

Future actions based on experiences such as exposure dose control at the TEPCO Fukushima Daiichi Nuclear Power Plant

1. Personal identification and exposure dose control

		Problems that occurred after the accident		Future actions based on the experiences	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers b
1	Insufficient exposure dose control system in the exposure dose control department	<p>As the exposure control systems that were normally used became unavailable due to tsunami, a significant amount of manual work emerged, such as making a dosimeter-lending record, inputting data on the results of internal exposure, and name-based accumulation of individual exposure dose, which delayed regular work in the radiation control department of the power plant. The work, including data input, was taken over to the head office. However, it still consumed a lot of time due to the manual process.</p> <p>Time was also consumed in collecting the implementation situation of internal exposure measurement because many of the employers (e.g., construction companies) were unfamiliar with radiation administration and did not have radiation administration departments.</p> <p>These factors resulted in a substantial delay in the task to accumulate individual exposure dose (name-based accumulation).</p>	<p>[Primary actions by Ministry of Health, Labour and Welfare (MHLW)] Provided guidance, with written notice, for the consolidation of the exposure administration in the head office (23 May).</p> <p>Directed the primary contractors with 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).</p> <p>Directed , with written notice, organization of a dedicated team to survey workers with unknown contact information (10 August).</p> <p>[Primary actions by TEPCO] (1) TEPCO increased the number of staffs in the radiation administration department of the head office, inputted data regarding the information in the lending record managed at the nuclear power plant, and accumulated the data using spreadsheet software in accordance with the direction . The data that could not be accumulated were modified by checking the original list and/or asking each employer. TEPCO was able to submit a report on exposure doses at the end of the subsequent month to MHLW, starting with the data from September.</p> <p>(2) The primary contractors established systematic control organization for exposure administration in their head office and reported to MHLW regarding the status of the exposure dose control on a monthly basis.</p>	<p>[Actions taken at the nuclear facilities including nuclear power plants (hereinafter referred to as "the nuclear facility")] (1) Develop a plan in preparation for emergency work to establish an organization to consolidate the radiation control of all emergency workers (hereinafter referred to as "systematic control organization") in the nuclear facility (or the head office if it is beyond the ability of the nuclear facility).</p> <p>(2) Develop an emergency action plan for the case that the normally used systems become unavailable for exposure dose control, and prepare for increasing temporary staffs to be engaged in exposure dose control</p> <p>[Actions taken by the primary contractors] Establish the organization's system for radiation control in emergency situations as well as educate and train staffs to perform radiation control.</p> <p>[Actions taken in the head office or at the facilities with the functionality of the nuclear department in the head office except the nuclear facilities (hereinafter "the head offices")] (1) If necessary, develop a plan in advance to establish systematic control organization in the head office. (2) In preparation for supporting radiation control in the head office and dispatching staffs to help at the nuclear facility, make a staff list, provide required preliminary education and training to inexperienced staffs, and establish a system in the head offices for being able to increase staffs in charge temporarily.</p>	<p>[Actions taken at the nuclear facility] Establish a system for exposure dose control, such as by temporarily increasing staffs in charge of dosimeter lending, in cases when the systems normally used are not available.</p> <p>[Actions taken by the primary contractors] Ensure a system for exposure dose control, such as by temporarily increasing the staffs in charge of radiation control in each primary contractor, and establishing an organization that can consolidate exposure doses of workers under all the involved contractors.</p> <p>[Actions taken in the head offices] (1) Check the system for exposure dose control at the nuclear facility and provide support such as dispatching staffs in charge from the head office, as appropriate. (2) 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 nuclear power plant and perform exposure dose control including inputting exposure data and name-based accumulation directly in the head offices.</p>
2	Insufficient number of personal dosimeters	<p>Many personal alarm dosimeters (hereinafter referred to as "PAD ") were unavailable after the tsunami. Due to the shortages of PADs, they were distributed to some of the workers at a rate of only one per work group during the period of 15-30 March to measure the dose of one representative worker in the group.</p> <p>TEPCO claimed to have selected the groups working in areas where exposure was expected to be almost constant everywhere. However, the representative measurement could have overlooked some exposure because high radioactive contaminated waste was dispersed in this period.</p>	<p>[Primary actions by Ministry of Health, Labour and Welfare (MHLW)] Instructed TEPCO verbally to provide each worker with a PAD (31 March).</p> <p>Performed an on-site inspection (27 May) and recommended corrective action against TEPCO, which had not measured external exposure doses for workers by providing each of them with a dosimeter (30 May).</p> <p>[Primary actions by TEPCO] Obtained PADs from other nuclear power plants and fitted every worker with a PAD (1 April).</p> <p>Then, obtained 4,100 PADs in total for Fukushima Daiichi Nuclear Power Plant and 2,200 PADs for J-Village (as of 17 November)</p>	<p>[Actions taken at the nuclear facility] (1) Prepare a sufficient number of PADs as spares that can be used during emergencies (including battery chargers and emergency power generators, if not battery-powered. Hereinafter referred to as "PADs "). (2) Make agreements with other nuclear facilities in advance to prepare a sufficient number of PADs for all emergency workers (including those who are not normally engaged in radiation work).</p> <p>[Actions taken in the head offices] Support the nuclear facility, such as by discussing and making an agreement with other companies' head offices.</p>	<p>[Actions taken at the nuclear facility] (1) Check whether PADs are available enough just after the occurrence of an accident. (2) Once a shortage of PADs is identified, immediately borrow them from other nuclear facilities in accordance based on agreements made in advance.</p> <p>[Actions taken in the head 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.</p>

