourth edition is updated with new information in Sections 1.3.2 and 2.3, reflecting the latest numeric data and reports. The exposure dose distribution tables in Section 1.6 were thoroughly updated using the latest information of December 2016. Section 2.4 was newly created for explaining the status of lifting evacuation orders.

Regarding good practices in radiation dose control and exposure dose reduction by TEPCO and several primary contractors at the affected plant, Section 5 was created in the second edition of this document. In this edition, newly obtained information is introduced in Section 5. The information was obtained from the workshop held on 14 November 2016.

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

Emergency works that began in response to the accident of the TEPCO Fukushima Daiichi NPP associated with the Great East Japan Earthquake of 11 March 2011 were 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, in the summer, workers had to work under the blazing 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 works. 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 experiences 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 the accident started at the TEPCO Fukushima Daiichi NPP, emergency dose limits of 100mSv were in effect for the workers engaged in emergency works 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 its start, radiation protection of workers was also implemented in accordance with the Ionizing Radiation Ordinance. However, consideration for the security of the general public and the prevention of expansion of the 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 Resulting from the 2011 Tohoku-Pacific Ocean Earthquake (herein after the "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 symptoms.
・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

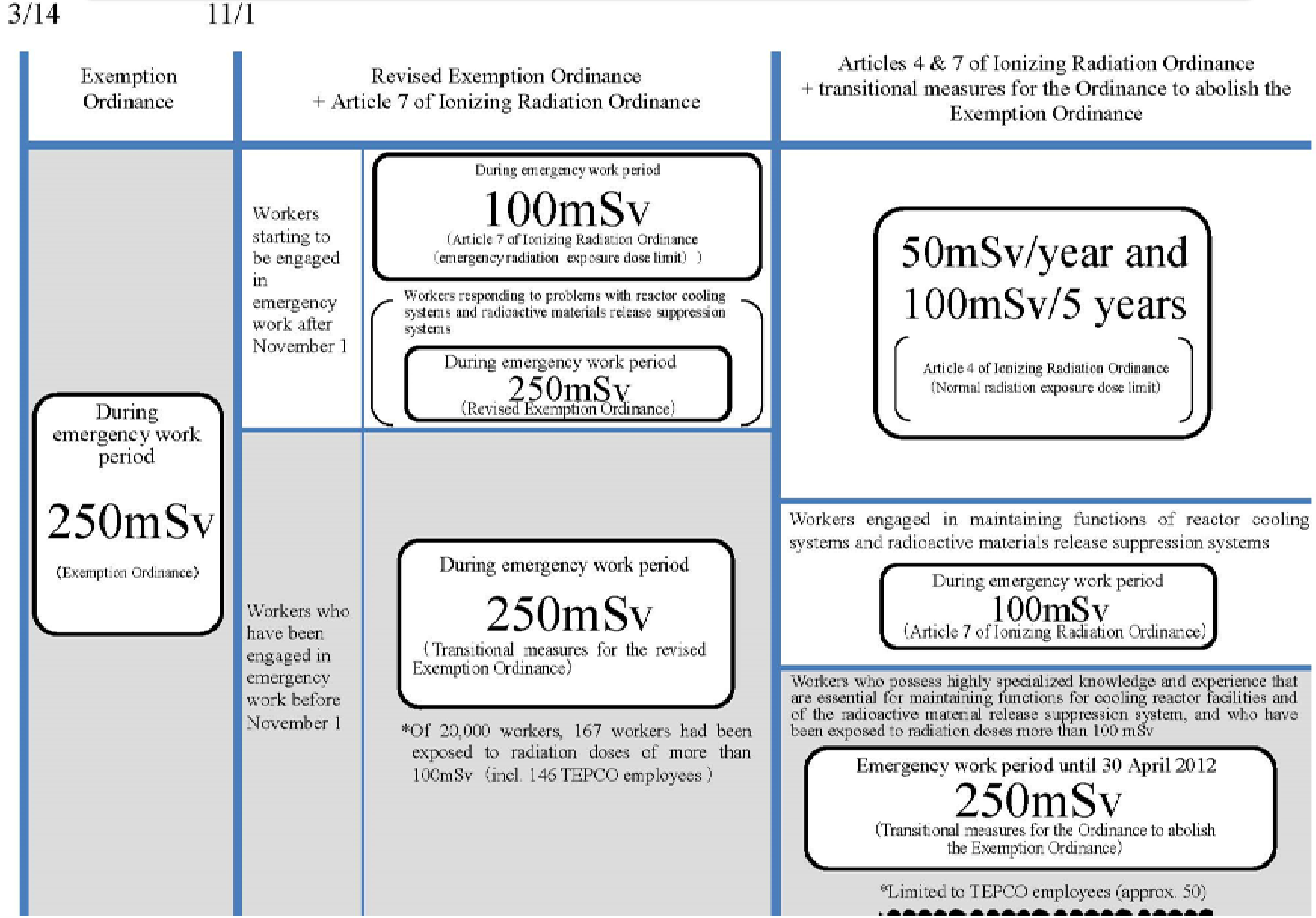
On 1 November 2011, the emergency dose limit for new workers was decreased to the original (100 mSv) with some exceptions designated by the Minister of MHLW. Exempted works were listed as the emergency works related to responses for the prevention of the loss of cooling systems of nuclear reactors and 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 works 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 the 20,000 persons who had been engaged in the emergency works, 167 persons had exceeded the100 mSv emergency dose (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 for 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 (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 be 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 in 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 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 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 badge.
(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 caused 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 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' offices 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 that 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 should be stopped 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 works (3 June, 7 June, 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 any 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 to assess the internal exposure of the 2 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 the instructions on how to wear respiratory protective equipment in the education of new workers. Thus, there were still 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 filters used by 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).

・Masks with electric powered fans were introduced (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), 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 unintentionally 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 establish 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 alarms of dosimeters go off 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 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 the 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 staff from November 2011.

・The University of Occupational and Environmental Health began to dispatch 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 J-Village (September 2011).

・The National Defense Medical College started dispatching teams of critical incident stress specialists (10 July). The teams provide mental health services on a monthly basis.

[Actions taken by TEPCO]

・TEPCO opened the on-site makeshift medical clinic at Units 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 plans 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 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 works, the larger the numbers of workers who were 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 the 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 works that the examinations must be taken within under the assumption of a short-term emergency works (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 1-2 hours were needed 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 helicopter airlift 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 town 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 the normal dose limit of 50 mSv/y and those who exceeded the emergency exposure dose limit of 100 mSv. It also became necessary to conduct health consultations 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 the 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 are 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 whose dose exceeded 100 mSv, in accordance with the report provided by the experts' meeting.

・The MHLW compiled a report on methods for providing health care and exposure dose control during emergency works in nuclear facilities (1 May 2015). In this report, the items that should be provided to workers were compiled regarding the following items:

1) Long-term health care including the period after termination of employment, such as the medical examination of emergency workers
2) Healthcare during emergency works
3) Ensuring a medical care system in nuclear facilities during emergency works
4) Mid- to long-term exposure dose control to be provided to the workers whose exposure doses exceed the dose limit for regular radiation works
5) Exposure dose control during emergency works
6) Special education to the emergency workers who will be engaged in exceptional emergency works

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 estimation of the maximum radiation exposure dose, improper use of dosimeters (glass badges, ring badges, and alarm settings), 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 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 possible contamination by 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 Health control at the TEPCO Fukushima Daiichi NPP

1.3.1 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 describe "Actions for long-term health control", "Development of a database for workers who have engaged in emergency works" and "Support provided by the Government".

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

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 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 of 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 reached 92.7% (the data registration reached 77.9%), and that of general medical examinations reached 91.9% (the data registration reached 71.2%).

(4) Status of the data base registration of cancer screening 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 screening 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%.

(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.

1.3.2 Approval for occupational accident of worker/injuries

A request of approval for an occupational accident/injury was made by a worker as he had developed leukemia due to his engagement in radiation work at the TEPCO Fukushima Daiichi NPP.

The MHLW held a review meeting attended by medical experts to discuss the matter. As a result, in October 2015 the MHLW acknowledged the causal relationship between the radiation exposure and the development of leukemia for this case, and they gave an approval for occupational accident/injury for the first time since the accident at the TEPCO Fukushima Daiichi NPP.

With respect to leukemia due to radiation exposure, MHLW has established the criteria for occupational accidents*, and based on examination by medical experts, judgment on whether it is on business-related or not shall be decided.

*Approval criteria of occupational accidents for leukemia
1) Exposure to an equivalent amount of ionizing radiation (5 mSv × years of engagement)
2) Onset of leukemia after a period of at least 1 year after the beginning of radiation exposure

In addition, in August 2016 the MHLW approved an occupational accident/injury for the second time based on the above approval criteria by medical experts for leukemia as an occupational accident also for leukemia that a worker developed after the accident at the TEPCO Fukushima Daiichi NPP.

