（Provisional translation）

Mid-and-long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station Units 1-4, TEPCO

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Nuclear Emergency Response Headquarters
Government and TEPCO’s Mid-to-Long Term Countermeasure Meeting

Contents

1. Introduction

After the accident at TEPCO Fukushima Daiichi nuclear power station, TEPCO and the government prepared the "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station", and pursued planned action on that basis towards an early resolution to the accident. The first objective of the above roadmap, the "steady downward trend in radiation levels" was achieved in July 2011, and the objective of Step 2, "Release of radioactive materials is under control and radiation doses are being significantly held down" was achieved in December of the same year. Through these efforts, the reactors have reached a state of cold shutdown, and it is now possible to maintain an adequately low level of radioactive exposure at the site boundaries, even in the event of unexpected situations. Therefore, in addition to the reactors of TEPCO Fukushima Daiichi nuclear power station to reaching a stable state, the impact of radiation beyond the plant site has been adequately reduced.

After the end of Step 2, there will be a transition from efforts up to that point, aimed at plant stabilization, to efforts to reliably maintain that stable state. In parallel, it is vitally important that the removal of fuel from the spent fuel pools of units 1□4, removal of fuel debris[1] from the reactor pressure vessels and primary containment vessels (PCVs) of units 1□3, and other measures towards decommissioning, should continue over the mid-and-long term, so that evacuated residents will be able to return to their homes as soon as possible and the people of the region, and of the country as a whole, will be able to live without fear.

For this kind of mid-and-long term efforts, the Expert Group for Mid-and-long Term Action at TEPCO Fukushima Daiichi Nuclear Power Station (referred to below as the "Japan Atomic Energy Commission Expert Group"), which was established by the Japan Atomic Energy Commission in August 2011, is examining technical challenges and research and development points. It has concluded that "The target is that it will take no more than ten years before removal of fuel debris starts. We estimate that the completion of decommissioning will take at least 30 years".

On November 9, 2011, Mr. Edano, the Minister of the Economy, Trade and Industry, and Mr. Hosono, the Minister for the Restoration from and Prevention of Nuclear Accident, issued an order (referred to below as "the joint ministerial order") on the writing of a mid-and-long term roadmap for decommissioning and other objectives (referred to below as "this roadmap") to TEPCO, the Agency for Natural Resources and Energy, and the Nuclear and Industrial Safety Agency.

Furthermore, with the completion of Step 2 on December 16, 2011, the Government-TEPCO Integrated Response Office was abolished and the Government and TEPCO's Mid-to-Long Term Countermeasure Meeting was established under the Nuclear Emergency Response Headquarters to manage the preparation and progress of this roadmap.

This roadmap was written by the above three parties, in response to the joint ministerial order, and decided by the Council.

[1] Material in which fuel and its cladding tubes etc. have melted and resolidified.

This roadmap defines the period from the completion of Step 2 to the start of fuel removal from the spent fuel pools (target is within two years), as Phase 1. In addition to work preparing to start removing fuel from the spent fuel pools, this phase will include research and development necessary for the removal of fuel debris, the start of site investigations using the results of that R&D, and other tasks in a period of intensive preparation for decommissioning to begin in earnest.

Beyond Phase 1, this roadmap defines the period targeted to start ten years after the completion of Step 2 and continuing to the start of fuel debris removal, as Phase 2, and the subsequent period to the end of decommissioning as Phase 3.

The implementation of this roadmap is a long-term task that faces many technically difficult challenges that have never been experienced before, so it is important to bring together the collective wisdom of the nation as the government and TEPCO work in close partnership.

2. Basic Policy towards Addressing the Mid-and-long Term Issues

[Policy 1]	Systematically tackle the issues while placing top priority on the safety of local citizens and workers.
[Policy 2]	Move forward while maintaining transparent communications with local and national citizens to gain their understanding and respect.
[Policy 3]	Continually update this roadmap in consideration of the on-site situation and the latest R&D results etc.
[Policy 4]	Harmonize the individual efforts of TEPCO, ANRE, and NISA to achieve our goal.

◆ Based on the above policy, TEPCO, the Agency for Natural Resources and Energy, and the Nuclear and Industrial Safety Agency, will take appropriate action on the basis of the following policies, aware of the importance of realizing this roadmap.

1. With the shared awareness that many of the tasks involved are unprecedented and of great technical difficulty, they will collaborate with relevant industries and research agencies to implement the necessary research and development, and to apply it to the site.
2. TEPCO will set detailed Holding points at each juncture as these results are obtained, and take on-site conditions into consideration in appraising the feasibility and suitability of the technologies to be applied, as it works steadily through action in the mid-and-long term and builds an organization to that end.
3. The Agency for Natural Resources and Energy will take a leading role in budgetary provisions and project management for the above research and development, and provide appropriate guidance and supervision to the work of TEPCO.
4. The Nuclear and Industrial Safety Agency will prepare necessary regulatory systems for work in the mid-and-long term, and confirm that safety is assured in work by TEPCO.
5. TEPCO, the Agency for Natural Resources and Energy, and the Nuclear and Industrial Safety Agency will maintain transparency by periodically reviewing this plan and publishing the status of work in the mid-and-long term.

3. Approach to Ensuring Safety

3-1. Basic Policies on Ensuring Mid-and-long Term Safety

(1) Facilities Operation Plan Based on the Concept of Ensuring the Mid-Term Safety

To ensure the safety of Fukushima Daiichi nuclear power station after the accident, Step 1 and Step 2 provided cooling to the damaged reactor cores through injection and circulation of water, provided circulating cooling to the spent fuel pools, processed and prevented the leakage of water contaminated with high-level radioactivity, injected nitrogen gas into the PCVs to prevent hydrogen explosions, and restored power supplies lost in the accident, among other actions. Furthermore, key equipment was installed with redundancy and diversity to ensure availability of necessary functions in the event of an accident. With the completion of Step 2, the cooling of the reactors is maintained in a stable state, and the amount of public exposure to additional emissions from PCVs has been greatly suppressed.

To ensure the safety of the public and workers in the period extending from the completion of Step 2 to the start of specific work towards decommissioning, the Nuclear and Industrial Safety Agency published "SAFETY DIRECTIVE Ensuring the Mid-Term Safety" on October 3rd, 2011, and TEPCO responded by publishing its "Facilities Operation Plan Based on the SAFETY DIRECTIVE Ensuring the Mid-Term Safety".

The Nuclear and Industrial Safety Agency confirmed that this facilities operation plan provided suitable measures for the following:

- It must be possible to appropriately remove decay heat from the reactor pressure vessels and PCVs.
- Hydrogen explosions in the PCVs must be prevented.
- Decay heat must be appropriately removed from the spent fuel pools and transported to a location for ultimate release.
- It must be possible to prevent criticality in the reactor pressure vessels and PCVs.

These measures together, devised appropriately, make it possible to rapidly restore cooling function from backup functions in the event that an accident causes a loss of cooling function, and even if extremely severe conditions are envisaged for such an accident, it is confirmed that radioactive exposure levels at the site boundaries would be adequately low.

Over the coming three years, TEPCO is to ensurely implement this facilities operation plan, reporting regularly to the Nuclear and Industrial Safety Agency. NISA will check and assess the safety of TEPCO's efforts, based on those reports and its own independent investigations. Based on the results of those assessments, it can revise individual items in "SAFETY DIRECTIVE Ensuring the Mid-Term Safety" at any time, as the need arises, and make an overall review at least once per year, to ensure the safety of the power station.

(2) Main basic goals for ensuring the safety of mid-and-long term actions

In the mid-and-long term, removal of fuel from the spent fuel pools, removal of fuel debris from reactor cores, and other tasks will be performed to move fuel from the accident-affected pools in the reactor buildings and fuel from the reactor cores to common pools and storage containers, which are in more stable condition. Safety measures must be devised for this fuel removal work, to prevent accidents such as dropped fuel in the removal process causing new emissions of radioactive substances.

TEPCO will continue to consider specific working methods for these tasks on the basis of basic targets indicated by the Nuclear and Industrial Safety Agency. At each stage, it will assess the safety of equipment and procedures (including earthquake resistance) and the radioactive impact on the surrounding environment, and will receive assessment and confirmation from the Nuclear and Industrial Safety Agency before implementation.

<Main basic goals for ensuring the safety of mid-and-long term actions>

1. It must be possible to identify emission sources of radioactive substances, devise appropriate anti-emission measures, and perform monitoring.
2. It must be possible to appropriately remove decay heat from the reactor pressure vessels, PCVs and spent fuel pools.
3. It must be possible to prevent criticality in the reactor pressure vessels, PCVs and spent fuel pools.
4. It must be possible to appropriately detect, manage and process flammable gases.
5. The effective dose caused by the reactor facilities must be reduced as far as is rationally attainable.
6. Even in the event of any temporary loss of safety-related function, the amount of exposure due to additional emissions of radioactive substances at the site boundaries must have no adverse effect on safety.
7. Worker radiation exposure must comply with the law.

(3) Implementation Plan related to Countermeasures for Improving Reliability

In consideration of continuing troubles, such as leaks, following the completion of Step 2, NISA instructed TEPCO to create detailed implementation plans for priority items in order to improve mid to long-term reliability, such as upgrading primary equipment from temporary equipment to permanent equipment, in response to which TEPCO submitted a “Implementation Plan related to Countermeasures for Improving Reliability”. Upon receiving this plan NISA evaluated the content of the aforementioned Implementation Plan after hearing the opinions of experts.

3-2. Policies for Ensuring Safety

(1) Equipment safety

In the same way as Step 2, Phase 1 will maintain and strengthen [1] functions for the suppression and management of radioactive substance emissions, [2] cooling functions in the reactors and spent fuel pools, [3] criticality prevention functions, and [4] hydrogen explosion prevention functions. Specifically, in addition to improvement of accumulated water processing facilities and addition of continuous monitoring functions against recriticality, the operational status of the equipment will be checked continuously, and necessary measures will be devised, to further improve reliability. Furthermore, replacement of equipment for which the term of use has not been specified at current time will be deliberated based on the results of future status monitoring and periodic inspections, and the replacement timing shall be reflected in maintenance plans.

Also, the aging and safety impact of concrete structures associated with the reactor building, the containment vessel and coolant injection piping, etc. (including a structural strength assessment that includes seismic-resistance) was assessed and it was determined that these systems will not lead to a significant decrease in seismic-resistance tolerance over the next few years. In particular, the soundness of Unit 4 R/B was investigated using optical equipment during which it was confirmed that the building is not tilting. This survey will be periodically implemented. In order to assess the long-term soundness of the facility a government project is underway under the supervision of the government, and the TEPCO Mid/Long-Term Countermeasures Conference/R&D Promotion Department to establish soundness assessment technology that includes corrosion data expansion and the remaining life expectancy of engineering structures.

Furthermore, anticipated risk due to earthquake and tsunami will be assessed for equipment and devices for which such as assessment has yet to be made and also equipment/devices that are to be upgraded in the future in order to implement countermeasures necessary for ensuring seismic-resistance and preventing the leakage of contaminated water. The risk associated with tornadoes will also be assessed for equipment that requires it based on importance and in consideration of construction upon which necessary countermeasures shall be deliberated and implemented.

The reliability of power sources shall be improved and maintained by, for example, upgrading temporary equipment to permanent equipment, so as to enable long-term use. The plan to start removing fuel from the spent fuel pool and further stabilize the plant is in parallel with that work.

In Phase 2 and beyond, the equipment necessary to maintain plant stability in the long term will continue to receive work to enhance its reliability, including appropriate maintenance and management. The removal of fuel debris and other operations will transition the plant into a state that can be maintained stably without depending on the above equipment, to be followed by final decommissioning.

(2) Working safety

General working safety, radiation management and health management for workers will continue and expand the work that was under way up to Step 2, including preliminary safety assessment, dose reduction measures, medical treatment organization development, and other measures.

For radiation management, monitoring of the working environment will be expanded, dosage management will be implemented thoroughly, and dosage due to decontamination etc. will be reduced. Robots and other remote operation technologies will be applied as appropriate in high-radiation environments. These and other measures will cut amounts of exposure to workers to below exposure limits.