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3	Deficiencies in dosimeter-lending administration	As the normally used access control system for the radiation controlled area became unavailable due to the tsunami, dosimeter-lending records were created by hand, and names, affiliations, and radiation exposure doses were recorded manually. However, some deficiencies and incorrect information in the lending records made it difficult to identify individuals. Thus, it became difficult to accumulate individual radiation exposure doses (name-based accumulation).	<p>[Primary actions by MHLW] Directed, with written notice, to obtain basic information on workers, issue access permits with IDs, and conduct management of entry/exit (23 May). Verbally directed to attach a photo to the access permit (7 July).</p> <p>[Primary actions by TEPCO] Started issuing a "worker identification card" with ID number on 14 April at the seismically isolated building and on 8 June at the J-Village; started writing ID numbers in the dosimeter-lending records.</p> <p>Started identifying individuals based on official documents at J-Village and issuing an access permit with photo ID on 29 July. Started using workers' identification cards in combination with the access permit on 8 August.</p>	<p>[Actions taken at the nuclear facility] (1) If the normally used system becomes unavailable, issue access permits with both personal ID numbers and photos as well as 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 "backup system").</p> <p>(2) If the backup system is not operable, establish in advance an administrative list form written by hand and initiate an administration method using the central registration number for each worker's radiation passbook and driver's license number (if it is difficult to use these, a combination of date of birth and name) as a temporary ID number (hereinafter referred to as "the temporary ID number").</p> <p>(3) Conduct training on a regular basis so as to implement the management stated in (1) and (2) immediately in emergency situations.</p> <p>[Actions taken in the head offices] If the backup system is not operable at the nuclear facility, set up a backup system in the head offices as well. Note, however, that this might not apply in the case that the backup system is installed in the seismically isolated buildings located at sufficient isolation distance and consisting of structure/equipment that can maintain internal radiation protective functions (hereinafter referred to as "seismically isolated building"), even when a hydrogen explosion occurs in a nuclear reactor or its vicinity.</p>	<p>[Actions taken at the nuclear facility] (1) Make a backup system available.</p> <p>(2) Use the handwritten administrative list to manage dosimeters using temporary ID numbers until the backup system is up and running.</p> <p>(3) Once the backup system is up and running, verify individuals based on official documents, issue access permits, lend dosimeters based on the ID number, and record exposure doses.</p> <p>[Actions taken by the primary contractors] Ensure proper management of the access permit to prevent its use by anyone except one with the registered name on it.</p> <p>[Actions taken in the head 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 head offices operable, as appropriate.</p>
4	Delay in notifying workers of radiation exposure doses	The normally used dose notification system became unavailable due to the tsunami. This created a delay in inputting dose data written in the dosimeter-lending record, which resulted in TEPCO falling behind notifying the employer. In addition, this made the receipts of exposure doses unable to be issued at the time of returning dosimeters. Thus, it became difficult for workers to know their own cumulative exposure.	<p>[Primary actions by MHLW] Directed, with written notice, to notify workers through their employers' office at the site of their cumulative radiation exposure doses once a week for external exposure and once a month for internal exposure (23 May).</p> <p>Directed, with written notice, to notify the employers of the cumulative exposure doses of April and May by 10 August (30 June). Directed the primary contractors with written notice to submit a report once a month regarding the situation of notifying workers of their radiation exposure doses (22 July). Directed, with written notice, to notify the employers of the radiation exposure doses in September and the subsequent months once a week. Verbally directed to start the issuance of receipts at the time of returning dosimeters on 16 August (10 August).</p> <p>[Primary actions by TEPCO] Notified the employers once a week (reported on 10 August). The receipts of exposure doses were issued to workers at the time of returning dosimeters starting 16 August.</p>	<p>[Actions taken at the nuclear facility] (1) Ensure that the backup system prepared for the unavailability of the normally used system provides the function of issuing receipts to provide daily exposure doses with written notice.</p> <p>(2) Specify in advance the procedures for immediately informing the primary contractors of the input data when doses are necessary to be input in the head offices.</p> <p>[Actions taken in the head offices] (1) Plan in advance the procedures for immediately informing the nuclear facility of the dose data input at the head offices, if the head offices is required to do so after the accident.</p> <p>(2) For cases when the backup system is not operable at the nuclear facility, set up a backup system with a function to issue receipts in the head offices. Note, however, that this might not apply to the case that the backup system is located in the seismically isolated building. (repeated notice)</p>	<p>[Actions taken at the nuclear facility] (1) Make a backup system operable and issue receipts of radiation exposure doses to workers.</p> <p>(2) While the backup system is unavailable, issue a written notice of radiation exposure dose to workers at the time of returning dosimeters (handwritten memos are acceptable).</p> <p>(3) Immediately inform the primary contractors of the radiation exposure dose data inputted.</p> <p>[Actions taken by the primary contractors] Immediately notify all the workers under the involved subcontractors through the involved subcontractors of the dose data obtained from the nuclear facility.</p> <p>[Actions taken in the head offices] (1) Check the situation in dose data input and notification among employers at the nuclear facility and perform tasks such as data input at the head offices, as appropriate.</p> <p>(2) If the data input task is performed at the head office, provide the input data to the nuclear facility immediately.</p>