Further, in December 2016 the MHLW compiled medical knowledge on thyroid cancer and radiation exposure in a report at a medical experts' review meeting, and published its immediate view on compensation for an occupational accident/injury** as indicated below.

**The MHLW's immediate view on compensation for an occupational accident/injury concerning thyroid cancer and radiation exposure
1) An association between radiation exposure and onset of cancer is suspected when onset of cancer is observed for an exposure dose of 100 mSv or more, and as the exposure dose increases, the association with onset of cancer is strengthened.
2) The period of time from radiation exposure to onset of cancer shall be five years or more.
3) Factors other than radiation exposure also need to be considered.

Based on the above immediate view on compensation for an occupational accident/injury, in the same month, MHLW recognized a case of thyroid cancer that developed in a worker after the accident at the TEPCO Fukushima Daiichi NPP, and approved it as an occupational accident/injury in the light of the deliberations by medical experts.

1.4 Implementation status of measures against ionizing radiation hazards associated with decommissioning works

In order to ensure the working conditions as well as the industrial safety and health of workers engaged in decommissioning works at the TEPCO Fukushima Daiichi NPP, the Fukushima Prefectural Labour Bureau provided employers of such workers with focused supervision and instruction. As a result of supervision and instruction provided for 724 employers by 30 September 2015, 409 employers were identified to be violating laws and ordinances related to the labour standards, namely, the Labour Standards Act and the Industrial Safety and Health Act, in some form (violation rate: 56.5%). The total number of violation cases was 656, where violations related to working conditions were found in 406 cases and violations related to industrial safety and health in 250 cases. For the employers discovered to be violating laws and ordinances, the Fukushima Prefectural Labour Bureau provided instruction towards rectification. Additionally, the Bureau has provided instruction on appropriate implementation of measures stipulated in the "Guidelines on occupational safety and health management at the TEPCO Fukushima Daiichi Nuclear Power Plant" formulated on 26 August 2015.

1.5 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 works 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

1.5.1 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 works 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 staff members to be engaged in temporarily 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 said facility and perform exposure dose control directly including the exposure data input and name-based dose consolidations 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 dose data inputted.

[Actions taken by the primary contractors]
- Immediately notify all the workers under the involved subcontractors through the said 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 Institutes.

・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 the employers' office on the site to investigate, 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 on the site for reconfirmation, in cooperation with the primary contractors' office on the 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 the 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.

1.5.2 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 the 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) Verifying proper fitting by using fitting testers.

2) Taking preventive measures against leak-in, especially having workers 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 it 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.

1.5.3Training 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 and sufficient instructional materials, 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, prepare materials 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 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.

1.5.4 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 there) with a sufficient distance to ensure safety, even if a hydrogen explosion occurs 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 works, 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 becames unavailable.

・Immediately establish the required medical care system to ensure mental and physical health of workers engaged in emergency works.

[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 to promote heat stroke occurrence using the WBGT; and obtaining educational materials about heat stroke, on the assumption that workers work wearing heavy equipment under the blazing sun.

・Establish in advance a framework to share information among the employers engaged in construction work in the nuclear facility site.

[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 places.

・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 works 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 works, 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 said 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.

1.5.5 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 works 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 works 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 staff to 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 works.

[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 nuclear facility cannot do the task properly in the case of an 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 works 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 works, 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.

1.6 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 2016

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	261	518
20＜E≦50	630	2,660	3,290
10＜E≦20	491	2,896	3,387
5＜E≦10	377	2,556	2,933
1＜E≦5	589	4,625	5,214
E≦1	735	4,633	5,368
Total	3,415	17,720	21,135
Maximum (mSv)	678.80	238.42	678.80
Average (mSv)	25.15	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	3,327	3,906
E≦1	589	4,239	4,828
Total	1,626	12,116	13,742
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 – March 2015

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	11	996	1,007
10＜E≦20	60	2,598	2,658
5＜E≦10	158	2,775	2,933
1＜E≦5	637	5,314	5,951
E≦1	822	7,359	8,181
Total	1,688	19,042	20,730
Maximum (mSv)	29.50	39.85	39.85
Average (mSv)	2.30	5.29	5.04

April 2015 - March 2016

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	6	592	598
10＜E≦20	52	1,947	1,999
5＜E≦10	108	2,247	2,355
1＜E≦5	533	5,114	5,647
E≦1	998	6,599	7,597
Total	1,697	16,499	18,196
Maximum (mSv)	24.00	43.20	43.20
Average (mSv)	1.85	4.52	4.27

April 2016 – December 2016

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	93	93
10＜E≦20	6	612	618
5＜E≦10	54	1,087	1,141
1＜E≦5	333	3,945	4,278
E≦1	1,223	7,290	8,513
Total	1,616	13,027	14,643
Maximum (mSv)	11.63	38.76	38.76
Average (mSv)	0.94	2.29	2.14

*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 2 Radiation Exposure Dose Distribution (by month)]