(3) Reduction and management of radiation levels at site boundaries

The reactors are now being cooled stably (as of July 2012), emissions of radioactive substances from reactor buildings have been suppressed, and as a result, annual radiation exposure at site boundaries is assessed at a maximum of 0.02 mSv/year thereby indicating a downward trend compared with when Step 2 was completed. Furthermore, the target to be achieved within FY2012 is to cut effective dose at the site boundaries to below 1 mSv/year. This is to be achieved by reducing the impact of additional emissions from the power station as a whole, and of radiation from rubble etc. and secondary waste from water processing (used cesium adsorption towers, sludge, etc., collectively referred to below as "secondary waste from water processing"), which are generated after the accident and stored on site.

In addition to the above, decontamination within the site will be implemented systematically to further reduce radiation at the site boundaries.

For gaseous waste, efforts to further reduce environmental emissions will continue, together with emission monitoring. For liquid waste, the following necessary deliberations will be made in future and used to devise countermeasures, and discharges of contaminated water to the ocean will not be made lightly.

[1] Radical countermeasures against inflow of groundwater to reactor buildings, which raises water levels

[2] Measures to raise the decontamination capacity of the water purification facilities and ensure their stable operation, including substitute facilities to use in case of failure

[3] Further installation of land-based facilities for contaminated water management

Discharges to the sea must not be performed without the approval of the relevant ministries.

To confirm that there is no abnormal situation, airborne radiation dosage rates and radioactivity of environmental samples will be monitored continuously, near the boundaries of the perimeter monitoring areas and in nearby areas.

(4) Other safety matters

Fire risk and the impact of fire shall be evaluated, firebreaks installed, fire monitoring enhanced, and water sprinkling/fire prevention training implemented as countermeasures. In particular, in addition to periodically sprinkling water on felled timber, patrolling the site and taking temperature readings, the temporary storage site for felled timber shall be covered with soil. Appropriate measures will be implemented, under the relevant laws and the guidance of the national government and related agencies, concerning physical protection of nuclear material, and nuclear material safeguards.

4. Phase Divisions and Timed Targets in the Mid-and-long Term Roadmap

Appendix 1-1 presents the main schedule of this Mid-and-long-term Roadmap for Decommissioning Reactors 1□4 of Fukushima Daiichi Nuclear Power Station. This roadmap was prepared jointly between TEPCO, the Agency for Natural Resources and Energy, and the Nuclear and Industrial Safety Agency, based on December 7, 2011 report from the Japan Atomic Energy Commission Expert Group and the joint ministerial order issued on November 9, and drawing on currently-available knowledge, such as the case of stabilizing the US TMI-2 accident[2]. The three parties performed the roles stated in Chapter 2, and are working steadily on the implementation tasks stated in this roadmap.

The processes and tasks in this roadmap are subject to revision due to future on-site circumstances, research and development results and other inputs, and will be revised accordingly through an ongoing process of verification.

4-1. Approach to Categorization in the Mid-and-long Term

This roadmap employs the following definitions for Phase 1□3.

- Phase 1: From the completion of Step 2 to the start of fuel removal from the spent fuel pool (target is within two years)
  - In addition to work preparing to start removing fuel from the spent fuel pool, this phase will include research and development necessary for the removal of fuel debris, the start of site investigations, and other tasks in a period of intensive preparation for decommissioning.
- Phase 2: From the end of Phase 1 to the start of fuel debris removal (target is within ten years)
  - Within this phase, we will step up many research and development tasks towards the removal of fuel debris, and tasks such as reinforcement of PCV.
  - This phase will be further divided into three steps: early, mid, and late, as a guideline for judging progress within the phase.
- Phase 3: From the end of Phase 2 to the end of decommissioning (target is 30□40 years)
  - This is the phase for implementation of tasks from fuel debris removal to the end of decommissioning.

4-2. Timed Targets and Holding points in the Mid-and-long Term Roadmap

For the immediate period of approximately three years (to the end of FY2014), including Phase 1, we have set the progression for each year, with timed targets wherever possible. In FY2015 and beyond, the timing and content of measures are

[2] Unit 2 of Three Mile Island nuclear power station at US.

subject to major change in response to on-site circumstances, research and development results, and other inputs. Therefore, rough timed targets have been set as far as possible. The tasks within each Phase also face many technical issues, and will have to proceed in a phased process, based on on-site circumstances, research and development results, safety requirements, and other circumstances. Therefore, at the key points for judgment on progression to subsequent processes, there will be further deliberation and judgment, including additional research and development and revision of process and task content. These are set as Holding points (HP).

The main timed targets and holding points (HP) in this roadmap are as follows:

(1) Reactor cooling / accumulated water[3] processing

- Methods to improve the reliability of the existing water processing facilities will be considered, with implementation of the main measures by the first half of FY2012, and ongoing improvements thereafter.
- Multi-nuclide removal facilities will be installed within 2012 that will be able to remove radioactive substances other than Cesium, which are difficult to remove with the existing facilities.
- Scale down of circulation line will be implemented in stages, by improving the reliability of the existing water processing facilities, and by measures in Phase 2 (mid), such as stopping inter-building water leakage and repairing lower part of the PCV.
- The amount of surplus water is increasing as underground water seeps into the buildings, so as a measure to suppress the flow of underground water pits that can be restored without disrupting construction in the surrounding area shall be cleaned and restored during FY2012. Furthermore, pits that interfere with surrounding construction shall be restored after FY2013 upon deliberating recovery methods, including the construction of new pits. Also, from the second half of FY2012 underground bypasses will be successively opened and the flow of underground water reduced in a stepped manner.
- Accumulated water processing of water in the turbine building and reactor buildings will be completed in Phase 2 (late).

<Holding points concerning accumulated water processing>

Methods for working to reduce accumulated water could change according to the success or failure of stopping inter-building water leakage and repairing lower part of the PCV, so the following related holding point is set:

(HP1-1): Completion of stopping inter-building water leakage between reactor and turbine buildings and repairing lower part of the PCV
[Phase 2 (mid)]

(2) Plans to Mitigate Sea Water Contamination

[3] Contaminated water accumulated in the turbine buildings and reactor buildings of units 1□4

- Should underground water be contaminated, in order to prevent underground water flowing into the ocean, installing water shielding walls by mid FY2014
- A silt fence will be installed on the side of units 5 and 6, and the seabed areas in front of units 1□4, and of units 5 and 6, will be covered with solidifying seabed soil, to prevent diffusion of seabed soil. In addition, circulating seawater purification facilities will continue to operate in the area in front of the intake canal for units 1□4, with the target of reducing radioactive substance concentrations in seawater in the port below the limit outside of the environment surveillance area, as stipulated by government notification, within the first half of FY2012.

(3) Plans for Radioactive Waste Management and Dose Reduction at the Site Boundaries

- Plans to reduce the effective radiation dose at the site boundaries to below 1 mSv/year within FY2012 as a target date, due to additional emissions from the whole site and radioactive waste stored on the site after the accident (secondary waste materials via water processing and debris etc.).
- Along with securing a suitable storage area based on the amount already present and in anticipation of the amount of radioactive waste generated from future work, a mid to long-term plan that includes moving the waste from temporary facilities to long-term facilities and that considers the impact of radiation on site borders shall be created by the end of FY2012.
- Based on an assessment of the form of secondary waste due to water processing that is now in progress, and the estimated lifespan of storage containers, a facility renewal plan for storage containers etc. will be adopted by the end of FY2014.
- Facilities will be updated as necessary, in Phase 2 (late) and beyond.

(4) Plan to Remove Fuels from Spent Fuel Pools

- Plan to start fuel removal from Unit 4 within 2 years after completing Step 2 (within 2013).
- Plan to start fuel removal from Unit 3 approximately 3 years after completing Step 2 (end of 2014).
- As for Unit 1, plan to develop a specific fuel removal plan based on knowledge and experiences at Units 3 & 4 and investigations of rubble, and finish fuel removal in the Phase 2 (mid).
- As for Unit 2, plan to develop a specific fuel removal plan based on the situation after the inside-building decontamination etc. and investigations of the installed facilities, and finish fuel removal in the Phase 2 (mid).
- Plan to complete fuel removal from all Units during Phase 2 (late).
- Plan to determine reprocessing and storing methods for removed fuels during Phase 2 (late).

<Holding points concerning removed fuel>

The following holding points are set for the handling of removed fuel, because it will be necessary to base such handling on assessment of the soundness of long-term storage and research and development results for reprocessing.

(HP2-1): Determination of methods for reprocessing and storing spent fuel [Phase 2 (late)]

(5) Fuel Debris Removal Plan

- Plan to start fuel debris removal in the first unit within 10 years after completion of Step 2.
- Research and development concerning construction methods, equipment development and other topics will be implemented for realization of the plan. Implementation of this plan will include thorough demonstration of the suitability of technologies produced by this research for use on the site (referred to below as "field test").
- The products of the development of remote decontamination technology, to be completed by the end of FY2013, will be applied on site, as appropriate. Other than decontamination within the reactor buildings, this technology will be used to develop technology for identification of PCV leakage point (by around mid-FY2014, including field test). That will be used for decontamination within reactor buildings by the end of FY2014, to gain access to building interiors, and begin surveying PCV leakage point, and making PCV internal investigations of reactor containment from outside.

<Holding points concerning fuel debris removal work etc.>

The following holding points are set on the basis of the on-site situation, research and development results (including field test), and the situation of safety requirements, etc. Holding points are also set concerning the handling of the removed fuel debris.

(HP3-1): Determining methods for repairing PCV, determining water stop methods [Phase 2 (early)]
(Target research and development timing)
End of field test of PCV repairing technology (inter-building, lower parts of PCV)
: Around the end of FY2015

(HP3-2): Completion of flooding of lower parts of PCV, determining PCV internal investigation methods [Phase 2 (mid)]
(Target research and development timing)
End of field test of PCV internal investigation technology: Around the end of FY2016

(HP3-3): Determining methods to repair upper parts of PCV [Phase 2 (mid)]
(Target research and development timing)

End of field test of PCV upper part repairing technology: Around the end of FY2017

(HP3-4): Completion of flooding of upper parts of PCV, determining RPV internal investigation methods [Phase 2 (late)]
(Target research and development timing)
End of field test of reactor pressure vessel internal investigation technology: Around mid-FY2019

(HP3-5): Determining fuel debris removal method and completion of preparation of fuel debris containers, etc.
[Phase 2 (late)]
(Target research and development end timing)
End of field test of fuel debris removal technology: Around the end of FY2021
End of development of fuel debris containers: Around the end of FY2019
Establishment of a fuel debris weighing and management policy: Around the end of FY2020

(HP3-6): Determining processing / disposal methods of fuel debris. [Phase 3]

(6) Reactor Facilities Demolition Plan

- Plan to complete the reactor facility demolition in Units 1 to 4 within 30 to 40 years after the completion of Step 2.
  (Reference) Demolition of one reactor unit is expected to take over 20 years, judging by the time taken for fuel debris removal at TMI-2 (over four years) and the standard demolition process for regular reactor facilities (around 15 years).
- The plan for establish a basic database of on-site contamination status etc., which will be required for consideration of demolition and decontamination engineering methods, is to be written within FY2012.
- A basic database for use in demolition of reactor facilities will be built between Phase 1 and Phase 2 (mid).
- Research and development of remote demolition (disposal standards etc. for demolition waste) for remote demolition of reactor facilities, based on the above database, will be implemented between Phase 2 (mid) and Phase 3.

<Holding point for demolition of reactor facilities>

(HP4-1): Determining demolition and decontamination engineering methods. Developing disposal standards for dismantled waste. [Phase 3]
-> Begin the design and manufacture of devices and equipment necessary for demolition and disposal.

(HP4-2): Outlook for disposal of demolition waste. Complete research & development and make plans. [Phase 3]

-> Begin demolition.

(7) Radioactive Waste Processing and Disposal[4] Plan

- The form of waste generated after this accident differs from that generated normally in nuclear power stations (nuclide composition, salt content, etc.), so a plan for research and development related to its processing and disposal will be written within FY2012.
- The form of waste materials will be identified and their quantities assessed by the end of FY2014.
- The disposal concept will be devised in Phase 2 on the basis of the results.

<Holding points for radioactive waste processing and disposal>

The aim is to carry these wastes to disposal sites at the end of Phase 3 together with waste generated in the demolition works, subject to the setting of the following holding points. Consideration of this area will continue, reflecting research results.