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5	Delay in measuring internal exposure	<p>Whole-body counters (hereinafter referred to as "WBC") in the nuclear power plant became unavailable due to an accident, which caused their shortage and delayed the measurement. It also took time to study how the exposure assessment method should be modified according to the changes in the target nuclide to be measured as well as identify the date of ingestion. These factors created a significant delay in determining the internal exposure dose.</p> <p>In particular, precise measurements were conducted to identify the nuclides at the Japan Atomic Energy Agency (JAEA) or National Institute of Radiological Sciences (NIRS) for workers who received high radiation exposure doses, which delayed the determination of their internal exposure doses.</p>	<p>[Primary actions by MHLW] (1) Directed, with written notice, to measure internal exposure for emergency workers on a monthly basis (23 May). Directed, with written notice, to measure internal exposure of those who worked in March by 10 June and those who worked in April and May by 10 August (30 May, 30 July).</p> <p>(2) Directed the primary contractors, with written notice, to promote internal exposure measurement and report on the situation of the measurement (22 July). Directed, with written notice, to measure internal exposure of those who worked during the period from May to August by 30 September and subsequently do the same by the end of the subsequent working month (10 August).</p> <p>(3) Recommended a corrective action against TEPCO and the employer who had not measured internal exposure of those who worked in March once within every three months (30 and 31 August).</p> <p>[Primary actions by TEPCO] (1) Determined the date of ingestion as 12 March in principle (reported on 13 June). Opened the WBC Center at J-Village on 10 July while increasing the number of WBCs by borrowing the "in-vehicle" type of three WBCs from JAEA (returned three respectively on 10 July, 2011, 23 April, 2011, and 21 May, 2012), transferring from Fukushima Daiichi and Daini Nuclear Power Plants, and purchasing new ones. Secured 11 WBCs in total on 18 October through the transfer from Fukushima Daiichi Nuclear Power Plant and an additional 6 new WBCs.</p> <p>(2) Assessed and determined internal exposure dose in support of JAEA and NIRS. Measurement became possible on a monthly basis in September.</p>	<p>[Actions taken at the nuclear facility] (1) In order to measure internal exposure, specify in advance where to locate transferable WBCs that can be borrowed in case of an accident under the agreement made by the head offices.</p> <p>(2) Develop in advance the method for evaluating internal exposure in emergency situations, such as identifying the date of ingestion through the study of workers' behavior.</p> <p>[Actions taken in the head offices] (1) For the agreements stated in (1) above, provide support such as by negotiating and concluding agreements with the head offices of other utilities and organizations, as appropriate.</p> <p>(2) Develop in advance the assessment model to evaluate exposure to radionuclide of cesium and radionuclide of iodine after accidents in cooperation with JAEA and NIRS (hereinafter referred to as "the advanced radiation expert institute").</p> <p>(3) Develop in advance a plan for responding to an accident, including the method for locating WBCs outside a nuclear facility for cases when they cannot be located inside, as well as make an agreement with other utilities and the Federation of Electric Power Companies of Japan to make WBCs available for transfer in emergency situations.</p>	<p>[Actions taken at the nuclear facility] (1) Ask other nuclear facilities, in accordance with the agreement concluded in advance, to obtain transferable WBCs and transfer them to a proper location when the normally used WBCs become unavailable.</p> <p>(2) Immediately establish an internal exposure assessment model suitable for the released nuclides, in cooperation with the advanced radiation expert institute.</p> <p>(3) Immediately determine the nuclides and the date of ingestion for workers who may have exceeded their normal exposure dose limit by making use of WBCs in the advanced radiation expert institute; determine the committed dose.</p> <p>(4) Immediately accumulate the committed doses and external radiation doses by name and calculate the sums to manage not to exceed the exposure dose limit.</p> <p>[Actions taken by the primary contractors] Check the situation of internal exposure measurement by the involved subcontractors and guide or support them in providing the measurement to all their workers.</p> <p>[Actions taken in the head offices] (1) Check the situation of internal exposure measurement at the nuclear facility and, if the normally used WBCs become unavailable, provide guidance or support to ensure that the nuclear facility can obtain transferable WBCs from other nuclear facilities and can measure internal exposure at other nuclear institutions.</p> <p>(2) Provide technical support in cooperation with the advanced radiation expert institute to identify the specific nuclides causing internal exposure, develop an exposure model, and identify the date of ingestion.</p>
6	Unexpected occurrence of workers with unknown contact information	<p>It was found that some workers could not be identified in the name-based accumulation of data (174 individuals at tentative maximum, as of 29 July), while a handwritten dosimeter-lending record was used for management because the normally used system became unavailable due to the tsunami.</p>	<p>[Primary actions by MHLW] Verbally directed to ask the primary contractors for cooperation and have public relation groups release the information (20 June). Directed to sort out the missing individuals, such as by verifying with other primary contractor groups and checking for overlaps of similar names (13 July).</p> <p>Verbally directed the primary contractors to consolidate exposure administration and attach a photo to each worker's identification card (22 and 29 July). Directed, with written notice, to organize a dedicated team to survey workers with unknown contact information (10 August).</p> <p>[Primary actions by TEPCO] TEPCO, in cooperation with the primary contractors' office on site, found individuals with unknown contact information 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.</p>	<p>[Actions taken at the nuclear facility] (1) 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 handwritten dosimeter-lending list.</p> <p>(2) When any individuals with unknown contact information are found, specify in advance the investigation methods, including checking the original records, checking for overlap of similar names, having them confirmed by other primary contractor groups, asking employers' office on site for investigation, making use of professional investigation agencies, and making those individuals' names public.</p> <p>[Actions taken in the head offices] Provide support when the nuclear facility develops the survey method, as appropriate.</p>	<p>[Actions taken at the nuclear facility] (1) Administer the dosimeter-lending program for emergency situations in the manner specified in advance.</p> <p>(2) If any individuals with unknown contact information are found, immediately check for overlap of similar names and ask the employers' office on site for reconfirmation, in cooperation with the primary contractors' office on site.</p> <p>[Actions taken by the primary contractors] If any individuals with unknown contact information are found, immediately check for overlap of similar names and ask the employer' office on site for confirmation.</p> <p>[Actions taken in the head offices] Check the dosimeter-lending procedures at the nuclear facility; if any individuals with unknown contact information are found, confirm the dose records with the head offices, as required.</p>