As of 31 December 2016

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	239	529	539	119	77	65	16		6	1,696	670.36	31.53
	Contractors	402	525	397	461	372	65	34	17	2	2		2,277	238.42	14.18
	Total	442	591	636	990	911	184	111	82	18	2	6	3,973	670.36	21.59
April 2011	TEPCO	228	323	857	186	62	1						1,657	59.60	6.66
	Contractors	1,550	1,467	625	433	128							4,203	49.61	4.35
	Total	1,778	1,790	1,482	619	190	1						5,860	59.60	5.00
May 2011	TEPCO	437	782	171	73	14							1,477	33.42	3.14
	Contractors	2,221	2,367	809	349	80							5,826	48.80	3.37
	Total	2,658	3,149	980	422	94							7,303	48.80	3.32
June 2011	TEPCO	513	723	85	30								1,351	16.29	2.12
	Contractors	2,560	2,651	772	351	65	1	1					6,401	89.50	3.08
	Total	3,073	3,374	857	381	65	1	1					7,752	89.50	2.91
July 2011	TEPCO	653	625	53	17	3							1,351	31.13	1.69
	Contractors	2,934	2,759	587	200	38	3						6,521	61.97	2.43
	Total	3,587	3,384	640	217	41	3						7,872	61.97	2.30
August 2011	TEPCO	543	666	57	19	1							1,286	23.33	1.72
	Contractors	2,826	2,731	485	162	24	2						6,230	66.50	2.20
	Total	3,369	3,397	542	181	25	2						7,516	66.50	2.12
September 2011	TEPCO	534	633	38	2								1,207	11.35	1.45
	Contractors	2,856	2,582	399	140	23							6,000	33.40	2.01
	Total	3,390	3,215	437	142	23							7,207	33.40	1.92
October 2011	TEPCO	564	552	45	15	3							1,179	36.35	1.57
	Contractors	2,823	2,352	337	103	8							5,623	23.50	1.84
	Total	3,387	2,904	382	118	11							6,802	36.35	1.80
November 2011	TEPCO	853	280	37	10								1,180	13.40	1.07
	Contractors	3,354	1,911	228	82	5							5,580	23.03	1.46
	Total	4,207	2,191	265	92	5							6,760	23.03	1.39
December 2011	TEPCO	868	282	26	13	3							1,192	23.20	1.10
	Contractors	3,345	1,729	258	76								5,408	19.20	1.43
	Total	4,213	2,011	284	89	3							6,600	23.20	1.37
January 2012	TEPCO	761	284	37	13								1,095	17.00	1.19
	Contractors	3,236	1,435	203	72	1							4,947	21.90	1.36
	Total	3,997	1,719	240	85	1							6,042	21.90	1.33
February 2012	TEPCO	845	231	25	8								1,109	17.63	0.91
	Contractors	2,940	1,584	221	100	2							4,847	20.91	1.51
	Total	3,785	1,815	246	108	2							5,956	20.91	1.40
March 2012	TEPCO	874	220	23	2								1,119	12.10	0.83
	Contractors	3,029	1,465	206	53	3							4,756	21.83	1.36
	Total	3,903	1,685	229	55	3							5,875	21.83	1.26
April 2012	TEPCO	870	179	19	3								1,071	13.00	0.75
	Contractors	2,835	1,305	151	75	3							4,369	23.90	1.30
	Total	3,705	1,484	170	78	3							5,440	23.90	1.19
May 2012	TEPCO	854	177	10	1								1,042	10.20	0.66
	Contractors	2,898	1,406	246	49								4,599	18.22	1.41
	Total	3,752	1,583	256	50								5,641	18.22	1.28
June 2012	TEPCO	829	162	20	3								1,014	12.10	0.78
	Contractors	3,086	1,652	220	29								4,987	14.94	1.29
	Total	3,915	1,814	240	32								6,001	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									1,013	6.60	0.62
	Contractors	3,065	1,621	222	38								4,946	17.33	1.34
	Total	3,919	1,771	231	38								5,959	17.33	1.21
August 2012	TEPCO	835	144	7									986	7.20	0.62
	Contractors	3,299	1,341	120	4								4,764	11.64	1.04
	Total	4,134	1,485	127	4								5,750	11.64	0.97
September 2012	TEPCO	850	123	9									982	8.20	0.57
	Contractors	3,272	1,274	163	29	1							4,739	20.50	1.15
	Total	4,122	1,397	172	29	1							5,721	20.50	1.05
October 2012	TEPCO	826	145	7									978	6.30	0.61
	Contractors	3,307	1,325	136	31								4,799	16.00	1.11
	Total	4,133	1,470	143	31								5,777	16.00	1.03
November 2012	TEPCO	812	149	7									968	9.50	0.61
	Contractors	3,306	1,222	145	27								4,700	18.70	1.09
	Total	4,118	1,371	152	27								5,668	18.70	1.01
December 2012	TEPCO	846	149	10									1,005	7.50	0.58
	Contractors	3,489	1,363	180	10								5,042	15.00	1.10
	Total	4,335	1,512	190	10								6,047	15.00	1.01
January 2013	TEPCO	870	96	3									969	7.39	0.42
	Contractors	3,768	1,310	115	7								5,200	12.90	0.96
	Total	4,638	1,406	118	7								6,169	12.90	0.88
February 2013	TEPCO	870	105	2									977	5.43	0.45
	Contractors	3,917	1,415	263	35								5,630	18.50	1.21
	Total	4,787	1,520	265	35								6,607	18.50	1.09
March 2013	TEPCO	845	140	10	2								997	11.03	0.60
	Contractors	3,908	1,706	335	35								5,984	19.30	1.35
	Total	4,753	1,846	345	37								6,981	19.30	1.24
April 2013	TEPCO	948	108	4									1,060	5.90	0.49
	Contractors	4,029	1,165	111	5								5,310	14.40	0.88
	Total	4,977	1,273	115	5								6,370	14.40	0.81
May 2013	TEPCO	896	100	4									1,000	8.60	0.45
	Contractors	3,920	1,141	92	5								5,158	15.80	0.85
	Total	4,816	1,241	96	5								6,158	15.80	0.78
June 2013	TEPCO	931	87	6									1,024	7.40	0.42
	Contractors	3,731	1,182	85	7								5,005	17.50	0.87
	Total	4,662	1,269	91	7								6,029	17.50	0.79
July 2013	TEPCO	891	96	1									988	5.50	0.43
	Contractors	3,752	1,128	107	9								4,996	14.80	0.89
	Total	4,643	1,224	108	9								5,984	14.80	0.81
August 2013	TEPCO	834	118	4									956	6.10	0.49
	Contractors	3,665	1,211	142	40								5,058	19.89	1.03
	Total	4,499	1,329	146	40								6,014	19.89	0.94
September 2013	TEPCO	933	102	3									1,038	5.60	0.44
	Contractors	3,525	1,420	247	61	1							5,254	20.58	1.28
	Total	4,458	1,522	250	61	1							6,292	20.58	1.14
October 2013	TEPCO	893	146	8									1,047	9.50	0.55
	Contractors	3,460	1,556	343	47								5,406	19.36	1.43
	Total	4,353	1,702	351	47								6,453	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									1,079	9.20	0.48
	Contractors	3,700	1,533	303	32								5,568	16.91	1.28
	Total	4,654	1,653	308	32								6,647	16.91	1.15
December 2013	TEPCO	968	116	2									1,086	5.40	0.44
	Contractors	3,852	1,627	199	23								5,701	16.81	1.13
	Total	4,820	1,743	201	23								6,787	16.81	1.02
January 2014	TEPCO	997	84										1,081	4.50	0.37
	Contractors	4,112	1,505	221	53								5,891	15.80	1.16
	Total	5,109	1,589	221	53								6,972	15.80	1.04
February 2014	TEPCO	1,018	56	4									1,078	6.50	0.34
	Contractors	4,611	1,611	168	30								6,420	17.29	1.02
	Total	5,629	1,667	172	30								7,498	17.29	0.92
March 2014	TEPCO	1,012	85										1,097	4.80	0.36
	Contractors	4,940	1,867	227	23								7,057	18.49	1.07
	Total	5,952	1,952	227	23								8,154	18.49	0.98
April 2014	TEPCO	999	94	1									1,094	5.70	0.38
	Contractors	5,449	1,743	234	19								7,445	16.00	0.98
	Total	6,448	1,837	235	19								8,539	16.00	0.91
May 2014	TEPCO	1,053	65	1									1,119	5.60	0.31
	Contractors	5,974	1,794	209	47	1							8,025	20.70	0.95
	Total	7,027	1,859	210	47	1							9,144	20.70	0.87
June 2014	TEPCO	1,056	66	1									1,123	6.80	0.32
	Contractors	6,773	1,790	329	26								8,918	16.89	0.95
	Total	7,829	1,856	330	26								10,041	16.89	0.88
July 2014	TEPCO	1,092	39	1									1,132	5.40	0.27
	Contractors	7,292	1,728	258	49								9,327	18.69	0.89
	Total	8,384	1,767	259	49								10,459	18.69	0.82
August 2014	TEPCO	1,062	39										1,101	3.40	0.25
	Contractors	7,818	1,338	214	9								9,379	17.13	0.71
	Total	8,880	1,377	214	9								10,480	17.13	0.67
September 2014	TEPCO	1,110	51	1									1,162	6.00	0.27
	Contractors	8,012	1,634	288	36								9,970	18.22	0.84
	Total	9,122	1,685	289	36								11,132	18.22	0.78
October 2014	TEPCO	1,112	62										1,174	2.70	0.29
	Contractors	7,951	1,766	234	18								9,969	14.92	0.80
	Total	9,063	1,828	234	18								11,143	14.92	0.74
November 2014	TEPCO	1,141	45										1,186	3.00	0.21
	Contractors	8,198	1,644	269	19								10,130	15.92	0.78
	Total	9,339	1,689	269	19								11,316	15.92	0.72
December 2014	TEPCO	1,099	60										1,159	4.30	0.24
	Contractors	8,272	1,912	283	34								10,501	16.74	0.85
	Total	9,371	1,972	283	34								11,660	16.74	0.79
January 2015	TEPCO	1,111	37										1,148	4.20	0.22
	Contractors	8,514	1,513	56	1								10,084	12.80	0.56
	Total	9,625	1,550	56	1								11,232	12.80	0.53
February 2015	TEPCO	1,096	74	6									1,176	8.00	0.33
	Contractors	8,498	2,214	285	36								11,033	16.80	0.89
	Total	9,594	2,288	291	36								12,209	16.80	0.83

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 2015	TEPCO	1,060	79	3									1,142	6.40	0.32
	Contractors	8,037	2,465	553	118								11,173	19.90	1.21
	Total	9,097	2,544	556	118								12,315	19.90	1.13
April 2015	TEPCO	1,100	66										1,166	4.80	0.27
	Contractors	7,694	2,413	248	20								10,375	15.60	0.93
	Total	8,794	2,479	248	20								11,541	15.60	0.86
May 2015	TEPCO	1,092	42										1,134	2.12	0.20
	Contractors	8,100	1,746	98	4								9,948	11.40	0.66
	Total	9,192	1,788	98	4								11,082	11.40	0.61
June 2015	TEPCO	1,128	64										1,192	3.90	0.25
	Contractors	8,185	1,737	167	12								10,101	11.50	0.72
	Total	9,313	1,801	167	12								11,293	11.50	0.67
July 2015	TEPCO	1,119	53	1									1,173	5.10	0.24
	Contractors	8,140	1,646	134	7								9,927	10.72	0.66
	Total	9,259	1,699	135	7								11,100	10.72	0.62
August 2015	TEPCO	1,083	53										1,136	3.38	0.21
	Contractors	8,369	1,040	36	1								9,446	10.30	0.43
	Total	9,452	1,093	36	1								10,582	10.30	0.41
September 2015	TEPCO	1,144	51	1									1,196	5.60	0.24
	Contractors	8,034	1,590	140	16								9,780	15.30	0.67
	Total	9,178	1,641	141	16								10,976	15.30	0.63
October 2015	TEPCO	1,130	52										1,182	3.20	0.22
	Contractors	7,864	1,699	145	9								9,717	14.42	0.70
	Total	8,994	1,751	145	9								10,899	14.42	0.64
November 2015	TEPCO	1,119	48										1,167	4.96	0.22
	Contractors	7,920	1,451	110	7								9,488	13.88	0.61
	Total	9,039	1,499	110	7								10,655	13.88	0.57
December 2015	TEPCO	1,122	47										1,169	2.70	0.21
	Contractors	8,026	1,335	73	5								9,439	13.50	0.56
	Total	9,148	1,382	73	5								10,608	13.50	0.52
January 2016	TEPCO	1,108	38										1,146	3.30	0.20
	Contractors	8,070	1,194	60	4								9,328	16.00	0.51
	Total	9,178	1,232	60	4								10,474	16.00	0.48
February 2016	TEPCO	1,128	49										1,177	4.70	0.22
	Contractors	7,896	1,461	78	12								9,447	12.36	0.59
	Total	9,024	1,510	78	12								10,624	12.36	0.55
March 2016	TEPCO	1,125	44										1,169	2.71	0.20
	Contractors	8,051	1,291	93	19								9,454	13.82	0.59
	Total	9,176	1,335	93	19								10,623	13.82	0.55
April 2016	TEPCO	1,097	16										1,113	1.90	0.16
	Contractors	7,853	870	42									8,765	9.78	0.41
	Total	8,950	886	42									9,878	9.78	0.38
May 2016	TEPCO	1,128	9										1,137	2.50	0.14
	Contractors	7,748	651	19									8,418	9.70	0.32
	Total	8,876	660	19									9,555	9.70	0.30
June 2016	TEPCO	1,166	26										1,192	2.00	0.16
	Contractors	7,928	833	56	6								8,823	13.81	0.42
	Total	9,094	859	56	6								10,015	13.81	0.38