(HP5-1): Confirm the suitability of existing disposal concepts for the forms of waste [Phase 2 (mid)]

(HP5-2): Confirm the outlook for safety in the processing and disposal of waste [Phase 2 (late)]

(HP5-3): Confirm solid waste specifications and manufacturing methods [Phase 3]

(HP5-4): Installation of solid waste manufacturing equipment and the outlook for processing [Phase 3]

5. Specific Plans for Mid-and-long Term Action

5-1. Efforts for Maintaining Plant in an Ongoing Stable State

(1) Plan for reactor cooling

1. Ongoing monitoring of reactor cold shutdown states

The reactors have already reached a state of cold shutdown in Step 2. In the period until the end of fuel debris removal in Phase 1 and beyond, cooling by water injection will continue as the reactor interior is reliably cooled. The stable maintenance of the state of cold shutdown will be monitored continuously, using parameters such as temperature and pressure. To complement the above monitoring, imaging scopes, etc. were inserted into the PCVs, of Unit 2, to permit at least partial observation of the interior, for direct confirmation of water level, temperature, and other circumstances of the PCV.

Unit 1 shall be surveyed in the same manner as Unit 2 by September 2012.At current time a survey of the inside of the Unit 3 PCV is difficult due to high atmospheric doses. Therefore, the implementation period for a Unit 3 survey shall be determined in accordance with the progress of development of

[4] Forming waste bundles by solidifying waste in containers using cement in accordance with the form of the radioactive waste (radionuclides contained, radiation levels) (hereinafter referred to as, "Processing"), transporting the waste bundle to a disposal area and burying it (hereinafter referred to as, "Disposal")

environmental improvement technology to lower doses through decontamination and shielding.

Furthermore, the malfunctioning Unit 2 PCV thermometer shall be replaced by August 2012. The thermometers in Unit 1 and Unit 3 must also be replaced in anticipation of similar malfunctions, but since environmental improvements, such as dose reduction, are required candidate systems through which alternate thermometers can be inserted will be narrowed down (desktop deliberation) during FY2012.

2. Improving the reliability of circulating water injection cooling equipment

The equipment for coolant water injection to the reactors current draws water from the turbine building and stores water that has been processed by accumulated water processing equipment in the processed water buffer tank. The stored water is used as the source for injection to units 1□3, via three normal reactor injection pumps on the hill and water injection lines.
As a backup for this equipment, two systems of tanks and water injection lines have been ensured as water sources, for diversity and redundancy. Furthermore, the condensate storage tank (CST) and the processed water buffer tank for Unit 3 are used as the water source for a normal water injection line fed by a water injection pump in the turbine building. These were added by March 2012 thereby achieving highly reliable water injection.

Furthermore, pressure resistant hoses used in primary line configurations were replaced with polyethylene pipes by February 2012. Also, in order to further improve reliability normal reactor coolant injection lines that use the processed water buffer tank as a water source will substituted with lines that use the CST as a water source during 2012.

As a result, the amount of water on hand for use as coolant injection water sources will be increased and seismic-resistance improved. Therefore, coolant injection lines that use the CST as a water source will be added to the reactor and hoses replaced with polyethylene pipes.

3. Decreasing circulation loop

During Phase 1, deliberation of whether or not it is possible to construct a circulation loop within the building quickly, as mentioned below, and water quality sampling of accumulated water in the R/B, etc., will take place by March 2013.

In Phase 2, the water intake source will be systematically changed from the current turbine buildings to the basement levels of the reactor buildings and the PCVs. This change will be implemented to ensure consistency with the plan to block inter-building leakage between the reactor buildings and the turbine buildings and reinforce leaking points in the PCVs, which will use the results of future research and development. Furthermore, a circulation loop inside the building that injects water accumulated inside the building into the reactor without passing through current accumulated water processing equipment shall be completed by March 2017.

After reinforcement of the leaking points in the PCVs is complete, the interiors of the PCVs will be filled with water, and consideration will be given to decreasing the circulation loop of coolant circulation and cleaning, to use only water held inside the PCVs. That would make cooling more stable.

(2) Plan for accumulated water processing

1. Improvement of the reliability of accumulated water processing facilities

Processing facilities for contaminated water (accumulated water) that has accumulated in turbine buildings will have their designs improved, based on various problems which occurred early in their operation, and redundancy will be added, to enhance their reliability. Leakage detectors within the embankment will be installed by the end of Step 2, in response to the water leakage from the evaporative concentration apparatus that happened on December 4, 2011.

In Phase 1, as a countermeasure to improve reliability some of the pressure resistant hoses used in the circulation line had been replaced with polyethylene pipes, and the remaining pressure hoses will be replaced with polyethylene pipe by September 2012 (lines from around the processed water buffer tank to the CST were replaced with polyethylene pipe prior to switching over to coolant injection lines that use the CST as a water source (and of December 2012)). Also, replacing branching pipes that use pressure resistant hoses with polyethylene piping shall be deliberated by September 2012. Furthermore, as a countermeasure for reducing the risk of leaks from piping that fundamentally comprise a shortened circulation line that is currently approximately 4 km long, this piping shall be replaced with polyethylene piping, as mentioned above, in consideration of past leaks. In addition, whether or not it is necessary to shorten the circulation line shall be decided by March 2013 in consideration of the deliberation over whether or not it is possible to quickly construct a circulation loop inside the building.

Furthermore, multi-nuclide removal equipment that aims to reduce the concentration of radioactive material found in processed water[5] to below detectable limits shall be introduced during the first half of FY2012 and the concentration of radioactive material in processed water shall be managed to keep it sufficiently low.

In Phase 2 (mid), the further reduction of circulation lines will be considered in response to the state of closure of leaks between reactor and turbine buildings, and of leaks from the PCV, which will be implemented on the basis of future research and development.

Storage facilities for waste etc. necessitated by water processing will be dealt with as necessary, such as by expanding existing storage facilities.

Furthermore, water processed using multi-nuclide removal equipment shall be stored in underground water tanks. There is a plan to increase the volume of currently installed underground water tanks from 4,000m^3 to 52,000m^3 by

[5] Water that has been purged of cesium by the current water processing equipment

the end of October 2012 (tentative).

Also, surplus water generated from water processing is accounted for by the flow of groundwater and since the amount of processed water generated from water processing and multi-nuclide removal equipment will fluctuate as a result of the following efforts, based on the circumstances a plan shall be created to store processed water that can be stored in tanks.

- Countermeasures for suppressing the flow of groundwater through underground water bypasses and subdrain recovery.
- Quick reduction in RO concentrated water through operation of three multi-nuclide removal equipment systems.
- Reduction in the amount of water processed by reducing the concentrations of saline and radiation in water accumulating buildings, and shortening of circulation lines.

Furthermore, a geological survey of the open lots next to present tank installation areas is underway in order to determine whether or not it is possible to use that area for additional tank installation.

2. Rapid processing of accumulated water

Sub-drainage[6] has yet to be raised from within the pits (wells) built around the turbine buildings etc., in which low-level contamination has been confirmed. Therefore, groundwater is constantly flowing into the turbine buildings etc.

In Phase 1, sub-drainage will be purified and confirmed free of contamination, and the level of accumulated water in the turbine buildings etc. will be managed so that it does not rise above the underground level, which will be gradually reduced. The following measures will be implemented on the basis of the state of sub-drainage purification etc., to suppress the volume of groundwater inflow and reduce the volume of accumulated water in the turbine buildings.

- Water pits that can be restored without disrupting construction in the surrounding area shall be cleaned and restored during FY2012. Furthermore, pits that interfere with surrounding construction shall be restored after FY2013 upon deliberating recovery methods, including the construction of new pits.
- From the second half of FY 2012 pumping wells on the mountain side of the building will be gradually put into operation to pump up groundwater and change the flow path so that it flows into the ocean (underground bypass) thereby reducing the level of groundwater around buildings.

In Phase 2 (mid), once leakage between the reactor buildings and turbine buildings, and leaks from PCVs, have been blocked, there will no longer be any increase of accumulated water due to leakage of reactor coolant water. Therefore, accumulated water processing will continue to be implemented steadily, with the aim of completing processing accumulated water below ground in the turbine buildings and reactor buildings by Phase 2 (late).

[6] Groundwater that has flowed into pits (wells) built around buildings.

For the processing of accumulated water, the following necessary deliberations will be made and used to devise countermeasures, and discharges of contaminated water to the ocean will not be made lightly.

- Radical countermeasures against inflow of groundwater to reactor buildings, which raises water levels
- Measures to raise the decontamination capacity of the water processing facilities and ensure their stable operation, including substitute facilities to use in case of failure
- Further installation of land-based facilities for contaminated water management

Discharges to the sea must not be performed without the approval of the relevant ministries.

(HP1-1) Completion of stopping inter-building water leakage between reactor and turbine buildings and repairing lower part of the PCVs

- Based on the ability to adequately suppress inflow of groundwater into buildings by blocking inter-building leakage between reactor buildings and turbine buildings and reinforcing the lower parts of PCVs, and by managing the level of sub-drainage, the volume of accumulated water below ground level in the turbine buildings and reactor buildings will be systematically processed and reduced.

5-2. Plan to Reduce Radioactive Dosage in the Power Station as a Whole, and to Mitigate Sea Water Contamination

(1) Plans to Mitigate Sea Water Contamination

1. Reduction of the risk of expanded sea water contamination when contaminated water leaks

Until now, a portion of the accumulated water in the buildings has passed through pits etc. to flow into the sea, so a variety of countermeasures have been devised, including blocking pits etc., installation of silt fences[7] in the port, and installation of circulating seawater purification facilities. The level of accumulated water inside buildings is managed to suppress its outflow into the ground, and that management will continue. In addition to these measures, work began in October to install water shielding walls on the front of the existing breakwaters in front of Units 1□4, to prevent the dispersion of sea water contamination in the event of contaminated water into groundwater. Ground was broken in October 2011 and full scale construction started in April 2012.

It is planned for completion by mid-FY2014.

2. Reduction of radioactive substance concentrations in sea water in the port (below announced density)

A silt fence on the side of Units 5 and 6 was installed in May 2012, and seabed

[7] This is an underwater fence consisting of curtains hung in the water, to retain dispersing silt.

soil in the area in front of the intake canals for Units 1□4, and for Units 5 and 6, was covered with solidifying soil in May and July of the same year, respectively.

These measures will prevent diffusion of seabed soil. In addition, circulating seawater purification facilities will continue to operate in the area in front of the intake canal for Units 1□4, with the target of rapidly reducing radioactive substance concentrations in sea water in the port to below the density limit that requires public announcement for areas not monitored by the first half of FY2012. Mud raised by dredging the port to a depth sufficient for the passage of large vessels will be accumulated within the port, and prevented from dispersing by covering it with solidifying soil, or other measures.

Also, in addition to the maintenance and management of constructed facilities etc., the quality of groundwater and sea water will be monitored constantly until decommissioning is complete.

(2) Plans for Radioactive Waste Management and Dose Reduction at the Site Boundaries

1. Solid waste management

The earthquake, tsunami and hydrogen explosions generated rubble etc. within the power station site. The rubble that has been recovered mainly consists of concrete and metal and varies widely from low to high radioactive dose rates. The accident restoration work also generates felled trees, secondary waste from water processing, used protective clothing, etc.

The rubble etc. is sorted, as far as possible, by dose rate and material, and that which risks airborne dispersion of radioactive substances will be protected by dispersion countermeasures (placement in containers, sheet covering, etc.) for temporary storage. Secondary waste from water processing will be stored in temporary storage facilities, based on consideration of radiation shielding.

Used protective clothing etc. will be packed in bags or containers and stored temporarily in a predetermined location. This used protective clothing will be incinerated in miscellaneous solid waste incineration facilities and the ash created from this incineration will be stored in solid waste storage warehouse. Felled trees will be stored temporarily in a predetermined location, and treated against fire.

As rubble etc. will require a long period of temporary storage before it is moved to disposal sites in Phase 3, a management plan will be written for ensuring and appropriately managing areas corresponding to the volumes and radioactive levels of waste generated in future by the end of FY2012. The plan will be implemented systematically, and reviewed as necessary. Within that plan, countermeasures will be implemented using shielding etc. according to the radioactive impact of the rubble etc. on the site boundaries. Consideration will also be given to reducing the volume of rubble, and reusing it.