2. Mask and protective clothing

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7	Exceeding emergency exposure dose limit	<p>The measurement results of internal exposure revealed that six emergency workers exceeded their exposure dose limit of 250 mSv (revealed on 10 June; 678 mSv was the highest). This presumably occurred because the workers did not use charcoal filter respirators and ate and drank in the central operating room, where the concentration of radioactive materials had increased after the hydrogen explosion (12 March).</p>	<p>[Primary actions by MHLW] (1) Instructed TEPCO to keep the workers who had worked at the central operating room right after the hydrogen explosion and those whose radiation exposure dose had tentatively exceeded 100 mSv from working until their doses were determined and to immediately exclude the 12 workers whose tentative doses had exceeded 200 mSv from emergency work (3 June, 7 June, and 13 June).</p> <p>(2) Performed on-site inspections ((1) 7 June, (2) 11 July) and recommended corrective actions against TEPCO, which (1) had made workers work in excess of 250 mSv and (2) had neglected to make workers use effective respiratory protective equipment or prohibit them from eating and drinking ((1) 10 June, (2) 14 July).</p> <p>[Primary actions by TEPCO] Excluded the relevant workers from work that might cause exposure and excluded those whose dose exceeded 200 mSv from Fukushima Daiichi Nuclear Power Plant work until their doses were determined to be in accordance with the instruction (reported on 13 June).</p>	<p>[Actions taken at the nuclear facility] (1) Prepare required measurement instruments and establish measurement procedures so as to measure radiation dose in ambient at any time in places inside the nuclear facilities where workers work or stand by in emergency situations (including a place where air is considered to be not contaminated under normal conditions; hereinafter referred to as "the standby areas").</p> <p>(2) If standby areas are contaminated, based on the breakthrough time, prepare a sufficient number of charcoal filters for workers to allow remain in the standby area for several days and store spare filters in the seismically isolated building.</p> <p>(3) Educate emergency workers (particularly focusing on those such as drivers who do not wear respiratory protective equipment very often and those wearing glasses) on how to wear respiratory protective equipment in an appropriate manner; re-educate them at proper intervals.</p> <p>(4) 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 emergency workers. (repeated notice)</p> <p>[Actions taken in the head offices] Provide support to allow the nuclear facility to take their actions in an appropriate manner, as appropriate.</p>	<p>[Actions taken at the nuclear facility] (1) Make all the workers in the standby areas wear charcoal filter respirators immediately after an accident, until it is verified that the air is not contaminated by measuring the concentration of radioactive materials in the air.</p> <p>(2) Distribute a sufficient number of charcoal filters in every standby areas, based on the breakthrough time.</p> <p>(3) If workers need to stand by in a work area where air contamination is uncertain, give them some rest at a proper interval in a work area where it has been verified that air has not been contaminated.</p> <p>(4) Continuously measure the concentrations of radioactive materials in the air and ambient dose rates in the standby areas.</p> <p>(5) Immediately measure internal exposure for all workers in the standby areas where air contamination is uncertain.</p> <p>[Actions taken in the head offices] Check the situation of radiation measurement in the standby areas of the nuclear facility and provide support such as by dispatching staffs of the radiation control departments in the other nuclear facilities, as appropriate.</p>
8	Exceeding exposure dose limit for women	<p>The measurement results of internal exposure revealed that two female workers had exceeded their exposure dose limit of 5 mSv in March (revealed on 27 April; 17 mSv was the highest).</p> <p>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.</p>	<p>[Primary actions by MHLW] Performed an on-site inspection (27 May) and recommended a corrective action against TEPCO, which had caused female workers to be exposed in excess of 5 mSv in March (30 May).</p> <p>Also instructed TEPCO to ensure the exposure dose control for all those who enter the site, monitor the health of those working regularly at the site, and measure the internal exposure of female workers after excluding them from the work.</p> <p>[Primary actions by TEPCO] Decided not to assign women to tasks in the area of the Fukushima Daiichi Nuclear Power Plant.</p>	<p>[Actions taken at the nuclear facility] (1) Prepare required measurement instruments and establish measurement procedures so as to measure radiation doses in air at any time in places in the standby areas. (repeated notice)</p> <p>(2) Prepare charcoal filter respirators at each standby area and store spares in the seismically isolated building in advance. (repeated notice)</p> <p>(3) Prepare a sufficient number of personal dosimeters, such as PADs, for all emergency workers (including those not normally engaged in radiation work). (repeated notice)</p> <p>[Actions taken in the head offices] Provide support to allow the nuclear facility to take actions in an appropriate manner, as necessary.</p>	<p>[Actions taken at the nuclear facility] (1) Measure the concentrations of radioactive materials in the air and ambient dose rates in the standby areas continuously, putting a higher priority on those where female workers are present. Evacuate female workers immediately if there are any possibilities that the doses might exceed exposure dose limit.</p> <p>(2) Make all workers in the standby areas wear charcoal filter respirators and PADs immediately after an accident, until it has been verified that the air has not been contaminated by measuring the concentration of radioactive materials in the air. (repeated notice)</p> <p>[Actions taken in the head offices] Check the measurement situation in standby areas of the nuclear facility and provide support regarding the management of female workers, as appropriate.</p>

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9	Improper use of respiratory protective equipment	<p>Insufficient explanation was provided with respect to instructions on how to wear respiratory protective equipment in the education of new workers. Thus, there still existed workers with internal exposure even in June.</p> <p>[Improper wearing of respirators] The survey on how workers wear respiratory protective equipment (conducted on 26 September) indicated that the leak-in rate from respiratory protective equipment was particularly high for those wearing glasses (56% at highest, 17% on average).</p> <p>[Neglecting to attach filters] One of the workers of the employer was found working without a charcoal filter on his full face near Unit 2 (13 June). A similar case occurred on June 29, suggesting that workers had not been well informed about the need to wear respiratory protective equipment.</p> <p>[Contamination inside of respiratory protective equipment] After an agitator in the coagulating sedimentation equipment was replaced by six workers, contamination was found on the inner surface of the mask filter in four workers during inspection (14 September). Several similar cases were subsequently found.</p>	<p>[Primary actions by MHLW] (1) Recommended a corrective action against the employer who had not made workers use effective respiratory protective equipments (22 June, 1 July).</p> <p>(2) Issued an instruction card instructing facilities to inform workers of the procedures for wearing respiratory protective equipment, to ensure that workers follow the rules regarding the correct way of wearing respiratory protective equipment, to provide education, and to post instructions on how to wear respirators (22 June).</p> <p>(3) Issued an instruction card that instructed facilities to establish work procedures for surveying contamination of respiratory protective equipment filters (5 October).</p> <p>(4) Instructed to (1) take measures for workers wearing glasses, (2) choose a mask best suited to each worker's face, (3) perform fitting tests, (4) introduce respiratory protective equipment with electric powered fans, and (5) improve the contents of the education, based on the results of tests (26 September) of leak-in rate from respiratory protective equipment using a mask fitting tester, conducted by MHLW and the National Institute of Occupational Safety and Health, Japan (JNIOOSH) (14 October).</p> <p>[Primary actions by TEPCO] (1) Grouped respiratory protective equipment by their product makers and size in accordance with the instruction so that workers could choose masks suited to their faces more easily (27 September).</p> <p>(2) Started to provide new workers with education using fitting testers (17 November).</p> <p>(3) Introduced masks with electric powered fans (25 August).</p>	<p>[Actions taken at the nuclear facility] (1) Group masks by size (or product makers, if multiple products are used) in order to have workers choose the one suited to their faces.</p> <p>(2) Promote the introduction of masks with electric powered fans.</p> <p>(3) Provide new workers with education on the performance and usage of masks focusing on the following points and re-educate them at proper intervals.</p> <ul style="list-style-type: none"> • Verification of proper fitting using fitting testers • Preventive measures against leak-in using seal pieces for workers wearing glasses • Procedures for wearing and taking off masks, and verification of fitting filters • Proper handling of masks to prevent contamination inside of masks <p>[Actions taken in the head offices] Provide support such as preparing instructional materials and instructors to dispatch in emergency situations, so that the nuclear facilities can take their actions in an appropriate manner, as necessary.</p>	<p>[Actions taken at the nuclear facility] Immediately educate new workers regarding the points shown in (3) of the left column.</p> <p>[Actions taken in the head offices] Check the situation of education for new workers in the nuclear facility and provide support such as by dispatching instructors for help and providing instructional materials, as appropriate.</p>