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 2016	TEPCO	1,138	12										1,150	1.92	0.11
	Contractors	7,849	791	80	3								8,723	10.70	0.41
	Total	8,987	803	80	3								9,873	10.70	0.38
August 2016	TEPCO	1,125	41										1,166	4.39	0.17
	Contractors	7,951	532	19									8,502	7.10	0.28
	Total	9,076	573	19									9,668	7.10	0.27
September 2016	TEPCO	1,160	20										1,180	3.50	0.14
	Contractors	8,041	689	35									8,765	8.80	0.35
	Total	9,201	709	35									9,945	8.80	0.33
October 2016	TEPCO	1,142	21										1,163	2.40	0.14
	Contractors	7,705	875	48									8,628	8.34	0.42
	Total	8,847	896	48									9,791	8.34	0.39
November 2016	TEPCO	1,167	29										1,196	3.10	0.15
	Contractors	7,646	1,000	50	5								8,701	12.00	0.45
	Total	8,813	1,029	50	5								9,897	12.00	0.42
December 2016	TEPCO	1,004	15	2									1,021	6.24	0.15
	Contractors	7,595	824	41	3								8,463	13.10	0.38
	Total	8,599	839	43	3								9,484	13.10	0.35

*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).

Note) The numbers of workers may have been corrected not only for those in fiscal 2016, but also for those before fiscal 2016.

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

As of 31 December 2016

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	0	0
10 < E≦20	0	1	1
5 < E≦10	0	3	3
1 < E≦5	2	10	12
E≦1	8	13	21
Total	10	27	37
Maximum (mSv)	1.96	11.11	11.11
Average (mSv)	0.59	2.45	1.95

Ages 20 to 29

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	8	8
10 < E≦20	0	84	84
5 < E≦10	16	125	141
1 < E≦5	96	472	568
E≦1	118	723	841
Total	230	1,412	1,642
Maximum (mSv)	9.64	29.50	29.50
Average (mSv)	1.71	2.51	2.39

Ages 30 to 39

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	19	19
10 < E≦20	3	134	137
5 < E≦10	15	220	235
1 < E≦5	69	802	871
E≦1	230	1,233	1,463
Total	317	2,408	2,725
Maximum (mSv)	11.63	38.27	38.27
Average (mSv)	1.12	2.57	2.40

Ages 40 to 49

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	31	31
10 < E≦20	1	197	198
5 < E≦10	13	331	344
1 < E≦5	92	1,225	1,317
E≦1	392	2,254	2,646
Total	498	4,038	4,536
Maximum (mSv)	10.10	37.69	37.69
Average (mSv)	0.80	2.33	2.16

Ages 50 to 59

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	27	27
10 < E≦20	2	146	148
5 < E≦10	8	280	288
1 < E≦5	70	1,011	1,081
E≦1	433	2,056	2,489
Total	513	3,520	4,033
Maximum (mSv)	11.20	38.43	38.43
Average (mSv)	0.66	2.15	1.96

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	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	8	8
10 < E≦20	0	49	49
5 < E≦10	2	127	129
1 < E≦5	4	422	426
E≦1	41	996	1,037
Total	47	1,602	1,649
Maximum (mSv)	8.03	38.76	38.76
Average (mSv)	0.67	1.92	1.89

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	0	0
50 < E≦75	0	0	0
20 < E≦50	0	0	0
10 < E≦20	0	1	1
5 < E≦10	0	1	1
1 < E≦5	0	3	3
E≦1	1	15	16
Total	1	20	21
Maximum (mSv)	0.20	14.13	14.13
Average (mSv)	0.20	1.65	1.58

Number of workers

	TEPCO	Contractors	Total
Ages 18 to 19	10	27	37
Ages 20 to 29	230	1,412	1,642
Ages 30 to 39	317	2,408	2,725
Ages 40 to 49	498	4,038	4,536
Ages 50 to 59	513	3,520	4,033
Ages 60 to 69	47	1,602	1,649
Ages 70 and over	1	20	21
Ages unknown*	0	0	0
Total	1,616	13,027	14,643
Maximum (mSv)	11.63	38.76	38.76
Average (mSv)	0.94	2.29	2.14

* 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).

2. Decontamination Works Resulting from the Accident of the TEPCO Fukushima Daiichi NPP 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 Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District Off the Pacific Ocean Earthquake That Occurred on 11 March 2011 (Act. No.110, 2011, hereinafter referred to as the "Act on Disaster Special Measures") was passed into law in August 2011, and fully implemented starting from 1 January 2012.

(1) The regulations established by the Act on Disaster Special Measures 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 on Disaster Special Measures 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 works that involve collection of wastes stipulated in the Act on Disaster Special Measures are not included. Furthermore, this 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 Disaster 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 wastes). For applications of the above activities, revision of the 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 Ionizing Radiation Ordinance; however, this 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 at 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 are 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 shall be kept for 30 years*4), as well, workers shall be notified of their doses.
- The decontamination shall 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 shall 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 shall wear proper respiratory protective equipment and protective clothes.
- Removed soil shall be stored in a container that meets certain requirements*5) and access to the containers shall be restricted.
- Smoking, drinking or eating in working areas that may have a risk of ingestion or inhalation of radioactive material shall be prohibited.
- Contamination inspection areas shall be set up where contamination surveys are conducted for the body and clothing 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 shall be 0.1 mSv/h or less.

(3) Education and health care of workers

- Education shall be provided to workers who will be engaged in the decontamination works with respect to radiation effects, radiation dose control, work methods, etc.
- Special medical examinations shall 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 shall be kept for 30 years*6) and notified to each worker. When any abnormalities are found in the medical examination of any workers, some consideration in their work shall 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 records shall be delivered to the organization designated by the MHLW, and copies shall be given to the workers.
- The results of periodical special medical examinations shall 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 Act on Disaster Special Measures.

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) shall also be included in the decontamination operation, and
2. The Ionizing Radiation Ordinance for Decontamination shall 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 workers from encountering radiological hazards . 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 increase in scale with the progress of decontamination project.

Disposal business employers were recommended to take radiological hazard prevention measures for the 5 revised points shown below. It should be noted that definitions of controlled area, dose limits, dose measurement and recording and measures for health care shall 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. These 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 shall implement in order to prevent workers from encountering radiological hazards. 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 system
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 Results of inspection and instructions provided to employers engaged in decontamination works, etc.

The Fukushima Prefectural Labour Bureau (PLB) has conducted inspections and given instructions within the jurisdiction of the Labour Standards Inspection Offices to employers 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.

As a result of inspections for 309 employers from January to December 2015, a total of 167 were recognized as being in violation (violation rate: 54.0%) of applicable laws such as the Labour Standards Act or the Industrial Safety and Health Act. The same inspections for 118 employers from January to June 2016 found a total of 53 were recognized as being in violation (violation rate: 44.9%). Corrective recommendations were issued to these employers to correct the said violations accordingly.

2.3.2 Voluntary activities towards compliance with laws and ordinances

On 30 October 2015, the Fukushima PLB formulated its own "General Measures toward Improvement of Level of Compliance with Laws and Ordinances for Decontamination Works, etc." Its contents include provision of focused supervision and instruction for decontamination worksites and promotion of voluntary activities towards compliance with the related laws and ordinances by the relevant employers.

On 9 November 2015, the Fukushima PLB held an information session on the General Measures. At the information session, the Bureau provided all the primary contractors of decontamination works ordered by the National Government (Ministry of the Environment) with detailed information on the General Measures, provided them with instruction on ensuring proper working conditions, safety and health of workers engaged in decontamination works as well as maintaining and improving the fairness in subcontracting relations, and requested them to thoroughly comply with the related laws and ordinances in collaboration with the Fukushima Office for Environmental Restoration.