Storage areas will also be ensured according to the quantities of secondary waste from water processing generated in future, and measures such as further shielding will be implemented, according to the radioactive impact of the waste on the site boundaries, to reduce that impact. Also, based on the form evaluation of secondary waste from water processing that is now in progress, and the estimated lifespan of storage containers, a facility renewal plan for storage containers etc. will be adopted by the end of FY2014.

In Phase 2 (late), measures implemented up to that time will continue, and storage containers and other equipment for secondary waste from water processing will be renewed as necessary.

2. Gaseous waste management

By now, with the cooling of the reactor, the annual radiation exposure at site boundaries due to emission of radioactive substances from reactor buildings is assessed at a maximum of 0.02 mSv/year, and new emissions have been suppressed. During Phase 1, Unit 3 PCV gas management equipment was installed and put into operation in March 2012 in addition to the equipment that was installed and put into operation for Units 1 and 2 during the completion of Step 2 (December 2011).

This equipment, along with the filters at the outlets for the Unit 1 reactor building, have been continually monitored for radioactive discharge using radiation monitors. By the end of FY2012 the blowout panel openings of the Unit 2 reactor building will be closed and ventilation equipment installed. At Unit 3 and Unit 4 the work area will be covered so as to prevent the dispersion of radioactive material during the removal of fuel from the spent fuel pools and ventilation equipment installed (Unit 3: fuel removal to commence around the end of 2014, Unit 4: fuel removal to commence during 2013).

Furthermore, the underground openings of the Unit 1～4 turbine building, waste processing building and concentrated RAD waste building are being sealed in order to prevent the dispersion of radioactive material that may dry and float into the air once again in the event that the level of accumulated water that contains radioactive material in the underground areas of these buildings decreases.

In the future, actual plans to restore function to contain radioactive material, such as a building to contain radioactive material, will be deliberated. Buildings that have the potential to generate new radioactive material or that are continually discharging material shall be monitored for discharges where possible and suitable. During the course of deliberation, plans will be made to restore containment function through methods that are feasible upon determination of feasibility based on the results of dust concentration measurements and site surveys implemented by the end of FY2012. Furthermore, current discharge depression and monitoring plans will be deliberated by June 2013 based on the results of confirming site conditions.

Airborne concentrations of radioactive substances will be monitored in areas near the site, to confirm that they are below airborne concentration density limits by the announcement for out of supervised areas. As all supervised areas are currently set as areas requiring the same level of management as controlled areas, airborne concentrations of radioactive substances will be monitored in perimeter monitoring areas as well, to confirm that they are below airborne concentration limits that require announcement.

3. Liquid waste management

Accumulated water and other liquid wastes will be stored, or treated (purified) in water purification facilities to reduce their levels of radioactive substances. Processed water generated by purification processes will be stored in tanks, and will be appropriately managed, such as by reuse after desalination.

Contaminated water will be handled as stated in 3-2 (3).

4. Reduction of dosage at site boundaries (attainment of dosage <1 mSv/year at site boundaries due sources such as new emissions of radioactive substances etc. from the power station as a whole)

The aim is to reduce the effective radiation dose at the site boundaries to below 1 mSv/year within FY2012, including effective dose due to additional emissions of radioactive substances from the power station as a whole, and radioactive waste produced after the accident and stored on the site (secondary waste from water processing, rubble, etc.), through appropriate implementation of the above measures.

To do this, dose reduction objectives shall be set for discharged radioactive material and stored radioactive waste, and reduction results confirmed quarterly to determine whether or not additional countermeasures are required. Dosage levels of radioactive waste shall be reduced by the end of FY2012 by moving debris to soil covered temporary storage sites, covering felled trees with soil, and shielding secondary waste produced from water processing.

5. Continuous implementation of environmental monitoring

To confirm that there is no abnormal situation, airborne radiation dose rates and radioactivity of environmental samples are monitored near the boundaries of the supervised areas and in nearby areas. The impact of radiation from radioactive materials discharged during the accident on monitoring posts that continually monitor dose rates has been reduced by cutting down trees, removing soil, and building shielding walls in the vicinity of monitoring post locations in order to enable early detection of abnormal discharges of radioactive material. In the future the effects of these reduction countermeasures shall be evaluated and effective decontamination methods for further reducing dose rates shall be deliberated by the end of FY2012. Furthermore, whereas it may be appropriate to remove the installed shielding wall mentioned above, measures for reducing the height of the shielding wall on the facility side in order to improve the sensitivity of abnormal detection will be deliberated by FY2012. Eventually the area will be decontaminated so as to further improve sensitivity and bring actual measurement values to below 1mSv/year at site borders.

Monitoring in the environment, both on land and at sea, will continue in Phase 1 and beyond. Current monitoring covers, to the extent possible, the environmental impact of radioactive substances released at the time of the accident, and watches for further abnormal emissions. In future, environmental monitoring will be performed in line with environmental radiation monitoring policies that are based on measurement targets and measured parameters etc. that were used before the accident.

(3) Plan for Decontamination within the site

Decontamination within the site will eventually cover the entire site, but in order to reduce exposure doses to the general public and to workers, and to facilitate work for smoother accident response in future, the site will be grouped into four areas, and specific decontamination plans will be devised and gradually implemented for those areas.

<Area categories within the site>

- Executive areas: Areas that are intended to be made into non-controlled areas (Main anti-earthquake buildings, etc.).
- Working areas: Areas in which many workers are engaged in restoration work.
- Access areas: Main roads on the site for access to working areas.
- Other areas: Forests and other areas not included in the above.

The decontamination plan will set orders of priority, based on area categories, for areas to receive decontamination, and decontamination will be implemented sequentially. The plan will be revised, checking effects on dose rate reduction and improving decontamination methods. Decontamination of office areas, work areas, and access areas on-site will be implemented in accordance with the amount of time that workers spend there and air dosage rate starting with areas where many workers reside.

In particular, office areas in the seismic isolated building that workers enter often were rendered a non-controlled area in May 2012.

By the first half of FY2012 shielding will be erected at the commuter bus stop in front of the seismic isolated building. Furthermore, the work areas where front gate security personnel reside will be decontaminated during FY2012. The dosage rates of new building construction sites and surrounding areas will be reduced through soil removal.

In Phase 2 and beyond, decontamination within the site will proceed with linkage to the state of reduction in the dosage environment as radioactive sources outside the site are eliminated. Ultimately, decontamination will cover the entire on-site area.

Work will begin promptly in checking whether rubble that was scattered by the hydrogen explosions has accumulated within the power station premises, and will end within FY2014 at the latest.

5-3. Plan for Fuel Removal from the Spent Fuel Pool

(1) Current situation

The impact of the tsunami caused the spent fuel pools of Units 1□4 to temporarily lose cooling function, but the injection of coolant water using concrete-pumping vehicles maintained cooling of fuel in the spent fuel pools. Fuel is now stably cooled by circulating cooling systems. Cooling function must be maintained until fuel removal is complete, so the maintenance management of the equipment will carry on, with equipment replacement as necessary, to maintain and improve reliability. The results of analysis of radioactive substance concentrations in the spent fuel pool water indicate that most of the fuel is in sound condition. Sea water was injected into the spent fuel pools of Units 2□4 as an initial emergency measure, leading to corrosion of the lining[8] of those spent fuel pools, and of equipment within the pools. Therefore, water quality is being improved using desalination equipment and the water quality of Unit 2 has been improved.

Currently, debris is being removed from the top of the Unit 3 and Unit 4 reactor buildings and work to improve the foundation for installation of a fuel removal cover at Unit 4 has been underway since April 2012. Furthermore, deliberation and design of the fuel removal cover, fuel handling equipment, and on-site transportation vessels is underway. Water quality will be monitored continuously in future, and countermeasures and improvements will be applied as necessary.

(2) Summary of Fuel Removal Work (see appendix 3)

The plan for the removal of fuel from the spent fuel pools is to remove rubble that was dropped onto the refueling deck by the hydrogen explosions, install covers (or containers) to improve the working environment that includes the fuel handling equipment, and then transfer fuel to the common pool inside the power station, for a more stable storage situation.

Appendix 2 shows the steps involved in fuel removal from the spent fuel pool. By now, the first step of this process, which is the removal of rubble from the upper part of the reactor building, and preparations for subsequent steps, including covers for fuel removal, fuel handling equipment, and on-site transportation containers, are being considered and designed for Units 3 and 4.

[1] Removal of rubble from upper parts of reactor buildings

The upper parts of the reactor buildings for Units 1, 3 and 4 were damaged and rubble was scattered over the refueling deck and into the spent fuel pools. As a result, fuel removal must be preceded by the use of heavy equipment and fuel handling equipment to clear rubble from the fuel handling floor and the spent fuel pools. A plan will be devised for rubble removal, including removal of the cover installed on Unit 1, and implementation will follow the plan.

[2] Cover (or container) installation and installation or restoration of fuel

[8] The lining applied to the inner walls of the spent fuel pools.

handling equipment

The upper parts of the reactor buildings for Units 1, 3, and 4 are damaged, so covers (or containers) will be installed to cover the fuel replacement areas, to maintain a working environment for fuel removal by blocking wind and rain. New fuel handling equipment will be installed inside for the fuel removal work. And the dose reduction countermeasures will be implemented at Unit 3.

The soundness of the fuel handling equipment in Unit 2 has not yet been checked, because of the high dosage within the reactor building. In future, the equipment will be inspected and repaired once decontamination etc. makes it possible to approach the fuel handling equipment.

[3] Design and manufacture of on-site transportation containers and storage drums

The movement of undamaged fuel from the spent fuel pools to the common pool will employ existing or newly constructed on-site transportation containers.

If fuel is confirmed to be damaged, it will be placed in newly designed and manufactured storage drums, and then placed in on-site transportation containers for movement, so that it can be handled with the same level of safety as moving undamaged fuel.

[4] Ensure/ remodel space within the common pool

To ensure an area to receive and store the fuel removed from the spent fuel pools, the undamaged spent fuel currently stored in the common pool will be stored in dry casks and moved out of the common pool. New dry cask temporary storage equipment will be installed within the power station site as the destination for these dry casks. The dry cask temporary storage equipment will be a modular type with flexible storage capacity. For the time being, it will house the existing dry casks now stored in the cask repository, in addition to dry casks received from the common pool.

Also, as the fuel removed from the spent fuel pools may be damaged by, or encrusted with salt, the necessity of washing it will be considered, and equipment will be remodeled and added, such as by installing a dedicated storage location.

[5] Fuel removal from the spent fuel pools

A crane will be used to lower on-site transportation containers into the spent fuel pools in the reactor buildings, and fuel handling machinery will be used to move fuel from spent fuel racks into the on-site transportation containers. The crane will then lower on-site transportation containers to ground level, where a trailer will be used to move them from the reactor building to the common pool on the power station site.

The soundness of the fuel will be checked before it is placed in the on-site transportation containers, and any fuel that is confirmed to be damaged will be placed in the above-mentioned storage drums for transportation.

[6] Storage and management of removed fuel

In the common pool, pool cooling and purification systems will improve and maintain the purity and transparency of the water. Water in the transportation containers will be changed to avoid bringing water from the spent fuel pool, which was injected with sea water, into the common pool.

(3) Plan for Fuel Removal from the Spent Fuel Pool (schedule)

Removal of fuel from the spent fuel pool differs between units in aspects such as fallen rubble, damage to buildings, equipment and fuel etc., and dosage levels, so periods required for preparation and movement will also differ. Therefore, the plan will consider the state and characteristics of each unit, specific plans for later units will reflect knowledge and experience gained in earlier ones. Other than receiving the removed fuel, the common pool will be used in parallel for the inspection of existing dry casks, placement of fuel into dry casks and relocation, preparations for receiving removed fuel, and other diverse operations. Therefore, the plan will consider ensuring safety, reducing confusion between tasks, and faster working.

The plan for fuel removal from Units 1□4 will be considered and formulated to optimize the fuel removal process as a whole, with the focus on ensuring safety and removing fuel as early as possible. It will include cask manufacture, port restoration, and dry cask temporary storage equipment.