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10	Improper protective clothing	<p>[The case that one of the workers soaked his feet in highly contaminated water]</p> <p>A worker from a contractor who was wearing mid-calf boots soaked his feet in water 30 cm deep during work. This caused his skin on both feet to become contaminated (beta ray exposure) (24 March) because the radiation dose in the work area was not measured before starting the work, the worker did not wear tall boots, and the worker continued to work while his dosimeter alarm was sounding.</p> <p>[The case that highly contaminated water was poured over a worker's head]</p> <p>One of the workers of the employer was contaminated when contaminated water was poured over his head while discharging water in the tank of the contaminant removal plant. He was not wearing an Anorak (waterproof clothing). Another worker who was engaged in curing hoses without wearing an Anorak was also contaminated with contaminated water (both occurred on 31 August).</p>	<p>[Primary actions by MHLW]</p> <p>(1) Verbally instructed TEPCO to conduct work after establishing safety and health administration system (24 March). Issued an instruction card that guided TEPCO and the employer to measure the radiation doses in the work area before starting the work in order to understand the contamination level and decide on the method for the work, ensure that workers evacuate when dosimeters alarm, and make workers use effective protective clothing and shoes according to the contamination level of the work area (26 March).</p> <p>(2) Verbally instructed TEPCO to ensure their best effort to determine the causes and prevent recurrence (1 September).</p> <p>(3) Performed on-site inspections (on 27 May and 28 September) and recommended corrective actions against the employer who (1) had not made workers wear effective shoes (tall boots) (the case of beta ray exposure on 24 March), and (2) had not made workers wear effective protective clothing (waterproof protective clothing) (the case at the time of hose curing on 31 August) (30 May and 5 October).</p> <p>[Primary actions by TEPCO]</p> <p>Ensured that workers put on rubber boots. Required workers who might be exposed to contaminated water to wear Anoraks. No cases of exposure to contaminated water have occurred since then.</p>	<p>[Actions taken at the nuclear facility]</p> <p>(1) Prepare a sufficient number of rubber boots, chemical protective suits, and waterproof protective clothing (hereinafter referred to "protective clothing") for emergency situations.</p> <p>(2) Prepare a sufficient number of dosimeters, including PADS, for emergency situations (repeated notice).</p> <p>[Actions taken in the head offices]</p> <p>Provide support to allow the nuclear facility to take actions in an appropriate manner, as necessary.</p>	<p>[Actions taken at the nuclear facility]</p> <p>(1) Prepare a sufficient amount of protective clothing and make workers wear in an appropriate manner.</p> <p>(2) Develop work instructions for activities handling contaminated water and provide appropriate education and training using the instructions.</p> <p>[Actions taken in the head offices]</p> <p>Check the state of wearing protective clothing in the nuclear facility and provide support, as appropriate.</p>

3. New worker education

		Problems that occurred after the accident		Future actions based on the experiences	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers
11	Insufficient worker education hours	<p>In the beginning (until around May), only 30 minutes were spent in worker education on the effect of radiation, how to control radiation dose, and the use of protective equipment at the J-Village with instructional materials developed by TEPCO.</p> <p>In addition, not enough space was available in the classroom where the worker education program was given. The classroom accommodated only around 20 people per 30 minute session.</p>	<p>[Primary actions by MHLW] Instructed TEPCO and the primary contractors with written notice to educate new workers on radiation hazards, the use of protective equipment, the emergency response, and evacuation methods (13 May, 23 May, 22 July).</p> <p>[Primary actions by TEPCO] Started providing the worker education program in Tokyo from 19 May and the special education program at the J-Village from 8 June to the staffs of TEPCO and contractors Arrangement was made to secure the sufficient classroom space.</p>	<p>[Actions taken at the nuclear facility] (1)Prepare the classroom setting and instructional materials for the session, and train instructors so in case of an emergency as many workers as needed will be able to receive the education.</p> <p>(2)In addition to the special education program conventionally offered in nuclear reactor and nuclear fuel handling, develop instructional materials on the evacuation methods, the emergency response, and radiation dose control methods at the time of an accident. The workers should receive periodically updated education that uses the aforementioned, newly developed instructional materials at proper intervals.</p> <p>(3)Educate workers engaged in radiation work (particularly, focusing on those such as drivers who do not wear respiratory protective equipment very often and those wearing glasses) on how to wear a respiratory protective equipment in an appropriate manner and re-educate them at proper intervals. (repeated notice)</p> <p>[Actions taken in the head offices] (1)Support the nuclear facility in developing curriculum and instructional materials. (2)Prepare a sufficient number of instructors for education and training of workers and prepare for the dispatch in time of emergency.</p>	<p>[Actions taken at the nuclear facility] Provide the needed education to newly staffed emergency workers with the well prepared curriculum and instructional materials.</p> <p>(2) Confirm the appropriateness of the venue and textbooks, and availability of instructors. If necessary, request support from the head offices.</p> <p>[Actions taken by the primary contractors] Coordinate with the nuclear facility and provide the education and training, and other necessary guidance and support to all newly hired subcontractors, as appropriate.</p> <p>[Actions taken in the head offices] Check the situation of education for new workers and provide support such as dispatching instructors for help and providing instructional materials, as appropriate.</p>