2.4 Status of lifting evacuation orders in the areas under evacuation orders

Evacuation orders were lifted for Tamura City and part of Kawauchi Village in 2014 and for Naraha Town in September 2015.

As of January 2016, preparation stays* are arranged for "zones in preparation for the lifting of the evacuation order" and "restricted residence areas" located in Minamisoma City (Odaka Ward, Haramachi Ward), Kawamata Town (Yamakiya Region), and Katsurao Village.

In the Cabinet Decision of 12 June 2015, it was decided to accelerate environmental improvement for "zones in preparation for the lifting of the evacuation order" and "restricted residence areas" to facilitate returning of the residents by lifting evacuation orders by six years after the accident (March 2017) at the latest, taking into account the reconstruction plans of relevant municipalities.

In the Cabinet Decision of 20 December 2016, the "Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster" was formulated to further accelerate this reconstruction and restoration of Fukushima.

Initiatives will be implemented aiming to realize early reconstruction of "difficult to return zones", and addition and expansion of necessary measures will be conducted to facilitate early starting of reconstruction work in FY2017, including establishment of a system for arranging designated reconstruction bases, etc.

* Preparation stays: A special arrangement to allow people to stay overnight at their own houses, etc., within an area under evacuation orders (in which people are normally prohibited to stay) so that they can make preparations for smoothly resuming their lives in their hometown once evacuation orders are lifted.

[Reference]

- Zones in preparation for the lifting of the evacuation order
  Among areas under evacuation orders, where it was confirmed that the annual cumulative dose of radiation estimated from the ambient dose rate will definitely be 20 mSv or less (confirmed, based on the dose as of March 2012).
- Restricted residence areas
  Among areas under evacuation orders, where it was confirmed that the annual cumulative dose of radiation estimated from the ambient dose rate may exceed 20 mSv (confirmed, based on the dose as of March 2012).
- Difficult to return zones
  Areas where the annual cumulative dose of radiation estimated from the ambient dose rate may not become less than 20 mSv in 6 years after the nuclear accident. Areas where the annual cumulative dose of radiation estimated from the ambient dose rate as of March 2012 exceeded 50 mSv.

3. Overview of Guidelines and Notifications

3.1 Overview of the Guidelines on Maintaining and Improving Health of Emergency Workers at Nuclear Facilities

These guidelines were issued on 11 October 2011 as "Guidelines on Maintaining and Improving Health of Emergency Workers at the TEPCO Fukushima Daiichi Nuclear Power Plant". 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 works or radiation works 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 works fall in the following ranges:
  (a) Higher than 50 mSv, a cataract examination once a year.
  (b) Higher than 100 mSv, 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 works

- Employers who assign their emergency workers to be engaged in the emergency works or radiation works should report to the Japanese Government the results of their medical examination and provide status reports 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 screenings and other examinations 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".

On 31 August 2015, the MHLW promulgated the partial revision of the Ministerial Ordinance on Prevention of Ionizing Radiation Hazards that defines actions to prevent workers from encountering radiation hazards, etc. In accordance with the partial revision of the ordinance, the above guidelines were revised (to be applied from 1 April 2016) as shown below.

- Modification of the name to "Guidelines on Maintaining and Improving Health of Emergency Workers at Nuclear Facilities".
- Enhanced long-term healthcare (examination items such as cancer screenings were added and a stress check will be provided).
- Mid-term exposure dose control for workers who were exposed to radiation beyond the dose limit for regular radiation works.
- Exposure dose control for the regular radiation works during the exposure dose control period including the time of the accident.

Further information is available on the following sites.
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/rp/pr_150831_attachment06.pdf
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/rp/pr_150831_attachment05.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 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 certain designated works, 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 businesses, 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.

Further information is available on the following site.
http://www.mhlw.go.jp/english/topics/2011eq/workers/ri/rl/rl_130412.pdf

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

These guidelines specify actions to be taken by the employers to prevent radiation exposure for workers engaged in decontamination works. The guidelines were issued on 22 December 2011, partially revised on 15 June 2012 and again 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 section 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 the 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.

Further information is available on the following site.
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

These guidelines specify 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.

Further information is available on the following site.
http://www.mhlw.go.jp/english/topics/2011eq/workers/dr/dr/pr_120615_a04.pdf

3.5 Overview of the notice, "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 works 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 relevant employers with respect to safety and health measures in preparation for emergency works at nuclear facilities (nuclear power plants, reprocessing facilities and fuel fabrication facilities).

The 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 at the TEPCO Fukushima Daiichi NPP associated with the Great East Japan Earthquake, measures in preparation for emergency works 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 works should be taken not only at nuclear facilities, but also at corporate offices and primary contractors;

(2) In making prior preparations for emergency works, 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.

<u>(a) Radiation dose control</u>

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

<u>(b) Protective equipment and clothing</u>

Protective equipment and clothing should be made available and workers should be shown the correct way to wear the 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 classrooms for educating new workers should be provided.

(d) Health care and medical care systems

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 plans and others

A system to prepare work plans 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 works.

Further information is available on the following site.
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

These 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 operators handling accident-derived waste should take.

(2) General principles

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

(8) Education for workers

The disposal operators should provide workers with special education on the following topics: what accident-derived wastes are and how they should be disposed.

(9) Measures for health care

The disposal operators 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 contractors 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.

Further information is 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 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 site.
http://www.mhlw.go.jp/english/topics/2011eq/workers/ors/oi/pr_131115.html

3.8 Overview of the Guidelines on Occupational Safety and Health Management at the TEPCO Fukushima Daiichi Nuclear Power Plant

The MHLW formulated the Guidelines on Occupational Safety and Health Management at the TEPCO Fukushima Daiichi Nuclear Power Plant (Labour Standards Bureau Notification No. 0826-1, 26 August 2015). This guideline summarizes transparently actions to be conducted by TEPCO and the primary contractors according to the subjects shown below in taking measures for occupational safety and health management toward decommissioning of the TEPCO Fukushima Daiichi NPP.

(1) Establishment of a system for occupational safety and health management undertaken by TEPCO and the primary contractors

- Selecting a general health and safety manager, etc. and holding safety and health coordinating meetings by TEPCO
- Providing instructions to, and support of, relevant subcontractors by the primary contractors

(2) Implementation of risk assessment and measures to be taken for enhancement of safety and health education based on the results

- Implementing a risk assessment (identifying dangers or hazards caused by the works, estimating occurrence of occupational injuries and diseases that may be caused by them, and considering measures to reduce the risks) and taking measures to reduce the possibility of occupational injuries and diseases based on the results
- Enhancing education of new workers or operation leaders

(3) Consideration and implementation of effective exposure dose reduction measures from the stage of placing orders

- Preparing an “Exposure dose reduction specification” by TEPCO for radiation works that may cause one man-sievert of total exposure dose for all workers, and preparing a “Dose control plan” by the primary contractors, etc., and submitting them to the Director of the Labour Standard Inspection Office

(4) Healthcare measures, etc.

- Providing health guidance based on medical examination results, establishing an emergency medical system, taking heat stroke measures and long-term healthcare measures, improving the work environment, etc.

Further information is available on the following site.
http://www.mhlw.go.jp/english/topics/2011eq/workers/tepco/rp/pr_150826_attachment03.pdf

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 report results, 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 NPP

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 collect and facilitate the sharing of information about good practices, the Workshop on Radiation Exposure Control at the Fukushima Daiichi NPP was held in cooperation with TEPCO and primary contractors at Iwaki Business Innovation Center in Iwaki City, Fukushima Prefecture on 14 November 2016.

The workshop consisted of three sessions: (i) Current situation of the Fukushima Daiichi Nuclear Power Plant and the improvement in working environment, (ii) Radiation exposure reduction by improvement of work efficiency and mechanized measures, and (iii) Radiation exposure reduction by the management and improvement of working environment. Presentations were given by TEPCO and primary contractors, followed by an exchange of opinions between participants and experts.

The details of the presentations are compiled and introduced below.

5.1 Current situation of the Fukushima Daiichi Nuclear Power Plant and the improvement in working environment

5.1.1 Efforts to Improve Working Environment and Reduce Radiation Exposure at Fukushima Daiichi Nuclear Power Plant

<u>Tokyo Electric Power Company Holdings, Inc.</u>

At Fukushima Daiichi Nuclear Power Plant, the working environment has been improved in various aspects, such as increasing convenience for workers engaged in the work and reducing radiation exposure.