At Unit 4 as part of work to remove debris from the top of the reactor building ([1] above) a survey of the inside of the pool was conducted in March 2012 and the distribution of debris within the entire pool was confirmed. Based on this survey a plan for removing debris from the pool will be proposed. Furthermore, heavy machinery was used to remove building debris, such as the roof, pillars, and beams, from the top of the reactor building in July 2012.

In April 2012 work began to improve the ground for installation of a cover as part of work to construct a fool removal cover and installed fuel handling equipment ([2] above).

Furthermore, in July 2012 two new fuel assemblies were removed from the fuel pool in order to examine the state of corrosion of fuel within the spent fuel pool.

At Unit 3 as part of work related to debris removal from the top of the reactor building ([1] above) in April 2012 the inside of the pool was surveyed and the condition of debris and some fuel was confirmed. More surveys will be implemented in the future in accordance with the status of debris removal from the top of the reactor building. Furthermore, debris removal using remotely operated dismantling equipment is underway due to the high doses at the work area.

At Unit 2 robots have been used multiple times to perform a visual inspection (video) of the fifth floor of the reactor building and take radiation measurements.

At the common pool the function of temporary power equipment needed to handle fuel, partial recovery of the pool cooling and cleansing system needed to maintain water quality, and the ceiling frame for handling dry casks, etc., was confirmed.

Future plans (schedules) aim for the completion of work using heavy machinery out of the work to remove debris from the top of the Unit 4 reactor building by the middle of FY2012 ([1] above) and the continued removal of equipment from the fifth floor level of the reactor building.

The installation of a fuel removal cover and fuel handling equipment ([2] above) is proceeding with the goal of completing the covered by the middle of FY2013.

Furthermore, new fuel removed in order to examine the corrosion of fuel inside the spent fuel pools has been transported to the common pool where it is being stored, and will be subject to a corrosion examination as soon as preparations are made.

At Unit 3 work continues to remove debris and construct a work platform on which to place heavy machinery as part of work to remove debris from the top of the reactor building ([1] above), and the completion of debris removal is anticipated for the end of FY2012 since the conditions of fallen debris have not been confirmed sufficiently.

Furthermore, in preparation for the installation of the fuel removal cover and fuel handling equipment ([2] above) dose reduction countermeasures are being implemented in order to allow the smooth progression of work to come due to the high radiation levels on the fuel charging floor of Unit 3 , and the cover should be completed by the beginning of FY2014.

Meanwhile vessels for transportation on-site are being designed and manufactured ([3] above) with fuel handling equipment and on-site transportation vessels that can be operated remotely to be used for units with high radiation levels in work areas. Furthermore, in preparation for receiving removed at the common pool, equipment will be inspected/restored, and dry casks will be temporarily stored by the end of FY2012. Fuel handling equipment at the common pool is currently being inspected and restored. On-site construction preparations are being made for the installation of dry cask temporary storage facilities and after the facilities are ready spent fuel stored in the common pool will be stored in dry casks and transported to the dry cask temporary storage facility thereby providing sufficient open space to receive more removed fuel ([4] above).

The newly installed fuel handling equipment etc. will be used to remove rubble from inside the pools, the fuel will be investigated, and preparations will be made in the reactor buildings and the common pool. Once these are complete, fuel removal will begin ([5] above). The targets for the timing of the start of fuel removal will be within two years from the completion of Step 2 for Unit 4, which is scheduled to begin removal first, followed by Unit 3 within three years of the completion of Step 2. Knowledge and experience will be gathered from Units 3 and 4 concerning removal of rubble, the operability and faults of remote operation equipment, and investigation. The rubble will also be investigated, and then a specific plan for Unit 1 will be studied and formulated. For Unit 2, decontamination of the building interiors and use of shielding will be based on the establishment of remote decontamination technologies. Once it is possible to approach the fuel handling equipment, the equipment will be investigated, and then a specific plan for inspection, repair and fuel removal in Unit 2 will be studied and formulated. Fuel removal from Units 1 and 2 depends on conditions on the site, and other factors, but the aim is to start within Phase 2 (mid).

It is assumed, based on the envisaged future working environment, that removal of undamaged fuel in Unit 4 will employ the same equipment, working organization and procedures as in normal operation, taking around two years on that basis. If a normal environment can be produced in Unit 2, it would take around 1.5 years. If dosage is high in Units 1 and 3, fuel removal by remote operation would use newly-installed fuel handling equipment and transportation containers, necessitating detailed consideration in future, but the target is to take 2□3 years per unit. The working environment, the state of the fuel, and other factors will be checked in the future, and working organizations, procedures and times etc. will be considered in order to formulate specific plans. The aim is to complete removal of fuel from Units 1□4 by Phase 2 (late).

The issues listed below, which could impact the process, must be solved in order to realize fuel removal according to plan. The work will be implemented through collaboration and liaison between all those involved, with the highest priority on ensuring safety.

- Rubble removal

  Many aspects of rubble scattering and dosage levels etc. have yet to be confirmed, and it is possible that the work could be prolonged, or require additional tasks.

- Installation of covers for fuel removal

  There are still many uncertain factors, such as the condition of building damage, dosage levels, and the condition of underground structures that obstruct foundation construction, and it is possible that the work could be prolonged, or require additional tasks.

- Common pool restoration and removal of fuel from the common pool

  Equipment is being checked for the restoration of the common pool, and it is possible that unanticipated faults could occur or be discovered, necessitating repairs.

- Step by step handling up to the start of usage

  Equipment related to fuel removal will be approved through a process with the steps of [design-> manufacture-> installation-> start of operation], and the process will be created with the approval periods in mind.

- Confirmation of fuel soundness

  Effective confirmation methods and procedures etc. will be devised with working efficiency in mind.

- Removal of fuel from the pools

  If the proportion of damaged fuel is higher than anticipated, or the degree of damage is more severe, it is possible that the work could be prolonged, or require additional tasks.

  There is no experience of remote operation, and particularly of handling faults, inspection and repair, and the handling of physical distortion etc. of fuel through remote operation. The aim will be to improve equipment reliability and safety and make the work faster, and equipment and working procedures will be improved to reflect knowledge and experience gained on the earlier units.

(4) Research and development into the handling of fuel after removal

Fuel removed from the spent fuel pools will be stored in the common pool for the time being. At the same time, assessment of the long-term soundness of fuel, taking the effects of sea water into account, related countermeasures, and research and development on reprocessing. will be implemented. (See the separate “Research and Development Plan” for details).

(HP2-1): Determination of methods for reprocessing and storing spent fuel

- Future processing and storage methods for spent fuel removed from the spent fuel pools will be decided on the basis of assessment of its long-term soundness and the results of research and development into its reprocessing.

5-4. Fuel debris removal plan

(1) Present status

When the earthquake occurred, there were a total of 1,496 containers of fuel loaded into the reactor core at Units 1□3 (in operation at the time). The reactor cores at all Units are damaged. Consequently, the fuel inside the reactor became fuel debris, and it is surmised that a portion of that debris is flowing out from reactor pressure vessels and into PCVs.

The coolant that is still being injected into the reactor cores is flowing into the adjoining turbine and other buildings via the lower basement levels of the reactor buildings from the bottom of the PCVs, and coolant is currently leaking into both the reactor pressure vessels and PCVs.

At the current time, neither the status of the fuel debris nor the exact outflow locations are known.

(2) Overview of the fuel debris removal plan

Work that will be required before beginning fuel debris removal presents a number of technological challenges considering as this work will need to be carried out in high dosage conditions inside reactor buildings. Thus, deciding definitively on a specific course of action is difficult at the present time. It is believed that removing the fuel debris while underwater (as was done at TMI-2) due to the excellent radiation shielding afforded will be the most reliable method.

At TMI-2, filling the reactor pressure vessel was accomplished without difficulty. As is mentioned above, however, at Units 1□3 the coolant added to the reactors in their current state is currently leaking out of the PCVs. Thus, creating the necessary boundaries for water filling will be an important step in removing fuel debris.

Consideration was thus given to the workflow that would be required to allow the underwater removal of fuel debris. The resulting plan that we formulated is comprised of the below work steps (1) through (10) and 6 holding points. We also included at each work step the technological challenges and necessary research and development—for which will seek assistance with from the national government, nuclear plant manufacturers and research institutes—necessary to resolve them. Having received the agreement of the Japan Atomic Energy Commission Expert Group concerning the validity of this research and development, the necessary research and development began in FY2011.

<Work steps involved in fuel debris removal>

Attachment 3 shows the work steps involved in fuel debris removal. Details of work steps (1) through (10) are provided below. Multiple holding points have been created for each process based on the idea that future site conditions and the results of research and development will require review of the content provided below. Developmental achievements will be assessed at each step and applied to the next step wherever possible.

1. Decontamination of the inside of the reactor building

   Past inspections have identified rubble scattered about and the existence of areas of high dosage (several hundred to 1,000 mSv/h) inside reactor buildings. Decontamination work will thus be prioritized for the necessary areas inside buildings.

   Decontamination work will be performed by workers in areas of relatively low dosage and remote removal will be used for high-dosage areas.

   Thorough measures (shielding, work hour management, etc.) will therefore be taken to reduce exposure while workers perform their duties, and remote contamination inspection devices and other useful decontamination technologies (or the development of remote decontamination devices using such technologies) will be used—or serve as a basis for developing remote contamination devices—as dosage conditions require.

2. Inspections of leakages inside PCVs

Performing the underwater fuel debris removal will require repairing leaks in PCVs and filling them up with water. Before this, inspections will be conducted to identify PCV leakages.

Because leakages may be located in highly radioactive environments, under water and in narrow parts, technologies for remotely accessing these areas and detecting leakages will be developed and applied.

3. Reactor building water stop, and PCV lower parts repair

Leakages identified through the inspections described in 2 will be repaired, leakages between the reactor buildings and turbine buildings stopped, and boundaries set up for partial filling up of the lower parts of PCVs.

Because leakages may be located in highly radioactive environments, under water and in narrow parts, technologies for remotely accessing these areas, as well as technologies and methods for performing repairs, will be developed and applied.

Also, it will be necessary before stopping any leakages from reactor buildings to switch intake sources for circulating water cooling from under turbine buildings to under reactor buildings or the lower parts of PCVs, which will require downsizing circulating injection loops.

To prepare for filling up PCVs, evaluating structural strength and seismic resistance and performing the necessary reinforcements will also be required.

4. Partially filling up the PCVs

The lower parts of the PCVs will be filled up by continuously injecting them with water after making repairs to and stopping leakages in the PCVs, as per 3.

When doing this, because the cooling water flow rate around the fuel debris will change, due consideration will also need to be given to critical detection and prevention measures.

5. Inspections and samplings of the insides of the PCVs

After partially filling up the PCVs as per 4, workers will remotely access the insides of PCVs and ascertain fuel debris distributions and characteristics by performing thorough inspections and sampling..

Because the insides of PCVs are highly radioactive and we presume the contaminated water inside is murky, remote inspection technologies and jigs will developed and used.

6. Repairs to the upper parts of PCVs

After performing inspections as per 5, workers will repair the upper parts of PCVs in an effort to raise water levels inside these PCVs.

Repair equipment utilizing remote repair technologies will also be developed here.

7. Filling up PCVs and reactor pressure vessels

After repairing the upper parts of PCVs as per 6., workers will fill up reactor pressure vessels and PCVs with consideration for critical detection and prevention measures.

After the above water filling procedures are completed, thorough safety checks for radioactive substance emissions and radioactive environments will be performed. Workers will then open the upper lids on PCVs and reactor pressure vessels and remove the steam separators and moisture separators, which are structures on the upper part of reactor pressure vessels.

Before starting the process of opening the upper lids, workers will install reactor building containers (or modify the covers) to create confined spaces. Because these reactor building container (or modified cover) structures will need to conform to fuel debris removal methods and equipment, further consideration will be made while assessing research and development progress.

8. Reactor core inspections and sampling

After completing the PCV and reactor pressure vessel opening procedures as per 7. above, workers will set up work cars for working on the upper parts of these vessels and ascertain the distributions and characteristics of fuel debris by performing inspections and samplings of the insides of reactor pressure vessels.

Because the insides of PCVs are highly radioactive and we presume the contaminated water inside is murky, remote inspection technologies and jigs will need to be developed and used.

9. Fuel debris removal technology preparation, and removal work

Workers will perform fuel debris removal with regard for critical detection and prevention measures using work carts, as per 8. After storing the removed fuel debris in special canisters, workers will transport them to a specified location.

