# Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station

Information about when each measure and action will begin and end will be added later upon further consideration.

## September 26, 2017

## the Inter-Ministerial Council for Contaminated Water and Decommissioning Issues

Contents

# 1. Introduction

In regard to Tokyo Electric Power Company Holdings, Incorporated's (TEPCO) Fukushima Daiichi Nuclear Power Station (hereinafter referred to as the "Fukushima Daiichi NPS"), the "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1 to 4" (hereinafter referred to as the "Mid-and-Long-Term Roadmap") was established in December 2011, and decommissioning and other measures are being conducted along with periodic review of the roadmap.

Since the last revision in June 2015, decommissioning and contaminated water management has progressed, and the site conditions have come improved along the way. In addition, a policy on fuel debris retrieval will be determined based on the results of the feasibility assesment of the fuel debris retrieval methods conducted by the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (hereinafter referred to as "NDF"). Therefore, the Inter-Ministerial Council for Contaminated Water and Decommissioning Issues (hereinafter referred to as the "Inter-Ministerial Council") decided to publish herein the fourth revision of the Mid-and-Long-Term Roadmap, listening to opinions of local citizens and experts.[1].

# 2. Basic principles for making mid- and long-term efforts

We will conduct decommissioning and other measures at the Fukushima Daiichi NPS as continuous risk reduction efforts to protect humans and the environment from radioactive materials and take necessary actions according to the principles listed below.

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|---|---|
| [Principle 1] | Systematical reduction of risk in consideration of site conditions, efficiency, timeliness and proof while placing top priority on the safety of local citizens, the environment and workers. |
| [Principle 2] | Move forward with mid- and long-term efforts while gaining the understanding of local and national citizens by actively releasing information and by further thorough interactive communications while maintaining transparency. |
| [Principle 3] | Continuously update the Mid-and-Long-Term Roadmap in |

[1] From this revision, we changed the title of this Roadmap to reflect the change of the company's name from "Tokyo Electric Power company" to "Tokyo Electric Power Company Holdings, Incorporated (Cover page and hearafter referred to as 'TEPCO')".

consideration of the site conditions, progress in the decommissioning and contaminated water disposal efforts, and the latest R&D results.

[Principle 4] Harmonize further the efforts of TEPCO, the NDF, R&D institutions, the Government of Japan, and other relevant organizations to achieve the goals indicated in this Mid-and-Long-Term Roadmap. The Government of Japan should take the initiative in promoting the efforts to implement decommissioning and other measures safety and steadily.

# 3. Approach to risk reduction and ensuring safety associated with implementation of mid- and long-term efforts

While grasping the present status of the Fukushima Daiichi NPS, we will organize policies for reducing risks and make efforts toward ensuring safety.

## 3-1. Current status of Fukushima Daiichi NPS

In proceeding with decommissioning and other measures at the Fukushima Daiichi NPS, we will continue to manage and maintain the Fukushima Daiichi NPS in a stable state and make efforts to win the understanding of local citizens and other people concerned by providing them with necessary information.

Below are the details about the decommissioning and contaminated water management being made:

A. Fuel debris[2] is being cooled stably and a cold shutdown state is being maintained with no substantial fluctuations in temperatures inside the PCVs or radioactive releases.

B. Fuel in the spent fuel pools of Units 1, 3 and 4 may have been affected by hydrogen explosions. Among these units, retrieval of fuel from Unit 4[3] was completed in December 2014, corresponding to more than half of the entire amount of fuel in the pools. We are working on removing spent fuel from the other units preventing dispersion of radioactive materials. For Unit 2, the yard around the reactor has been developed to prepare for fuel removal, and installation of an access platform for the operating floor has been completed.

[2] The relevant reactors are Units 1 to 3, which were in operation at the time of the earthquake and experienced meltdown.

[3] Unit 4 was under periodic inspection at the time of the earthquake, with all the fuel removed from the reactor pressure vessel and stored in the spent fuel pool.

C. Removal of highly contaminated water in the sea-side seawater pipe trench (Units 2 to 4) was completed in December 2015. Regarding highly contaminated water that results from mixing of cooling water for fuel debris with groundwater entering buildings, our measures to control its increase, including through subdrainage, construction of the land-side impermeable walls, and site pavement (facing) in more than 90% of the areas planned[4], are beginning to prove effective. At buildings where highly contaminated water is stagnant, measures to prevent outflow of such water are being taken in light of the experience of the tsunami triggered by the Great East Japan Earthquake.

D. Measures to prevent the outflow of radioactive materials from the sea side of the Unit 1 to 4 buildings have been taken, including soil improvement using sodium silicate, installation of sea-side impermeable walls, etc.

E. The concentration of radioactive materials in seawater in the surrounding sea areas is maintained at a low level that is below the concentration limit defined in the Notification and the level set out in WHO's guidelines for drinking water quality.