(1) Use of zoning and reducing need to wear protective equipment on-site at the Fukushima Daiichi Nuclear Power Plant

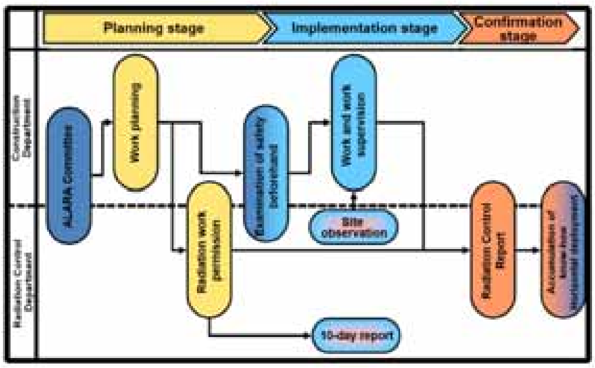
Decontamination work to control radioactive materials that had spread over the entire site (e.g. construction of facings) was completed by the end of FY2015 using methods such as removal of surface soil, base course construction, paving and mortar spraying, excluding rubble storage areas. In addition, dose rate monitors and radioactive aerosol monitors with continuous moving filter have been installed on-site where real time measurement results can be obtained. Based on the progress of measures to reduce environmental radiation dose, the site has been divided into three separate zoning categories based on contamination levels and types of work. Efforts have been made to improve safety and efficiency by providing appropriate protective equipment for each zone and reducing workload, in order to reduce risk in radioactive environments while keeping areas treated with facings at the lowest possible contamination level.

Overview of zoning

(2) ALARA Committee: beginnings and concept

When radiation exposure is considered a risk, one possibility is to avoid the risk itself (i.e. if no one encounters it, the risk will not occur), but there is a pressing need to proceed with decommissioning while putting safety first. As for ways to reduce risk, changing work methods to low-dose approaches through remote operations, removal of radiation sources, and shielding installation, are important as engineering measures (physical measures). In addition, operational measures such as work procedures, training (mock-ups) and time management will also be implemented as management measures. If those measures are still insufficient, radiation dose limits may also be enforced by having workers wear personal protective gear (protective equipment) such as shielding suits.

Among these measures, implementation of engineering measures has a great effect in reducing radiation exposure but also has a major impact on costs and the work schedule. Because it is difficult to make changes or additions immediately before starting work, measures need to be incorporated into the work design otherwise complications will arise during implementation. Therefore, it is crucial to examine measures to reduce radiation exposure in the early



Overview of Exposure Reduction Measures for Individual Tasks stages. It is also meaningful to discuss the implementation in the ALARA Committee based on the three rules of radiation protection (justification, optimization and dose limits) and in the spirit of ALARA (As Low As Reasonably Achievable) when optimizing radiation exposure. Because management measures and personal protective gear can even be implemented immediately before work with established operational processes, they have been confirmed through examination of safety beforehand and with a radiation management plan (RWA).

5.2 Radiation exposure reduction by improvement of work efficiency and mechanized measures

5.2.1 About Reducing Radiation Exposure Dose Rates on the Refueling Floor of the Reactor Building for Unit 3

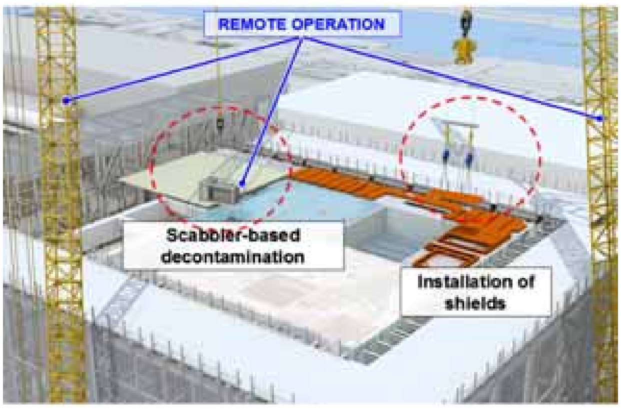
Kajima Corporation

Kajima has been working on the project for removing the fuel from the Unit 3 spent fuel pool. In October 2013, Kajima completed the demolition and removal of the contaminated debris such as steel trusses and concrete debris that had fallen on the refueling floor as a result of the hydrogen explosion. In order to facilitate the fuel removal project, it was necessary to first reduce the air dose rates on the highly contaminated refueling floor.

(1) Designing the Dose Rate Reduction Method

The measurement showed the high air dose rate on the refueling floor, especially in the area directly above the reactor well (756 mSv/h). Because manned work near the refueling floor would be unavoidable in the spent fuel removal project, it was necessary to design and implement a dose rate reduction method which combines decontamination and shielding.

Because of the schedule constraints, Kajima had to plan the dose rate reduction of the refueling floor in parallel with the debris removal. Based on the damage condition around the Unit 4 reactor and other information, Kajima developed a dose rate reduction plan for those areas that could not be sufficiently monitored and confirmed by camera images, assuming that the structures with a slab thickness exceeding 300 mm were sound and those with a slab thickness of 300 mm or less were damaged.



Overview of the dose rate reduction method

(2) Decontamination Work

Taking into consideration the damage condition of the floor and the material composition of the surface, Kajima developed the decontamination plan for the areas excluding the large openings such as the D/S pits and the northwestern area where the refueling floor had been severely damaged. Prior to the full-scale decontamination, the refueling floor surface was cleaned with several machines. "Dozer" collected debris with piece sizes of 300 mm or smaller and "Vacuum" sucked in debris with piece sizes of 100 mm or smaller and dust. The areas with a slab thickness of 600 mm or more, which were assumed to be sound, were decontaminated by using a chipper called "Scabbler" to scrape off the contaminated surface. All of these machines were developed for remote operation and were successfully used as planned.

Decontamination equipment: The system is operated from a remote operation room using a camera equipped on the scabbler.

(3) Shielding Work

The objective of the shielding work was to reduce the air dose rates to the level at which manned work would be feasible. Kajima planned the shielding work based on the load capacities of the structures and the dose condition after decontamination. The steel shields with thicknesses of 150 to 250 mm meeting the required shielding were used for the reactor building, the walls around the pool and the areas with thick slabs which can adequately withstand the load of the shield structures. The steel shields with a thickness of 65 mm were used for the areas of the structures with limited load capacities.

(4) Effects of the Decontamination Work and Shielding Work

The air dose rate measurements conducted before and after the decontamination work and the shielding work showed that both reduced the dose rate. The outcomes showed that decontamination and shielding will significantly contribute to reducing radiation exposure in the case of manned work for the fuel removal.

5.2.2 Report on improvement of work efficiency and reduction of exposure dose by improving the working environment and using mechanization

Taisei Corporation

Taisei Corporation improved efficiency and reduced exposure dose in the coastal area on the south side of the reactor building, through work environment improvements and mechanization carried out in the on-site south-side maintenance work performed starting in December 2015.

(1) Examples of reduction in exposure dose

1) Improvement of method of access the work location

The work location is located at the edge of the site, on the south side of the reactor building, and movement is done by car and walking in the order: 1; Off-site parking lot, 2; Access management, etc., 3; Welfare building, 4; Specific work location. Movement time every day was 118 minutes, and this was shortened to 30 minutes by considering other routes. This reduced the time spent on the 1F site, improved work efficiency, and reduced the daily exposure dose over the entire work period by 17%.

2) Providing rest facilities and a materials yard near the work location

In line with the change in access method, a site owned by Fukushima Prefecture and located a five-minute walk away from the work location was borrowed, and after decontamination a temporary shed and materials yard were set up. Also, a clean-room was set up on-site about 1 minute away from the work location, to make it possible for workers to remove their equipment and replenish liquids, etc.

3) Mechanization of mowing work

Manual mowing work is a task with a possibility for high radiation exposure due to the high dose. The mowing area in this work is an extensive 10,000 m2 and there are some obstructions; thus mechanical mowing was adopted by mounting a mower to the backhoe attachment. This made it possible to reduce the exposure dose in this work to 79%.

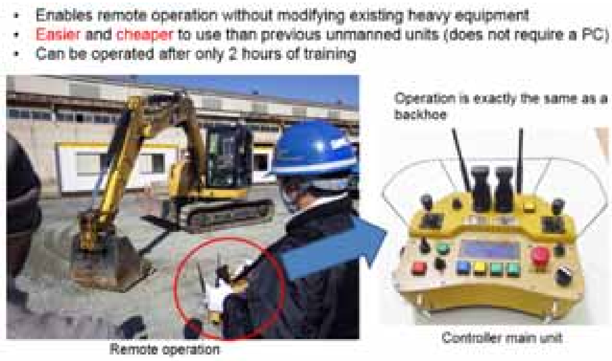
Mechanization of mowing work

4) Topographic surveying of inclined ground using drones

Aerial photography by drones was used for topographic surveying of inclined ground, one type of review work carried out prior to specific work. This reduced the exposure dose in topographic surveying work by 96% in comparison with the previous method of posting surveyors on dangerous slopes with a high dose (including tasks such as mowing and safety rope installation and removal).