As the removal work will likely entail a variety of processes including crashing, holding, vacuuming, etc. the fuel debris, methods, equipment, and jigs for performing this work remotely will be developed and used.

10. Safe storage, processing, and disposal of removed fuel debris

Because seawater was pumped into the core for a short time at Units 1□3, it is assumed that the fuel debris will be highly saline. Thus, in addition to the normal requirement specifications concerning cooling functions, sealing functions, etc., fuel debris will be stored in storage canisters developed to resist corrosion caused by salt. The canisters will then be removed and, for the time being, safely stored in suitable storage facilities.

(3) Research and development to facilitate the above

We will work with the support of and collaboration with the national government, industry, and research institutes in conducting the research and development mentioned in 1 through 10 above. These research and development efforts will be conducted as per the schedule in Chapter 4, and we will try to move schedules forward as much as possible. Along with research and development, we will also be making preparations for work using any machinery developed, as the case may be. (See Supplementary Document 1: "Research and Development Plan" for more details)

- Shared platform technology development

  Given the high-dosage environments present inside reactor buildings, it will be necessary to develop and use robots and other remote-control technologies to perform various kinds of work such as decontamination, inspections, and repair work to remove fuel debris from inside these buildings.

  As these remote-control technologies will need to be usable with in a number of different work processes performed inside reactor buildings, we will clarify what is required for each process and identify the kind of shared platform (shared elemental technologies, basic technologies, etc.) that will be needed and then developing them with an eye to modularizing and standardizing them.

- Consideration of alternative policy

  The development of methods for repairing PCVs will be a necessary step in the process of removing fuel debris, and we suppose there will be major technological difficulties involved. We therefore suppose difficulties will be encountered in the development of repair technologies based on the results of inspections of PCV leakages, and will be moving forward with the development of repair methods as we look at alternative methods along the way.

- Maintaining the structural integrity of reactor pressure vessels and PCVs

  Maintaining the structural integrity of reactor pressure vessels and PCVs will be extremely vital to performing the proper removal of fuel debris. Currently, to prevent the corrosion of reactor pressure vessels and PCVs, we are conducting water quality management measures including the inhibition of chloride ion concentrations and deaeration (dissolved oxygen reduction via nitrogen bubbling) of the treated water being pumped in. We will also gather data from various assessments and examine anticorrosion measures aimed at ensuring the long-term integrity of the reactor pressure vessels and PCVs.

(4) Fuel debris removal schedule

Looking at TMI-2 as a point of reference, the Japan Atomic Energy Commission Expert Group has established the goal of beginning fuel debris removal within 10 years. Based on the fact that both ministers have instructed this same goal to be met, we will be conducting the necessary research and development to begin fuel debris removal for the first Unit within 10 years (beginning with the completion of step 2).

We surmise that all removal procedures for all Units will be completed in 20 to 25 years' time (10 to 15 years for removal). This is due to the fact that fuel debris distribution here is much broader in comparison to TMI-2, as evidenced by such phenomena as fuel debris having fallen into even PCVs.

To achieve this goal, we will be working in collaboration with the national government, industry, and research institutes in research and development, the results of which we will apply and use to complete plant work. However, based on the fact that site conditions are unknown and that there are many uncertainties concerning the development of repair technologies for leakages, we will be making revisions to the removal plan to ensure it is always optimal. As far as work processes, we have established several holding points and, in addition to applying the necessary development results achieved up to that point, we will be taking into consideration related site work conditions, the status of preparations regarding work processes and safety equipment aimed at the next step, progress made with regulatory procedures, etc.

Concerning the decontamination of reactor buildings, we will begin with areas of relatively light contamination as determined by current technologies and, by effectively combining remote contamination removal technologies that are developed along the way, remove contamination in stages from highly contaminated areas. Through these efforts, we will enable the areas around PCVs (the lower parts in particular) to be accessed by the end of FY2014.

We are also aiming for a full scale start to internal inspections performed from outside PCVs and inspections of leakages in PCVs by the end of FY2014 depending on the results of the above decontamination and onsite conditions.

Robots have been used to survey the extent of decontamination (dose rate and radiation source survey) inside the Unit1～3 reactor buildings and multiple decontamination samples were taken in accordance with the form of decontamination.

There are plans to select suitable decontamination technology and develop remotely operated devices based on these survey/analysis results.

In regard to leak point surveys, in Unit 1 a CCD camera was used to confirm accumulated water conditions in the basement of the reactor building, and at Unit 2 and 3 an existing remotely operated robot was used to confirm conditions in the basement of the reactor buildings to the extent possible.

Future surveys of mainly the torus will be conducted using robots and measurements devices that can be used.

For example, there are plans to survey the inside of the torus, which is difficult to access, by inserting measurement devices through openings in the floor of the first floor of the reactor building, and inserting a submersible robot.

Furthermore, deliberation of possible leak points continues and there are plans to survey these possible leak points and develop survey devices for identifying leak points.

(HP3-1): Determining methods for repairing lower parts of PCV, determining water stop methods

- Through inspections of PCV leakages, we will identify leaks and conditions present in the lower parts of PCVs and building basement levels and verify that the development of the methods and equipment required to repair these parts has been completed. At the same time, we will verify the extent to which these technologies can be used, and that circulating coolant can be removed from these areas, etc. before determining when to begin repair work (water cutoff) in these areas.
- At this time, we will also decide the Unit order for the repair of these parts based on the locations of leakages, which will allow us to conduct primary evaluations of Unit order for the removal of fuel debris.

(HP3-2): Completion of flooding of lower parts of PCV, determining PCV internal investigation methods

- In determining when to begin internal inspections of PCVs, we will first verify that both the repair of any leakages present in the lower parts of the PCVs and the filling of these vessels have been completed, and that internal inspection methods and the development of any necessary equipment has been completed.

(HP3-3): Determining methods to repair upper parts of PCV

- Once the areas requiring repair in these parts are identified as and we verify that the development of the necessary methods and equipment has been completed, we will determine when to begin repair work on the upper parts of the PCVs.
- Depending on research and development progress and on site conditions and number of personnel required, it may be possible to perform these repairs in tandem with repairs to the bottom parts of PCVs.

(HP3-4): Completion of flooding of upper parts of PCV, determining RPV internal investigation methods

- In determining when to begin the opening of the top lids on RPVs and reactor inspections, we will first verify that water has been pumped in up to the upper parts of PCVs (including the reactor pressure vessels), that reactor building containers have been created or covers modified to create confined spaces, and that the development of methods and equipment for inspecting reactors has been completed.

(HP3-5) Determining fuel debris removal methods and completion of preparation of fuel debris containers, etc.

(Target : to accomplish within 10 years from the completion of step 2)

- In determining when to begin fuel debris removal, we will first look at the results of internal inspections of PCVs and reactor pressure vessels to verify that the development of fuel debris removal methods and equipment, as well as storage containers (storage canisters) needed for removal, has been completed and that there are places to store the removed fuel debris.

(HP3-6) Determining processing / disposal methods of fuel debris

- We will act in conformity with any related research and development and national policy in devising methods for the future processing and disposal of removed fuel debris.

(*) We will continuously refer to the below holding points and make revisions as necessary concerning Unit priority for fuel debris removal established in HP3-1.

5-5. Plan for Disassembly of Reactor Facilities and Processing and Disposal of Radioactive Waste

(1) Plan for disassembly of reactor facilities

1. Outline

With regard to the disassembly of Units 1-4, following the removal of fuel from the spent fuel pools and fuel debris from the reactor cores, it will be necessary to proceed on the basis of a plan for the disassembly of the reactor facilities that takes into consideration factors including the projected type and quantity of radioactive waste, the impact on the environment (including the general public), the risk of exposure for workers, the work methods and procedures applied, and the prospects for disposal of the waste.

Given this, in line with the status of progress in decontamination of buildings, the surveying of reactor pressure vessels and PCVs, the removal of fuel debris and other work, from this point onwards we will collect the necessary data for the formulation of a decommissioning plan, encompassing factors including the state of radioactive contamination of buildings and equipment (including evaluation of the degree of migration of radioactive substances due to the buildup of high-level contaminated water in reactor buildings, turbine buildings, main process buildings, etc.) and the amount of fuel debris remaining in the reactor pressure vessels and PCVs, in addition to conducting the research and development necessary for the development of technologies including remote disassembly technologies and technologies for the decontamination and reduction in volume of concrete and metal.

Based on the standard procedural schedule examined in accordance with the system of allowances for disassembly of nuclear facilities, a period of approximately 15 years is projected for disassembly of reactor facilities. The first 10 years of this standard procedural schedule is devoted to waiting for the decay of radioactive substances in order to minimize the dose to which workers will be exposed, in addition to the commencement of disassembly of the turbine buildings and other comparatively lightly contaminated areas. The final five years sees the commencement of disassembly of the reactor cores.

It will be essential to determine the disassembly method to be employed in the present case with consideration of the fact that due to the effects of the tsunami disaster it is highly possible that the disassembly of the reactor facilities of Fukushima Daiichi Nuclear Power Station Units 1□4 will differ from normal reactor disassembly procedures in terms of the type and amount of radioactive waste products involved. In addition, prior to commencement of disassembly procedures for the reactor facilities, it will be important to upgrade technological standards and establish a firm outlook for the disposal of the waste products produced by the disassembly. The government and TEPCO will cooperate in these areas.

Based on the above, a target of 30□40 years has been set for the completion of the disassembly of the reactor facilities of Fukushima Daiichi Nuclear Power Station Units 1□4. Work will proceed with consideration of the points listed below. The disassembly work will commence from Unit 4, in which there is no fuel debris in the reactor core.

2. Schedule for disassembly of reactor facilities

Items that should be included in the fundamental database are being deliberated in preparation for disassembly (~FY2012)

(HP4-1) Determination of method of disassembly and decontamination. Formulation of standards for disposal of waste products from disassembly

It is predicted that the type and quantity of radioactive waste products produced by the disassembly will differ from the case of a normal nuclear plant due to the effects of the tsunami disaster. Given this, the design and manufacture of the necessary devices and equipment will commence following verification of the completion of a review of standards for waste disposal, a research and development program for decontamination and reduction of the volume of waste produced, and the development of a method of disassembly that reduces exposure during the course of the work, in response to the type of radioactive substances which will be encountered.

(HP4-2) Formulation of outlook for disposal of waste generated from disassembly. Completion of necessary research and development

Disassembly procedures will be commenced when a firm outlook for disposal of the waste products from the procedures has been obtained.

(2) Radioactive Waste Processing and Disposal Plan

1. Outline

Basic guideline: Depending on the characteristics of the radioactive waste (the radionuclides it contains and its level of radioactivity), it will be subject to processing and disposal, such as being sealed in containers and encased in concrete to form blocks of waste (hereinafter referred to as, "Processing") and transported to a waste disposal site and buried (hereinafter referred to as "disposal").

The waste products produced following the tsunami disaster differ from the waste products conventionally produced by nuclear reactors in a variety of characteristics, including the fact that radionuclides originating in damaged fuel are adhering to them and they contain high quantities of salt, which will have a negative impact on the performance of the disposal sites.

Because of this, realizing the Processing and disposal of the waste will necessitate the implementation of research and development based on adequate analysis and understanding of the characteristics of the waste and the determination of a firm outlook for its safe Processing and disposal.

Safety regulations and technological standards for the Processing and disposal of the waste will be clarified via a determination of the outlook for safety and a process of examination of the necessary systemic measures.

To make it possible to install Processing equipment in the power station and commence the production of blocks of waste for transportation to the disposal sites following this process, for the present waste will continue to be stored after sorting to ensure that it does not impede the future Processing and disposal procedures. The research and development necessary for the Processing and disposal of the waste will be conducted on the basis of collaboration between the national government, TEPCO, related industries and research organizations. (For details, see "Research and Development Plan" in Supplement 1)

2. Schedule for Processing and disposal of radioactive waste

As part of deliberations on the long-term storage and waste bundling of secondary waste from water processing attribute tests, such as form surveys conducted through performing heating tests and solidification tests using simulated waste, are being conducted. (～FY2013).

In order to calculate the concentration of radioactivity of radionuclides contained in the waste, which is important for disposal, accumulated water and debris continues to be analyzed.