F. The estimated value of additional effective dose at the site boundary due to radioactive materials from the entire facilities (hereinafter referred to as the "effective dose") achieved the target value of less than 1 mSv/yr by the purification of highly contaminated water in tanks and other measures. The level of less than 1 mSv/yr is being continuously maintained.

G. Except for highly contaminated water, water containing radioactive materials is checked comprehensively for any risk of off-site impact, and measures are being taken, such as removal of contamination sources and cleaning of drainage channels.

H. To store and manage wastes that increase as decommissioning proceeds, appropriate measures are being taken, such as construction of additional facilities for solid waste storage and volume reduction, and volume reduction process in an incinerator.

I. Measures for industrial safety and health are being taken to achieve an even higher standard of safety and to implement health management in the workplace.

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[4] Areas (1.45 $km^2$) determined in April 2014 by the Contaminated Water Treatment Committee in view of effective suppression of groundwater inflow, performance of construction, etc.

## 3-2. Approach to risk reduction associated with implementation of mid-and-long-term efforts

It is necessary to take action to reduce the risk of the overall facility of the Fukushima Daiichi NPS. There a variety of risks that need to be mitigated, including risks related to the radiation safety of local citizens and the environment, risks related to the radiation safety of workers and industrial safety, social risks such as harmful rumors associated with plant troubles, and risks that affect smooth implementation of decommissioning.

To reduce these risks, in particular those that affect local citizens and the environment, various measures are expected to be taken as early as possible. However, reducing risks often entails increasing some risks temporarily, and excessive increase of risks may occur depending on the implementation method of risk reduction. Therefore, according to the types of potential sources of risks, it is essential to select optimum timing and methods of risk reduction to avoid the excessive increase of risks, even on a temporary basis while taking into account both risks that will occur if the current state is maintained and risks that will arise if additional measures are taken. In addition, it is necessary to take multiple measures aiming at surely reducing each risk in the long term,

Since the site conditions are becoming more clear as decommissioning progresses, we are getting a clearer picture on how best to proceed with each task. In creating a concrete plan of how to proceed with each task, it is important to optimize the entire decommissioning project, which basically consists of streamlining the entire project, including coordinating with other activities, while giving top priority to safety.

The decommissioning work of the Fukushima Daiichi NPS is an unprecedented undertaking, and the working environment remains complicated since the situation inside the reactor PCVs is only beginning to become known, and there are many on-site locations with high dose rates. Therefore, in consideration of newly found issues and risks that may arise during work, it is necessary to review the existing approach flexibly by, for example, implementing additional safety measures or changing the work items, etc.

Moreover, to reduce social risks such as harmful rumors, we must explain our approaches thoroughly to local citizens and people concerned in the wold and communicate extensively with them.

While we originally tended to set up processes that focused on rapidity, this consequently placed a burden on site workers. While quick implementation is important, true value is earned only after reducing risks to local citizens, the environment, and workers.

Therefore, we should continue to avoid the excessive increase of risks, even on a temporary basis, by selecting and implementing optimum timing and methods of risk reduction, reviewing tasks flexibly and explaining adequately how the decommissioning operations will proceed, both individually and as a whole,

according to the sources of risks. With these efforts, it is necessary to achieve “decommissioning as soon as possible” by reducing each risk reliably in the long term and conducting decommissioning work safely, which will consequently lead to the early completion of tasks.

## 3-3. Concept of efforts to ensuring safety according to the sources of risks at the Fukushima Daiichi NPS

The radioactive materials that can be sources of risks at the Fukushima Daiichi NPS will be classified into the following three broad categories that are relevant to risk management. Their priorities[5] will be set, and appropriate measures will be taken in consideration of the current state of each material.

The risk categories are as follows.

Category 1) Relatively high risks given high priority

Highly contaminated water and fuels in the spent fuel pools of the buildings affected by hydrogen explosions fall into this category.

Actions will be taken as soon as possible while taking into account the optimization of the entire decommissioning project, with due consideration of the state of equipment, dispersion and leakage of radioactive materials, exposure of workers, workplace accidents, harmful rumors and other risks.

Category 2) Immidiate risks unlikely, risks may grow if neglected

Fuel debris falls into this category.

Actions should be taken on collecting information and accumulating expertise. After thorough preparations, actions should be made for safe, proven, prudent execution of work with due consideration of aging, external impact of radiation and radioactive materials during work, exposure of workers, workplace accidents, harmful rumors and other risks.

Category 3) Increased risk unlikely, but appropriate decommissioning efforts necessary

Solid waste[6] falls into this category.

Actions should be taken on a long-term basis with due consideration of

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[5] In setting priorities, the "Strategic Technology Plan for Decommissioning of TEPCO's Fukushima Daiichi NPS 2017" presented by the Nuclear Damage Compensation and Decommissioning Facilitation Corporation and the "Target Map for Reducing Mid-Term Risks at TEPCO's Fukushima Daiichi NPS" (July 2017 edition) presented by the Nuclear Regulation Authority will be taken into account.