5) Backhoe equipped with robot

An unmanned backhoe was used to perform backfilling work for collapsed slopes. This equipment has a robot installed in the cabin, and the robot's arms are connected to the control sticks of the heavy equipment. The heavy equipment is operated by controlling the robot remotely. Since the heavy equipment can be used without modification, the system is inexpensive and highly versatile. Machinery used at locations with a high dose can be easily adapted for unmanned operation.



Backhoe equipped with robot

(2) Conclusion

The most effective measures in this work were improving the access method, and accompanying that, providing rest facilities and a materials yard near the work location. Improvement of the working environment raised efficiency of all work over the entire work period, and had a major effect on exposure dose, safety and process steps (cost). It will also be important to specify high dose work at the planning stage, and consider mechanization or elimination of such work.

5.2.3 Unit 1 reactor building cover - Efforts regarding measures to reduce exposure in work to demolish wall panels

Shimizu Corporation

At Unit 1 of the Fukushima Daiichi Nuclear Power Plant, reactor building covers were installed in October 2011, soon after the disaster, to prevent scattering of radioactive dust. After that, the amount of dust released greatly declined due to continued stable cooling of the reactor and other factors, and thus removal of fuel from the spent fuel pool was planned as a step toward decommissioning, and work began on building cover demolition in April 2015. By the end of 2015, removal of roof panels was finished, and demolishing of wall panels will commence in September 2016.

After demolishing the building cover, rubble accumulated on the operation floor of the reactor building will be removed, but to prepare for the possibility of radioactive dust scattering during rubble removal work, a plan was adopted for installing mist spraying equipment to suppress dispersion of radioactive dust on the existing operation floor steel frames, and that equipment was installed in June 2016, prior to the start of wall panel demolishing.

The following items 1−3 report on measures taken to reduce radiation exposure of workers during suction of small rubble pieces that interfered with installation of mist spraying equipment, removal of obstructing steel frames, and installation of mist spraying equipment. Also, as an extension of that, it introduces (item 4) suction work for items such as roof blocks on the operation floor, carried out prior to wall panel demolition.

(1) Suction of small rubble pieces using rubble suction system "Karuwaza-1"

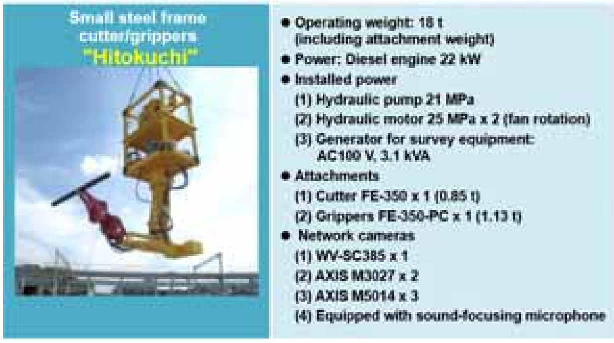
Due to the reactor building explosions which occurred after the earthquake, many small pieces of rubble, such as pieces of concrete, were present on the existing operation floor steel frame. These interfered with the installation of mist spraying equipment (nozzle unit steel frame), but since this is an elevated work environment with a high dose, equipment was developed to suction up the small rubble pieces through remote operation, and work was done using a remote guidance system developed at the time the cover was installed.

▲ Rubble suction system ▲ Rubble suction in progress

Decontamination equipment: The equipment was developed to suction up the small rubble pieces through remote operation

(2) Removal of obstructing steel frame using obstructing steel frame removal system "Hitokuchi"

In addition to the small rubble pieces on top of the existing operation floor steel frame, bent steel frames, pipes and other components are entangled, and present as obstacles. Therefore, an obstructing steel frame removal system with a small cutter and grippers function was developed, and work was done through remote operation, just as in the above case.



Specifications of "Hitokuchi"

(3) Installation of mist spraying equipment

Basic assembly and unit integration of the nozzle unit steel frame of the mist spraying equipment (with pre-installed vertical pipe) were carried out in an area with a comparatively low dose, and in mounting to the existing operation floor steel frame, all work was done remotely using a remote guidance system.

However, some non-remote manned work was necessary on the roof of the lower section of the reactor building, such as installation of a horizontal pipe unit and connection of the pipe with the nozzle unit steel frame. On the pertinent rooftop, the radiation dose was high due to dispersion of small rubble pieces by the explosion after the earthquake, and thus the environment was improved by removing the small rubble pieces, roof blocks and other material. This was done as far as possible through remote operation, using the machinery developed in 1 and 2 above.

(4) Suction of rubble pieces such as roof blocks on the operation floor using the large rubble suction system "Karuwaza-2"

Prior to demolishing of the building cover wall panels, it was decided to suction small loose rubble pieces such as roof blocks on the operation floor in order to reduce, even a little, the risk of scattering radioactive dust. In order to efficiently remove small rubble pieces over a wide area, a large rubble suction system was developed, and all guidance and operation were performed remotely.

5.3 Radiation exposure reduction by the management and improvement of working environment

5.3.1 Measures to prevent the spread of contamination in hot laboratory expansion and removal work at 1F Units 5 and 6

<u>Toshiba Corporation</u>

As work on measures to decommission reactors and improve the work environment progresses at Fukushima Daiichi Nuclear Power Plant, there are increasing numbers of samples requiring analysis in terms of characteristics such as radioactivity density and concentration.

At TEPCO, samples to be analyzed are divided between three analysis facilities depending on radioactivity concentration: Low-concentration samples at the Chemical Analysis Building, medium-concentration samples at the Environmental Management Building, and high-concentration samples at the hot laboratory in Units 5 and 6. Recently, Toshiba conducted expansion work at the hot laboratory in Units 5 and 6.

In this expansion work, exposure reduction was achieved by preventing contamination from being brought in from outside the building, and by improving work efficiency through reduction of physical burdens on the body, prevention of bodily contamination, and prevention of the spread of contamination of the area.

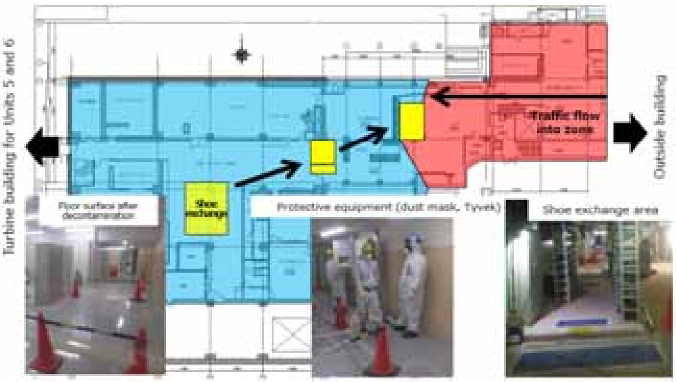
(1) Contamination situation prior to start of work

Shoe exchange when entering the building has been implemented at Units 5 and 6 since the initial stage of the disaster. Contamination levels in the area after the shoe exchange have been maintained at an average of 160 cpm, and the ambient dose rate is at or below 0.1 μSv/h. On the other hand, in the area before the shoe exchange, contamination levels and ambient dose rates are both high, at an average of 5,000 cpm and 2.5 μSv/h respectively.

(2) Description of expansion work

The hot laboratory to be expanded was spread out broadly, even in the high-contamination area in front of the shoe exchange area, and there were concerns that, if left in that condition, there would be worsening of work efficiency and safety due to heavy contamination of equipment/gear, and increased exposure due to the rise in ambient dose rates. Therefore, the following measures were implemented:

1) Decontamination of the high-contamination area (guideline: 100 cpm)
2) Relocation of the shoe-exchange location to the front of the expanded work area and installation of laminated adhesive mats
3) Installation of shoe-exchange spaces and laminated adhesive mats in front of the entrances to each new hot laboratory room



Modification of contamination zones

4) Checking of work materials and tools brought into the expanded work area for contamination
5) Survey of ceiling panels for contamination prior to removal, and removal using local exhaust fans
6) Implementation of various measures to seal in contamination in removal of highly contaminated equipment
7) Implementation of measures to prevent contamination from spreading when doing duct work at the rest station (uncontaminated area)

Contamination control during expansion work

(3) Results of work

The above measures lowered contamination levels and dose rates in the work area.

This enabled reduction of physical burdens on the body by allowing workers to wear dust masks (low-contamination work), prevented bodily contamination by preventing contamination from being brought it, and prevented the spread of contamination of the area by using a clean-shed and local exhaust fans. These measures contributed to completion of work on schedule, without any accidents or disasters.

These improvements in work efficiency contributed greatly to reduction of exposure.