Analysis of accumulated water started in FY2011 and analysis of debris started in FY2012. In addition, development of analysis technology not yet established for radionuclides, which are difficult to measure, has begun.

A Research and Development Plan towards the Processing and disposal of radioactive waste will be formulated in FY2012, when it is projected that the removal of the debris from the reactor buildings of Units 3 and 4 will have been completed.

In addition, because it will be necessary to proceed in stages, revising the outlook for safety based on the outcomes of research and development, the following points for judgment have been established based on the process of review concerning the disposal of radioactive waste which has been employed in Japan up to the present.

(HP5-1): Verification of applicability of existing concept of disposal to characteristics of radioactive waste

- The applicability of the adopted concept of waste disposal will be verified based on the results of research on the characteristics of the waste.
- Given that there is a possibility that it may be difficult to apply the existing concept of waste disposal to some of the waste (for example, waste with a high salt content), as necessary, new methods of Processing and disposal (construction of artificial barriers, etc.) will be examined, research and development plans will be formulated, and research will be commenced.

(HP5-2): Verification of safety of waste Processing and disposal

- The prospects for safe Processing and disposal of the waste products, etc. resulting from the tsunami disaster, will be verified based on technological viability. In addition, the information necessary for the creation of a framework for a safety system for waste Processing and disposal will be compiled.
- It is predicted that new data will be obtained concerning the characteristics of the waste products as the removal of fuel debris and disassembly work proceed. In addition, it is also possible that new waste products will be produced in the process of decontamination during the work. Given this, research will be continued as necessary in order to increase the safety of waste Processing and disposal.

(HP5-3): Determination of specifications and method of manufacture of blocks of waste

- Based on the results of research and development in relation to the Processing and disposal of radioactive waste, as necessary, the system of regulations will be revised, and the necessary conditions for Processing and disposal (specifications of blocks of waste, essential site requirements for disposal sites, design requirements for disposal sites) will be clarified.
- The specifications and method of manufacture of blocks of waste will be determined based on the above conditions.

(HP5-4): Installation of equipment for manufacture of blocks of waste and prospects for waste disposal

- The manufacture and shipment of blocks of waste will be commenced when the installation of equipment for their manufacture has been completed and firm prospects for disposal have been confirmed.

6. Establishment of Systems and Optimization of Environments for Facilitation of Work to be Performed at Fukushima Daiichi Nuclear Power Station

It is predicted that even from the first stage of the disassembly work, operations will be conducted in numerous environments with a high level of radioactive contamination. Against this background, it will be necessary to secure personnel over the long-term, while ensuring the safety of employees by limiting exposure to 100 mSv/5 years and maintaining the system of cooperation between TEPCO and its contractors, as has been the case up to the present.

This section will deal with the formulation of a Personnel Plan based on the necessary work procedures to be conducted and total potential exposure as projected at present and the evaluation of the feasibility of this plan, in addition to a Safety Plan for onsite operations which encompasses measures to increase the motivation of personnel and guidelines for the management of radioactivity.

6-1. TEPCO System of Implementation in relation to Mid-and-long-term Initiatives

Tokyo Electric Power Company established a full-time dedicated organization called the "Fukushima Daiichi Countermeasure Project Team" in February 2012 at its headquarters in order to ensure that mid-and-long-term initiatives proceed steadily.

This organization will cooperate with the Fukushima Daiichi Stabilization Center, which is responsible for overseeing operations at the site, and the Fukushima Daiichi Nuclear Power Station, in activities including the formulation of basic guidelines for mid-and-long-term initiatives, and the management and design of the overall project and the obtaining of the relevant permissions.

Taking familiarity with the site and experience in proceeding to Step 2 into consideration, the system for the realization of mid-and-long-term initiatives will involve Tokyo Electric Power Company and approximately 400 contractors, and work will proceed according to the system of implementation used up to the present for site operations of the same type.

A dedicated system for integrated exposure and health management for workers of TEPCO and other companies called the "Nuclear Health and Safety Center" was established in TEPCO's headquarters in February 2012. The center engages in such activities as offering health consultations and examinations in response to exposure levels.

The center will continue to manage the health of workers after finishing radiation work and workers that are no longer on duty over the long-term in accordance with exposure dose.

6-2. TEPCO Personnel Plan in relation to Mid-and-long-term Initiatives

(1) Personnel Plan and feasibility of Plan

TEPCO has projected the number of personnel required for work scheduled for the next five years* and the cumulative exposure of those personnel, and has verified the feasibility of its Personnel Plan.

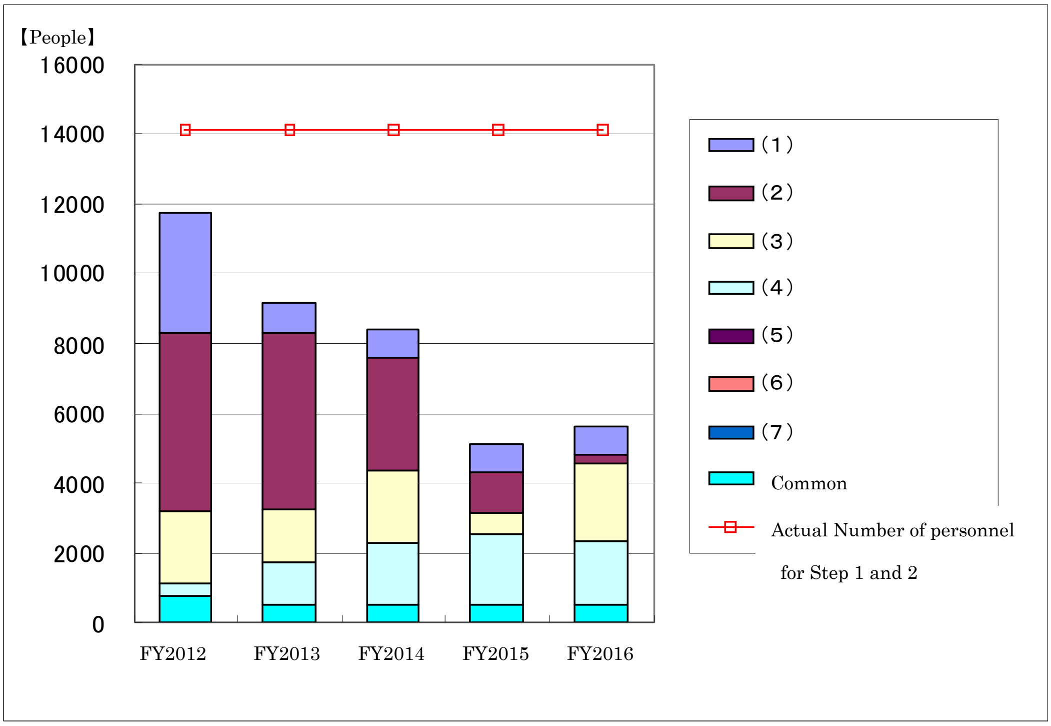
*: Based on factors including the accuracy of the outlook for the work to be performed and a limit of 100 mSv/5 years for exposure management, the

projected period for the Personnel Plan was set at five years.

1. Essential number of workers and projected level of exposure

Taking the figure of 100 mSv/5 years into consideration, it is projected that the following numbers of workers will be required to ensure an annual level of exposure per person of 20 mSv or less (excepting certain operations entailing a higher level of exposure*).

*: Operations including increasing the reliability of the processing facilities for accumulated water and reducing the loops are expected to involve exposure to levels of 40 mSv.



(1) Plan for Maintaining Plant in an Ongoing Stable State
(Improvement of reliability of circulating water cooling system, etc.)

(2) Plan to Reduce Radioactive Dosage in the Power Station as a Whole, and to Mitigate Sea Water Contamination
(Construction of shielding walls, etc.)

(3) Plan for Fuel Removal from Spent Fuel Pools
(Fuel removal, etc.)

(4) Fuel Debris Removal Plan
(Stopping inter-building water leakage, etc.)

(5) Plan for Disassembly of Reactor Facilities and Processing and Disposal of Radioactive Waste

(6) System of Implementation/Personnel Plan

(7) Plan for Ensuring Work Safety

Common // Actual number of personnel for Steps 1 and 2

Note): This plan is based on provisional calculations performed within the scope that can presently be projected. The number of required personnel may increase or decrease in future based on changes in circumstances, for example if further procedures come to be deemed necessary as onsite surveys proceed.

Note): The actual number of personnel for Steps 1 and 2 is the number of employees of TEPCO and major companies engaged in operations at TEPCO's Fukushima Daiichi Nuclear Power Station during the relevant period (aggregated from March to November).

The actual number of personnel involved in Steps 1 and 2 was approximately 14,100, and it is projected that it will be possible to secure at least this number of personnel in the future. The required number of personnel for the first five years based on current projections (Maximum: Approximately 11,700 for the first year) is lower than that figure, and it is therefore predicted that there will be no impediment to onsite operations due to a shortage of personnel.

Since January 2012 the number of secured personnel and the local employment rate have been checked monthly and field work has not been hindered by a lack of personnel. Furthermore, in order to suppress per capita exposure doses many workers are being used. The final numbers for 2012 will most likely exceed the personnel plan (approx. 11,700 workers). As of May 2012 there were approx. 24,300 workers registered to work at the Fukushima Daiichi Nuclear Power Station and it does not appear that there will be a worker shortage. Furthermore, we continue to secure workers while considering local employment and are maintaining a local employment rate of over 60%.

From 2017 onwards, in addition to continuous work for the processing of accumulated water, etc., major operations for the placing of the reactor building containers and the removal of fuel debris will be due to commence. It is therefore predicted that in the future also it will be necessary to secure a constant number of personnel, and we will continue to work to secure these personnel with consideration of employment in the local region.

2. Future initiatives to secure personnel

From 1, the actual number of personnel involved in Steps 1 and 2 exceeded the number of personnel that will be required for operations in the future, but the following initiatives have been implemented and will continue in order to increase the certainty of securing personnel.

- Allocation of personnel based on predicted dose
  Personnel will be allocated in a planned manner based on advance predictions of the individual dose for personnel engaged in specific procedures.
- Systematic training of personnel
  Training will be essential for particularly specialized operations, and training of personnel will therefore be carried out in a systematic manner.

－For processing of water

TEPCO will be introducing water processing equipment for the first time, and the processing system is complex. Given this, prior to the allocation of personnel, theoretical training will be provided concerning elements including the design of equipment and the positioning of devices, and hands-on training will be provided concerning the operation and maintenance of transport and processing equipment, etc.

—Radiation control

Education and training programs conducted for employees of TEPCO and contractors to foster personnel engaged in radiation measurements have continued since Step 1 and Step 2. We will continue to foster radiation measurement personnel in a planned manner.

- Measures for further reduction of exposure

  In addition to continuing measures such as the employment of shielding equipment and avoidance of areas of high radioactivity, we will engage in the development of equipment enabling procedures to be performed remotely and will ensure further decontamination of work areas.

- In order to increase the accuracy of the Personnel Plan, we will revise the plan on an annual basis.

(2) Measures to increase motivation

To enable TEPCO and its contractors to continue the decommissioning work into the future, conditions will be improved as follows to ensure that personnel are able to work with peace of mind.

- Improvement of meals

  — We will continue to examine possibilities for the diversification of the food menu and the improvement of the nutritional balance provided by meals.

  — In June 2012 the cafeteria at the Fukushima Daini NPS was reopened thereby allowing hot meals to be offered

. • Improvement of environments

—Measures are being taken to reduce doses at rest areas in the main building and the seismic-isolated building, which are focal points of worker activity.

— A portion of the seismic-isolated building where workers reside for long periods while awaiting instructions was deemed as a non-controlled area on May 1, 2012.

—Corporate buildings will be gradually restored to secure office space in accordance with contractor needs.

— We will continue to establish rest areas in accordance with changes in the scale of the work or the areas in which it is being conducted.

— Suitable protective equipment will be determined in accordance with the environment and, for example, areas in which a mask is not required will be enlarged..

— Continuing efforts will be made to improve the working environment, for example by increasing working space and offering increased benefits.

- Monitoring of effects of improvements
  - In order to verify the effects of the improvements above, in addition to the improvements in health management discussed in 6-3(3), effects will be periodically monitored via twice-yearly questionnaires and other measures, and further improvements will be made as necessary.