4. Health care and medical care system

		Problems that occurred after the accident		Lessons learned and future response	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers
12	Establishment of the medical care system at the Fukushima Daiichi Nuclear Power Plant	<p>TEPCO was able to provide medical doctors only intermittently at the Fukushima Daiichi Nuclear Power Plant.</p> <p>In the first one month after the accident, 25 workers were sick or wounded, and 31 workers presented complaints of poor health.</p> <p>One case of heart attack was reported on 14 May, and this incident presented the urgent need for the clinic that provides 24-hour medical services by medical doctors.</p> <p>However, securing a qualified staff of medical doctors, nurses, and radiological technologists posed a great challenge, and establishing the clinic turned out to be an extremely difficult undertaking.</p>	<p>[Primary response by MHLW and relevant ministries and agencies]</p> <p>(1)Fukushima Prefectural Labour Bureau sent the written request to TEPCO to give due consideration to ensuring workers' mental and physical health.</p> <p>(2)Contacted and coordinated with the relevant parties and sent the request letter to medical dispatch agencies under the name of the director of Occupational Safety and Health Department (the director of Management Office for Health Protection against Ionizing Radiation)</p> <p>(3)Requested the training in emergency radiation medicine for staffs with experience in emergency medicine to secure nursing staffs.</p> <p>(4)Allocated radiological technologists in cooperation with the Association of Radiological Technologists (September)</p> <p>(5)Nurses were dispatched by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) through sending the request to a wider range of radiation medicine institutions.</p> <p>MHLW also asked the Japan Labour Health and Welfare Organization for cooperation. This line of endeavor has resulted in a steady supply of nurses since November.</p> <p>(6)The University of Occupational and Environmental Health, Japan has started dispatching medical doctors who provide services mainly during the daytime on 15 May.</p> <p>The 24-hour medical system was established on 29 May with the arrival of medical doctors dispatched across Japan from Rosai Hospitals (hospitals for laborers) managed by the Japan Labour Health and Welfare Organization.</p> <p>Subsequently, the clinic was relocated to the J-Village (September).</p> <p>(7)The National Defense Medical College started dispatching the teams of critical incident stress specialists on 10 July. The team provides mental health services on a monthly basis.</p> <p>[Primary response by TEPCO] Opened the emergency medical service centers in the Unit 5 and 6 in July. More medical doctors have been allocated in September to the medical center in J-Village in order to create the emergency medical care, health care, and general practice teams.</p>	<p>[Actions taken at the nuclear facility]</p> <p>(1)The labour bureau will support the coordination of the relevant agencies and establish a liaison council that constitutes prefectural health care and medical offices, fire departments, local medical facilities, nuclear facilities, prefectural labour bureaus, and other relevant agencies (hereinafter referred to as "the council for the medical care system"). The aim of this council is to establish a proper medical care system for workers in nuclear facilities.</p> <p>(2)In case of an accident that disables the use of the medical center, reserve a building in which all the necessary supplies and equipment currently installed at the medical center can be accommodated within the site of the nuclear power plant. Alternatively, the building located several kilometers away from the facility can be chosen if no such building exists within the site. The building must be located sufficient distance from the nuclear reactor to ensure safety even at the time of hydrogen explosion.</p> <p>(3)Strengthen emergency preparedness of the medical and health care system so that physical as well as mental health of workers will be protected in case of an emergency work.</p> <p>[Actions taken in the head offices] Participate in the council for the medical care system to ensure emergency preparedness of the medical care system in the nuclear facility.</p>	<p>[Instructions to the nuclear facility]</p> <p>(1)Considering the number of existing emergency medical staff and the present system of medical care, make the request to dispatch medical care staff.</p> <p>(2)Launch the operation of the alternative emergency medical center established in advance at the different location of the nuclear facility.</p> <p>(3)Immediately establish the required medical care system to ensure mental and physical health of workers engaged in emergency work</p> <p>[Actions taken in the head offices] Confirm the state of the medical care system in the nuclear facility and provide support as appropriate.</p>

		Problems that occurred after the accident		Future actions based on the experience	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers
13	Preventive measures against heat stroke	<p>Since May, there have been concerns that emergency workers might be at risk of occupational hazards derived from heat stroke while working for long hours under the blazing sun with heavy equipment, such as a full-face mask, Tyvek, and rubber gloves.</p>	<p>[Primary actions by MHLW] (1) Directed, with written notice, to suspend work during higher temperature period from 2 p.m. to 5 p.m. in July and August, shift working hours to early morning, specify the upper limit of continuous working hours, check workers' health before starting work, make available air-conditioned rooms where workers can remove and re-attach their full face masks, provide education regarding heat stroke, and establish a medical care system (10 June).</p> <p>(2) Directed to attach checklists for protective measures against heat stroke with a work notice. Furthermore, the director of Fukushima Prefectural Labour Bureau directed to analyze causes and take measures to prevent recurrence in case anyone develops heat stroke as well as share the analysis results and measures to prevent recurrence with the primary contractors through the council and leverage them for future actions (27 July).</p> <p>[Primary actions by TEPCO] Immediately excluded workers with the heat stroke symptoms, in addition to taking actions as directed. As a result, 40 workers in total developed the disease (including suspected ones), but none of the cases were serious.</p>	<p>[Actions taken at nuclear facilities] (1) Take preventive measures against heat stroke in advance, including determining the supplier of cool vests (including cooling boxes); consider building a rest area equipped with required functions; develop the procedures for taking actions when heat stroke occurs; forecast to prevent heat stroke using Wet-Bulb Globe Temperature (hereinafter referred to as "WBGT values"); and obtain instructional materials on heat stroke, with the assumption that workers work wearing heavy equipment under the blazing sun.</p> <p>(2) Establish in advance a mechanism to share information among the employers engaged in construction work in the plant.</p> <p>[Actions taken in the head offices] Provide the nuclear facility with support to take proper preventive measures against heat stroke, as appropriate.</p>	<p>[Actions taken at nuclear facilities] (1) Take the planned preventive measures against heat stroke in a proper manner when workers work in a hot and humid place.</p> <p>(2) Check physical conditions frequently, making use of medical questionnaires.</p> <p>(3) When heat stroke occurs, analyze causes and leverage the results to the measures to prevent the recurrence; share the information through the council of the primary contractors.</p> <p>[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.</p> <p>[Actions taken in the head offices] Check the state of taking preventive measures against heat stroke in the nuclear facility and provide support, as appropriate.</p>
14	Instructions to conduct special medical examinations	<p>Considering that exposure exceeding the normal exposure dose limit might cause acute radiation hazards such as cataracts, special medical examinations conducted every six months have become insufficient for preventing radiation hazards of emergency workers.</p> <p>The more time was spent on emergency work, the more workers subject to medical examinations were successively increased. This made it difficult to collect information on the subcontractors, and the percentage of workers who undertook medical examinations was as low as 60% as of June, 2011.</p>	<p>[Primary actions by MHLW] (1) Instructed, under Item 4, Article 66 of the Industrial Safety and Health Act, to conduct special medical examinations including blood test, skin test, and weight measurement, specifying the number of days after the completion of the emergency work under the assumption of a short-term emergency work by reference to the JCO accident (2001)(16 March).</p> <p>Additionally instructed to conduct medical examinations while in work (at the time of exceeding 100 mSv and/or a month), as more time was spent on the work (25 April).</p> <p>(2) In an effort to raise the percentage of workers who undertook special medical examinations, MHLW regularly checked the situation of conducting the medical examinations and gave instructions to TEPCO and each relevant primary contractor (May and June). The Fukushima Labour Bureau organized inspection items of the special medical examination and the inspection time in and after the emergency work period, and then instructed primary contractors to conduct them (22 August). Furthermore, the Fukushima Labour Bureau instructed the primary contractors to limit the workers subject to the medical examination to those who exceeded 100 mSv, in light of the completion of Step 2 (22 December).</p>	<p>[Actions taken at nuclear facilities] Build a consensus with the relevant parties in the council for medical care system on medical care system to immediately conduct special medical examinations when an emergency work leads to high levels of exposure.</p> <p>[Actions taken in the head offices] If the nuclear facility cannot conduct a special medical examination during emergency work, consider and make required preparations to directly conduct and manage it.</p>	<p>[Actions taken at nuclear facilities] (1) Conduct special medical examinations in accordance with the inspection items in the examinations as instructed.</p> <p>(2) Obtain the correct information on the primary contractors and provide special medical examinations to workers under the involved subcontractors.</p> <p>(3) Check the situation of special medical examinations conducted by the primary contractors.</p> <p>[Actions taken by the primary contractors] (1) Obtain the correct number of workers under the involved subcontractors and provide the required guidance or support to ensure that the workers under the involved subcontractors can undertake special medical examinations.</p> <p>(2) Check the situation of special medical examinations conducted by the involved subcontractors.</p> <p>[Actions taken in the head offices] Check the situation of special medical examinations in the nuclear facility and provide support, such as by dispatching medical care workers for help, as appropriate.</p>