5.3.2 Radiation Protection Initiatives for D-Pit Waste Sludge Desalination Facility

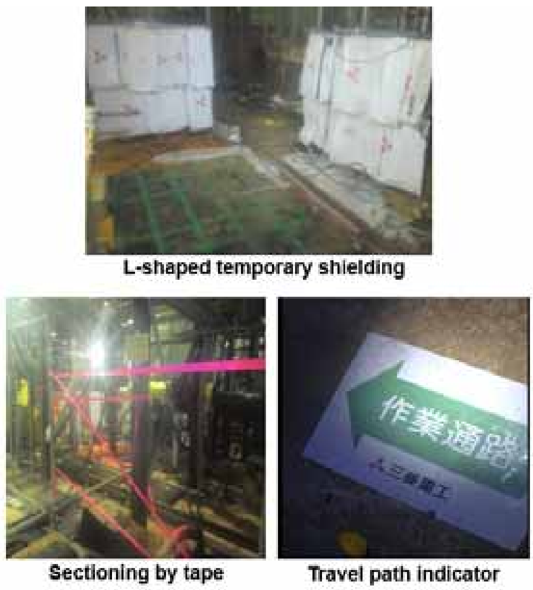
Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries, Ltd. carried out construction work to install a temporary pump for the purpose of transferring the supernatant in a pit that stores high dose rate waste sludge generated since the 2011 earthquake to the underground floor of the main processing building. The work site inside the main processing building has extremely poor working conditions, has high γ-ray and β-ray dose rates, and high radioactive contamination. The measures and radiation protection initiatives implemented to address these issues are described in this report.

(1) Exposure dose Reduction Measures

1) Improving the work environment

- L-shaped temporary shieldings were installed at the main work site to reduce the environmental dose rate.
- Efforts were made to reduce exposure when traveling within the site by clearly sectioning the travel path using fluorescent tape, putting up warning signs for high dose rate places, and by placing travel path indicator arrows on the floor surface.



Dose Reduction Measures: Improving work environment

2) Implementing prevention measures for β-ray overexposure

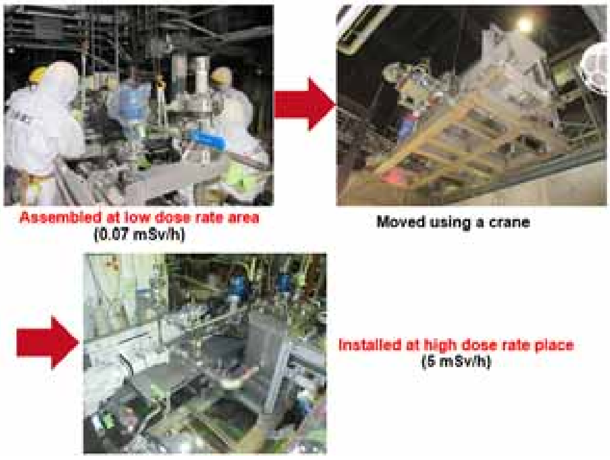
- Overexposure to β-rays was prevented by placing rubber mats at places with a high β-ray dose rate among the main work areas and by making workers wear thick rubber gloves.

3) Implementing exposure dose reduction measures for supervisors

- Exposure dose of supervisors was reduced by installing remote control cameras to enable remote monitoring of operations and doses at the main work areas and by checking and giving instructions using communication devices.

4) Reducing operation time at high dose rate places

- The operation time for the actual work was reduced by carrying out training for 1 month prior to the commencement of construction under the conditions simulating the actual work conditions of the work site.
- The amount of work at high dose rate places was reduced by adopting a method to assemble the temporary pump in a low dose area and to move the assembled pump to the installation location using a crane.



Dose Reduction Measures: Reducing operation time at high dose rate places

(2) Measures to prevent body contamination during work in a high contamination area

1) Providing education based on previous experiences for radiation protection and personal protective equipment (PPE) put-on/removal training

- Incidents of failed radiation protection were prevented by educating workers based on previous incidents and experiences.
- Body contamination was prevented by providing training in which workers put on and removed PPE.

2) Specifying PPE put-on/removal areas and ensuring sufficient allocation of helpers

- Body contamination was prevented by securing separate areas for PPE put-on and PPE removal, and by ensuring sufficient allocation of helpers at such areas.

(3) Measures to prevent internal exposure due to high air contamination

- Internal exposure was prevented by requiring workers wear an air purifying respirator with a special hood over a full face mask.
- Operation time control was carried out by setting the maximum operation time since the air of the work environment had a high radioactive concentration and there was a concern over the dust particles leaking through the mask filter, etc.

(4) Summary

Failed radiation protection incidents were prevented by implementing various measures and educating workers about radiation protection. However, the radiation protection staff engaged in carrying out on-site survey had higher dose exposures, MHI would like to examine the environmental survey by remote control in the next construction phase.

Additionally, regarding measures against high β-ray dose rate, further considerations will be given on ideal control methods. MHI will continue employing creative and original approaches for future operations as well to realize maximum radiation protection for workers.

5.3.3 Radiation Exposure Dose Survey of the Small Rooms on the First Floor of the Reactor Building for Unit 1 of the Fukushima Daiichi Nuclear Power Plant

Hitachi-GE Nuclear Energy, Ltd.

For future removal of the fuel debris, repair of the primary containment vessel (PCV) in the reactor building (R/B) and related tasks are planned. To perform such work, it is necessary to grasp in advance the situations and the atmosphere dose rates of the work areas and conduct environmental improvement that allow such work to be performed. Because there still are areas whose actual environments in the field have not been clearly confirmed, Hitachi-GE Nuclear Energy conducted surveys of such areas to confirm their actual environments.

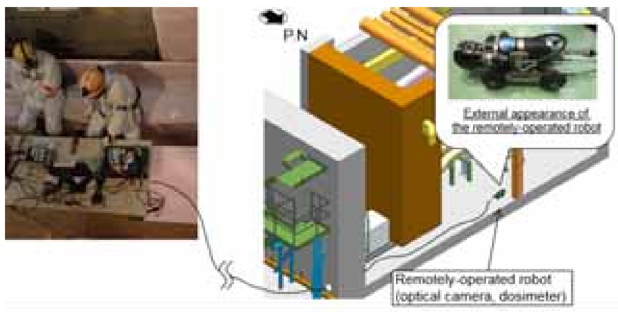
(1) Survey Plan

The surveys of the small rooms were conducted by setting up bases in low dose areas and having workers send remotely-operated robots and other equipment from the bases into the rooms. The next section presents the results for the individual small rooms surveyed.

(2) Survey Results

1) Traversing in-core probe (TIP) room

Small remotely-operated robots and other equipment were sent into the TIP room through a hole drilled in a wall of the room and a survey was conducted using the robots and equipment to determine the dose rate distribution and locate the contaminants. The result of the survey shows that the west half (the half on the PCV side) of the room is a high dose area and that the main contaminant is located



TIP room survey

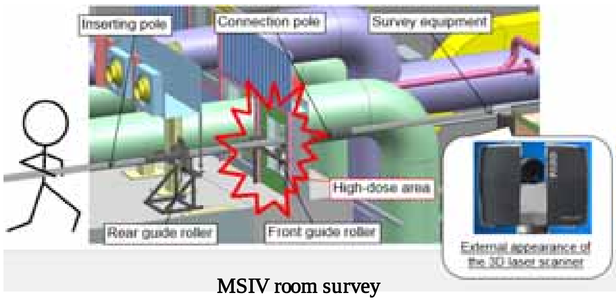
in the instrumentation piping penetration section (the maximum value was 290 mSv/h). The dose rate measurements taken in the east half of the room are relatively low (less than 5 mSv/h), which means that the east half has been less affected by the contaminants and that indicated the possibility to perform the planned PCV repair work and related tasks.

2) High pressure coolant injection system (HPCI) valve room

The dose rate distribution in the room was measured using small remotely-operated robots and other equipment. The result of the survey shows that the dose rate in the area around the HPCI piping penetration section (root part) is about 7000 mSv/h. It is deduced from this that contaminated vapor is the source of contamination that has flowed into and concentrated in the bellows cover of the penetration section. It is necessary to start studying dose reduction methods for this area.

3) Main steam isolation valve (MSIV) room

The dose rate distribution in the room was measured by inserting survey equipment mounted on a long pole into the room. The result of the survey shows that there are highly contaminated areas in the room but the dose in the east passage in the room is low, and that indicated the possibility to survey the adjacent small room for the reactor shutdown cooling system-pump (SHC-P) room.



MSIV room survey

(3) Conclusions

By these surveys, Hitachi-GE Nuclear Energy successfully obtained information about the actual environments of the target small rooms by devising methods and equipment for each room, without having workers to approach high dose areas. Since various tasks are planned towards removing the debris, further studies will be conducted by making use of experiences that have been gained from these surveys, with the highest priority given to reducing the exposure of workers.

31 January 2017
Office for Radiation Protection of Workers
Ministry of Health, Labour and Welfare
1-2-2 Kasumigaseki Chiyoda-ku Tokyo 100-8916, Japan

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