6-3. Plan for Ensuring Work Safety

Work safety management and radiation management are important elements in ensuring workers' safety and maintaining their health.

Guaranteeing safety is a prerequisite for our future mid-and-long-term initiatives. Complex operations which diverge from standard procedures will be ongoing in future, and all personnel involved will share a strong awareness of safety which stresses care in avoiding major accidents and excessive exposure, and will conduct the activities described below. In addition, we will conduct constant checks in an attempt to make continuous improvements to operations.

(1) Overall work safety

Following the tsunami disaster, up to the present we have been forced to respond to working environments and types of operations for which we had no previous experience, and this has seen us conducting advance evaluations of safety, share information and enhance cooperation with contractors, establish rest areas, and adopt measures for heat exhaustion.

Complex operations which diverge from standard procedures will be ongoing in future, and we will therefore place an emphasis on the following four items in order to prioritize safety.

- Continuous safety activities
  - To ensure safety in work operations, we will conduct continuous advance examinations of work methods, safety measures, safety education, and the effect of the work on other equipment. In particular, work that will be conducted under special conditions, and work that involves the introduction of new technologies or new methods, will be subject to deliberations by the (in-house) Advance Safety Evaluation Committee, and safety patrols and monitoring devices will be employed to check on the status of the work, in an attempt to improve safety initiatives.
- Cooperation with contractors
  - We will continue to hold safety liaison meetings with contractors working within the site (once weekly), sharing information concerning safety in order to increase safety awareness among personnel.
  - In response to the misuse of alarm personal dosimeters (APD) by some employees rules of use shall be disseminated through an intranet bulletin board that contractors can view and strict adherence to these rules will be demanded.
  - We will also attempt to improve working environments in order to facilitate communication.
- Maintenance and expansion of rest areas

- In addition to appropriately maintaining the rest areas that we established from the stage of Step 1 and the facilities provided in these areas, we will examine the conditions for the establishment of rest areas which come to be required in response to changes such as changes in the scale of the work or the areas in which it is being conducted.

・ Prevention of heat exhaustion

- In areas in which there is concern over the possibility of heat exhaustion, we will monitor the environment using Wet-Globe Bulb temperature (WBGT) devices[9], encourage reductions in working hours and increased fluid intake, and provide cooling vests, among other measures for the prevention of the condition. We will also educate personnel about ways to prevent heat exhaustion.

－Education concerning preventing heat exhaustion was implemented (April) － Measurements are taken with WBGT and the results are displayed on an illuminated display panel. Also, reminders about heat exhaustion are continually given by posting daily WBGT forecasts on internal bulletin boards. － Reminders about shortening work times and hydration are given every week during the Safety Promotion Update －Additional equipment, such as cool vests, were obtained (200 additional vests for a total of 800). － Coveralls that breathe better than conventional coveralls were distributed in the field at the end of June 2012.

(2) Radiation management

・ Establishment of entrance and exit points

- As the result of an increase in the level of radioactivity due to the large-scale release of radioactive substances, values for doses originating in external doses, the concentration of radioactive substances in the atmosphere, and the density of radioactive substances on contaminated wall surfaces in monitored areas exceed values for controlled areas. Because of this, at present monitored areas are being considered as areas subject to controls, requiring the same level of management as controlled areas.

  －At present time, management of entry/exit into controlled areas (screening, and wearing of protective clothing and dosimeters) is conducted at areas removed from the controlled area, but by the end of FY2012 an entry/exit management facility will be constructed at the main gate of Fukushima Daiichi NPS in order to abide by revisions made to caution area and evacuation area demarcations.

[9] Instrument for measuring indicators that detect humidity, radiant heat, and temperature, the three elements that have the largest impact on human heat balance.

－In April 2012 trial operation of a vehicle screening and decontamination facility began at Fukushima Daiichi NPS within a caution area.

－In conjunction with caution area demarcation revisions, this vehicle screening and decontamination function shall be relocated.

・ Expansion of continuous monitoring of work environments

 － Area monitoring of radiation in existing buildings is not presently functioning. However, because the frequency of entry to the buildings is low and the areas in question are limited, we are presently working to detect any abnormalities by having employees themselves measure radioactivity in the vicinity of these areas.

 － This means that in the case of work in areas subject to control, in an attempt to reduce the dose to which employees are exposed to the lowest reasonably achievable level, as necessary workers take measurements of the dose equivalent rate for external radiation and the concentration of radioactive substances in the air prior to and during the work procedures, and perform the work after identifying the procedures for which the dose is highest.

 － In future, taking the frequency of entry and the expansion of areas into consideration, we will proceed with studies to enable us, as necessary, to make the transition to management using conventional area radiation monitors. In addition, with regard to outdoor areas and buildings which have been established since the tsunami, we will position area radiation monitors in areas which personnel are using for the purposes of equipment operation, monitoring, inspection, etc., and we will conduct continuous monitoring of radiation levels to enable us to understand the status of radiation environments and share information concerning protection from exposure.

・ Ensuring individual radiation control

－ In May 2012, in addition to increasing the reliability of data management, including integrated management of issuance of dosimeters and management of individual dose histories, a system for managing data including external dose data, the results of internal dose measurements and dates of examinations for effects of ionizing radiation to enable systematic provision of whole body counts (WBC)[10] (incorporating the rationalization of evaluation frequency in line with the improvement of working environments) and management of the due dates for health checks was created.

 － In response to the misuse of alarm pocket dosimeters (APD) by some employees an assessment of the impact on radiation control and recurrence prevention measures will be implemented. Furthermore, employees will continue to be asked to strictly abide by the current radiation control rules.

[10] Instrument for measuring personal internal exposure and whole-body radioactivity by measuring radioactive materials ingested in the body from outside the body.

— Going forward in order to strictly abide by normal dose limits (50mSv/year, 100mSv/5 years) and dose limits for emergency work (100mSv/emergency, 100mSv/5 years) external and internal exposure assessments will be conducted without fail as all efforts are made to control radiation.

・ Examination and implementation of measures for reduction of dose optimized for individual work operations

The following measures were taken to reduce exposure. These efforts will continue in the future.

— Attempting to reduce the dose to which employees are exposed to the lowest reasonably achievable level, for the performance of individual work operations, essential conditions such as the need for protective clothing and equipment, the number of personnel involved, and time limitations will be decided in advance in response to the working environment, and rational work plans will be formulated and implemented taking the individual exposure history of the employees who will be performing radiation-related duties into consideration.

— In order to enable the determination of the abovementioned essential conditions for work plans, advance training in work operations and the use of robots will be considered.

・ Adjustment of protective equipment

— As all efforts are made to manage exposure such as by assessing the concentration of radioactive materials in the air, protective equipment will be adjusted so as to reduce the burden on workers and improve ease-of-work.

Full face masks are no longer required when moving between the seismic-isolated building, corporate center and welfare building and the main gate in consideration of the radiation environment inside the buildings. Also, changes have been made to the protective clothing required when moving in specific vehicles (from coveralls to regular work clothes) and to the filters in full face masks.

Going forward in conjunction with monitoring and evaluating the level of concentration of radioactive material in the air and decontaminating the site the area in which full face masks are not required will be gradually expanded.

(3) Health management

・ Ongoing provision of healthcare system

— Until local healthcare services recover a fixed level of function, a healthcare system will be provided on a continuing basis at the Fukushima Daiichi Nuclear Power Station, the Fukushima Daini Nuclear Power Station, and J-Village in terms of personnel safety and security. Specifically, healthcare personnel including physicians will be allocated as necessary, and the necessary equipment, devices and pharmaceuticals will continue to be procured. In addition, a system for transportation to external medical facilities will be maintained. Operational improvements will also be made constantly to ensure the optimum quality of healthcare and rapid transportation.

- Implementation of long-term health management
  - Based on "Guidelines for the protection of the health of emergency workers at the Fukushima Daiichi Nuclear Power Station" published on October 11, 2011 by the Ministry of Health, Labour and Welfare, we will institute long-term health management measures for emergency workers after engaging in radiation work and after leaving duty. In addition to operating a health consultation center, we will provide extensive support for health checkups including cancer screenings. This support will also be provided for the employees of companies which are cooperating in the work on the site.

7. Cooperation with the International Community

Viewing transparency in relation to the international community as an issue of the greatest importance, the Nuclear Emergency Response Headquarters has made available the information it has obtained rapidly and accurately, providing "Additional Report of the Japanese Government to the IAEA –The accident at TEPCO's Fukushima Nuclear Power Stations-"reports concerning the status of the accident at the Fukushima Daiichi Nuclear Power Station to the International Atomic Energy Agency in June and September, 2011.

It is essential to bring together knowledge from all sources in responding to the Fukushima accident. Therefore, in March 2012, with the cooperation of OECD/NEA and the IAEA, an international symposium on R&D plans aimed at developing decommissioning devices was held. Furthermore, a "Technical Catalog" was created to recruit engineering "seeds" from both domestically and overseas that should be employed by the aforementioned R&D projects. From the initial stage of the decommissioning work, we will continue to proceed on the basis of cooperation with the governments of other countries and international organizations.

In order to conduct the research and development necessary to a large-scale and long-term reactor decommissioning project effectively and efficiently, we will make extensive use of knowledge and experience gained from responses to overseas accidents and other sources, in addition to enhancing cooperation with overseas government-affiliated research organizations and private companies.

8. System of Implementation for Mid-and-long-term Initiatives

Since the accident, the government and Tokyo Electric Power Company have formulated the "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO", and cooperated in regard to recovery initiatives while revising the Roadmap as necessary in response to the status of progress.

In implementing the new Roadmap, it is essential that the government and Tokyo Electric Power Company once again establish a strong cooperative system, ensuring transparency and securing the understanding of local residents and the broader Japanese public while proceeding steadily with efforts towards the decommissioning of the reactors on the basis of technological knowledge in a broad range of fields sourced both domestically and internationally. To this end, with the completion of Step 2, Government-TEPCO Integrated Response Office been disbanded, and Government and TEPCO's Mid-to-Long Term Countermeasure Conference has been created under the Nuclear Emergency Response Headquarters in order to formulate and supervise the implementation of this Roadmap. Furthermore, under the supervision of this conference "Operation Meetings" and "R&D Promotion Headquarters" meetings are held approximately once a month in order to manage progress by sharing and confirming information regarding implementation.

In addition, because essential research and development in relation to the examination and implementation of mid-and-long-term measures towards the decommissioning of the reactors faces numerous complex issues which are unprecedented on a global scale, it will be necessary to gain knowledge from domestic and overseas sources. In order to do this the best system for addressing these issues that have arisen will be constructed and the mechanism for promoting R&D will be further enhanced, including the establishment of R&D focal points.

9. Conclusion

Seeking to ensure the earliest possible return for local residents displaced by the accident to the Fukushima Daiichi Nuclear Power Station and to alleviate the anxiety felt both in this region and across the nation, Tokyo Electric Power Company, the Agency for Natural Resources and Energy, and the Nuclear and Industrial Safety Agency intend to commence mid-and-long-term work towards the decommissioning of Fukushima Daiichi Nuclear Power Station Units 1□4 on the basis of this Roadmap, under an appropriate cooperative framework.

At the same time, based on factors including the conditions at the site and the outcomes of research and development, Tokyo Electric Power Company, the Agency for Natural Resources and Energy, and the Nuclear and Industrial Safety Agency will periodically revise this plan, and will ensure transparency by announcing the status of mid-and-long-term initiatives.

This Roadmap compiles details of technological procedures related to decommissioning work, essential research and development, etc. No estimates of costs were made in the process of their examination.

The functions of the Nuclear and Industrial Safety Agency will be transferred to the Nuclear Regulatory Committee to be established in the future that will take on the responsibility for this Roadmap and its purport.

<Attached materials>

Attachment 1-1: Main Schedule of Mid-and-long-term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station Units 1-4, TEPCO

Attachment 1-2: Mid-term Schedule

Attachment 2: Reliability Improvement Countermeasure List

Attachment 3: Procedural Steps for the Removal of Fuel from the Spent Fuel Pools

Attachment 4: Procedural Steps for the Removal of Fuel Debris

<Supplementary materials>

Supplement 1: Concerning the Research and Development Plan related to the Decommissioning of Fukushima Daiichi Nuclear Power Station Units 1-4, TEPCO