		Problems that occurred after the accident		Future actions based on the experience	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers
15	Establishing patient transport systems from the nuclear power plant	<p>When transporting potentially seriously injured workers from the nuclear facility, a faster way to transport patients to a hospital was required because it was requested to transport the patients via J-Village at that time, which would have taken 1 to 2 hours. Thus, establishing emergency transport systems and making use of an air ambulance were considered. The coordination, however, did not go smoothly with the medical care institutions that were supposed to receive the patients.</p>	<p>[Primary actions by MHLW] (1) Verified that vehicles for transportation were reserved and the method for screening radioactive materials used, and then medical care institutions were requested. (The section director and staff made several visits to the site.)</p> <p>(2) Directed TEPCO to prepare land for a heliport used for an air ambulance, persuaded a helicopter operation company, and coordinated as a liaison regarding test flights to be conducted by a TEPCO-affiliated company.</p> <p>[Primary actions by TEPCO] (1) Decided to allow direct transport in emergency situations if no contamination was found on the vehicle, without going through J-Village to have to decontaminate and/or replace the vehicle (August).</p> <p>(2) Agreed with the operation company to locate a heliport facility in Fukushima Daini Nuclear Power Plant instead of using Hirono playground near J-Village as a heliport (February, 2012).</p>	<p>[Actions taken at nuclear facilities] (1) Build a consensus with the relevant parties in the council for the medical care system on the emergency transport systems.</p> <p>(2) Prepare a heliport near the nuclear facility to be used by an air ambulance after the occurrence of an accident.</p> <p>[Actions taken in the head offices] Participate in the council for medical care system to support the nuclear facility in providing transport systems.</p>	<p>[Instructions to the nuclear facility] (1) Request emergency transport systems based on the consensus in the council for a medical care system.</p> <p>(2) Prepare the pre-arranged heliport for an air ambulance according to the severity of an accident and request the operation of an air ambulance in accordance with the consensus of the council for the medical care system.</p> <p>[Actions taken in the head 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.</p>
16	Long-term health care program (Conducting medical examination and health consultation)	<p>In addition to the statutory medical examinations, it became necessary to examine workers who exceeded their normal exposure limit of 50 mSv/y and those who exceeded their conventional exposure dose limit of 100 mSv during emergency work, according to their exposure dose.</p> <p>It also became necessary to conduct health consultation activities for workers who changed their jobs to those that were not related to radiation work in order to ease their concerns about their long-term mental and physical health.</p>	<p>[Primary actions by MHLW] (1) Formulated the minister's guidelines pursuant to Item 2, Article 70 of the Industrial Safety and Health Act (11 October). According to these guidelines, employers are basically required to conduct long-term health care. However, the government should conduct it for workers who changed their jobs to those that were not related to radiation work, those who are continuously employed by the firms (small to midsize only) supporting emergency work s but not engaged in radiation work, and those not currently employed by any employers.</p> <p>(2) Decided to provide eye examinations for cataracts for workers who exceeded 50 mSv as well as and thyroid examinations and cancer screenings (stomach, lung, and bowel) for those who exceeded 100 mSv as additional medical examinations, in accordance with the report provided by the experts' working group.</p>	<p>[Actions taken at nuclear facilities] Make prior preparations to take actions for emergency workers, conforming to the minister's guidelines.</p> <p>[Actions taken in the head offices] Support the nuclear facility to make the required preparation for properly conducting long-term health care in emergency situations.</p>	<p>[Actions taken at nuclear facilities] Take actions for emergency workers, in accordance with the minister's guidelines.</p> <p>[Actions taken in the head offices] Check the situation of the long-term healthcare conducted by the nuclear facility to provide support, as appropriate.</p>

5. Work plan and others

		Problems that occurred after the accident		Future actions based on the experience	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers
17	Insufficient organizational system for developing work plans	During the first month from the start of receiving work notices, a large number of work notices were submitted from TEPCO in which many deficiencies were found. It took a lot of time to revise the work notices despite having performed correction instruction afterwards. As there was no other organizational system to revise the work notices except for Fukushima Daiichi Nuclear Power Plant at that time, the situation was that a staff in charge at the plant could not respond to reminder notices.	<p>[Primary actions by MHLW]</p> <p>(1) The Tomioka Labour Standard Supervision Office developed a review standard, prepared instruction materials to be made available at its office counter, and continued to give instructions at the counter.</p> <p>(2) Finally, MHLW guided the head offices with written notice (30 June). This improved the situation in ways that the organizations were strengthened and the staffs for the task were increased in the nuclear power plant and head offices, which led to on-site inspections at J-Village on a regular basis.</p> <p>[Primary actions by TEPCO]</p> <p>Increased the number of staffs to prepare work notices and defined the roles of the nuclear power plant and head offices (reported on 13 July).</p>	<p>[Actions taken at nuclear facilities]</p> <p>If emergency work is required, establish an organizational system at both the nuclear facility and the head offices to develop and review the emergency work plans.</p> <p>[Actions taken in the head offices]</p> <p>Formulate an organizational system in advance that allows the head offices to directly review the emergency work plans in case of emergency.</p>	<p>[Actions taken at nuclear facilities]</p> <p>Formulate and review the detail of emergency work under the predetermined organizational system to prepare and submit work notices that include proper actions to mitigate exposure.</p> <p>[Actions taken in the head offices]</p> <p>Check the situation of preparing work plans at the nuclear facility and provide support such as by reviewing the details at the head offices and dispatching staff for help, as appropriate.</p>
18	Deficiencies of work notices	<p>Directed the primary contractors conducting activities associated with doses exceeding 1 mSv per day to submit a radiation work notice to the authority within the jurisdiction (notified on 23 May).</p> <p>A lot of deficiencies were found in the submitted requests, such as excessive length of work period, improper personnel in charge, unrealistic estimate of the maximum radiation exposure dose, improper use of dosimeters (glass badges, ring badges, and alarm set point), work location, work description, and dose evaluation.</p>	<p>[Primary actions by MHLW]</p> <p>Developed a review standard and prepared instruction materials to be made available at the office counter (late in June) and continued to give instructions for correction at the counter.</p>	<p>[Actions taken at nuclear facilities]</p> <p>Leverage the summary of the typical findings indicated by the Labour Standard Inspection Office within the jurisdiction when developing work plans in normal situations in addition to emergency work.</p> <p>[Actions taken in the head offices]</p> <p>Plan the organizational system in advance to allow the head offices to directly review the details of work in case that the nuclear power plant cannot do the task properly during an emergency.</p>	<p>[Actions taken at nuclear facilities]</p> <p>Develop and review the details of emergency work plans and prepare and submit work notices that include proper actions to mitigate exposure, based on the findings indicated in advance.</p> <p>[Actions taken in the head offices]</p> <p>Check the situation of the work plans prepared by the nuclear facility and provide support such as by directly reviewing them at the head offices, as appropriate.</p>
19	Insufficient knowledge about contract conditions	Despite the emergency work being conducted by subcontractors, information obtained by TEPCO on the relation among subcontractors, the number of subcontractors (contractors) and workers, and whether education and medical examinations were provided at the time of employment was not sufficient to realize correctly.	<p>[Primary actions by MHLW]</p> <p>(1) Collected information on the situation of exposure dose control by interviewing the primary contractors (from late May to mid-June).</p> <p>(2) Requested the primary contractors to report the current contract condition (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).</p>	<p>[Actions taken at nuclear facilities]</p> <p>Arrange in advance the system for collecting information on workers under the involved subcontractors through primary contractors during an emergency.</p> <p>[Actions taken by the primary contractors]</p> <p>Establish in advance the system for obtaining the correct information on workers engaged in emergency work under the involved subcontractors.</p> <p>[Actions taken in the head offices]</p> <p>Provide support to allow the nuclear facility to carry out their actions in an appropriate manner, as necessary.</p>	<p>[Actions taken at nuclear facilities]</p> <p>Collect information on subcontractors through the primary contractors and check if education and medical examinations are provided in an appropriate manner.</p> <p>[Actions taken by the primary contractors]</p> <p>Be sure to obtain information on workers under the involved subcontractors who are engaged in emergency work, and provide guidance or support appropriately to ensure that education and medical examinations are provided in a proper manner.</p> <p>[Actions taken in the head offices]</p> <p>Check the situation of collecting the information on contract conditions at the nuclear facility and provide support appropriately.</p>

		Problems that occurred after the accident		Future actions based on the experience	
		Problems that occurred	Responses to the problems	Preparation to be made by the employers	Post-accident actions to be taken by the employers
20	Improvement of the accommodations situation and meal contents	<p>Many workers were unable to go back home or to dormitories because the area in a 20-km radius of Fukushima Daiichi Nuclear Power Plant was designated as a restricted area. Furthermore, many workers had to stay near the plant in preparation for any unexpected events. As the result, many workers were forced to sleep crowded together on the floor in the seismically isolated building of the Fukushima Daiichi Nuclear Power Plant or the gymnasium of the Fukushima Daini Nuclear Power Plant.</p> <p>In addition, the meals served were processed food in retort pouch in order to prevent internal exposure.</p> <p>Because of the hard work required, without sufficient rest or nutritious meals, there were concerns about worsening workers' health and the occurrence of an accident caused by their operational errors.</p>	<p>[Primary actions by MHLW] Directed TEPCO to take the following actions (20 April):</p> <p>(1) Reserve sleeping or temporary sleeping areas equipped with bedding and other required supplies.</p> <p>(2) Take preventive measures against infectious diseases.</p> <p>(3) Ensure nutrients and take measures required for factories when meals of non-ready-made food are provided.</p> <p>[Primary actions by TEPCO] (1) Installed bunk beds with bedclothes for 240 workers in the gymnasium at the Fukushima Daini Nuclear Power Plant.</p> <p>Installed 30 showers in the gymnasium.</p> <p>Installed 42 bunk beds in the seismically isolated building.</p> <p>(2) Built a temporary dormitory around J-Village that accommodated 1600 workers.</p> <p>(3) Changed meals from ready-made food in retort pouch to bento boxes in response to the decrease of radioactive materials. Reopened the restaurant in J-Village.</p> <p>(4) Reopened the restaurants in the main administration building at the Fukushima Daini Power Plant and other places (18 June 2012).</p>	<p>[Actions taken at nuclear facilities] (1) Prepare temporary sleeping equipment with bedclothes and plan in advance where to locate it during emergencies.</p> <p>(2) Prepare a sufficient volume of emergency food with good nutritional balance for emergencies.</p> <p>[Actions taken in the head offices] Provide support to enable the nuclear facilities to take their actions in an appropriate manner, as necessary.</p>	<p>[Actions taken at nuclear facilities] Make temporary sleep area available and provide meals based on the pre-determined plan.</p> <p>[Actions taken in the head offices] Check the conditions of the temporary sleep area and meals in the nuclear facility and provide support, as appropriate.</p>