[6] Although some of the rubble generated after the accident may be reused on the site, as described later, and may not be considered as waste or radioactive waste, such materials, secondary waste from water treatment, and solid radioactive waste that has been stored in the Fukushima Daiichi NPS since before the accident are hereinafter inclusively referred to as "solid waste."

aging, dispersion and leakage of radioactive materials, exposure of workers, harmful rumors and other risks.

When considering the above-mentioned risks, the latest findings will be applied as appropriate to risks associated with earthquakes, tsunamis and other events (earthquake ground motion or tsunami height, for consideration).

Other risks that may affect off-site areas will also be checked comprehensively on a periodical basis, and measures will be taken by setting priorities.

## 3-4. Specific efforts for ensuring safety

### (1) Safety of workers

Measures for industrial accident prevention (e.g., operation of a system for industrial safety and health management of TEPCO and contractors, risk assessment by TEPCO and others, thorough coordination among measures, and improvement of the risk prediction capabilities of new plant workers using experience-based education and training facilities) will be taken and reviewed continuously, medical preparedness will be planned in anticipation of industrial accidents, and measures will be taken to reduce occupational risk exposure as much as possible.

### (2) Equipment safety

Equipment safety will be ensured to prevent risks from surfacing by taking measures to maintain and improve equipment reliability, including inspection, updates, and conversion to permanent use at the appropriate timing based on a maintenance plan for every piece of equipment, so that such equipment can endure extended periods of use. For equipment vital to securing safety, e.g., cooling equipment, thorough measures will be taken to prevent their important functions from stopping, not just from the standpoint of equipment but from management and operation standpoints as well.

### (3) Mitigation of environmental impact

Measures to reduce risks that affect the off-site areas of the Fukushima Daiichi NPS will continue to be taken and reviewed as appropriate according to changes in the site condition.

Liquid waste, which will be handled while gaining the understanding of local communities, will not easily be released to the sea. No release to the sea will be conducted without approval from a competent government office.

Rubble and other solid waste will be stored in buildings as their volume is reduced as much as possible to eliminate the need for temporary storage areas outside the buildings.

### (4) Security enhancement

The security of the Fukushima Daiichi NPS will be improved by, for example,

confirming the reliability of each individual, and strengthening alertness against unauthorized intrusion to the site.

## 3-5. Preparation for responding to regulations in new efforts

The Fukushima Daiichi NPS was designated as a specified nuclear facility in November 2012 by the Nuclear Regulation Authority. TEPCO is therefore installing and operating equipment according to implementation plans approved by the Nuclear Regulation Authority.

Because we need to discuss, in parallel, specific tasks and regulations to be observed in conducting tasks such as fuel debris retrieval for which no preceding experience exists in the world, the NDF, TEPCO, the Agency for Natural Resources and Energy and other organizations will cooperate with each other, communicate actively with the Nuclear Regulation Authority, and take appropriate actions such as presenting policies and observation data related to ensuring safety at an early stage.

## 3-6. Strengthening systems to conduct mid- and long-term decommissioning works steadily

The decommissioning of the Fukushima Daiichi NPS should be implemented safely and steadily on a mid- and long-term basis.

In May 2017, an amendment to the Nuclear Damage Compensation and Decommissioning Facilitation Corporation Law (hereinafter referred to as "the NDF Law") was passed and a reserve fund where the NDF manages funds for decommissioning[7] was founded. It is meant to meet the long-term funding needs required to achieve the decommissioning and thus helps to construct a sustainable decommissioning framework.

After the enforcement of the amendment, 1) TEPCO will accumulate an amount set by the NDF and authorized by the competent minister on a fiscal year basis, and 2) TEPCO will recover the reserve funds to implement the decommissioning, based on a recovery plan jointly created by the NDF and TEPCO and authorized by the competent minister.

This allows NDF to 1) properly manage the funds relating to the decommissioning, 2) manage a decommissioning framework properly, and 3) provide sound work management based on the fund, as an entity in charge of managing and supervising TEPCO's decommissioning enterprise.

Furthermore, TEPCO will strive to enhance its project management features and improve its engineering capability for steady implementation of this large-scale project, and will promote its joint activities with Japan Atomic Power

[7] The NDF Law stipulates that "decommissioning" is defined as "including management of water contaminated by radioactive materials," i.e., defining decommissioning as encompassing contaminated water management. This definitaion is only applyed in the section 3-6.

Co. Inc. and cooperate with the NDF, government agencies, and related contractors to establish a decommissioning framework that relies on concerted efforts throughout Japan.

# 4. Specific mid- and long-term measures

The Mid-and-Long-Term Roadmap has been developed based on findings currently available and analysis of the situation of each reactor unit. The processes and tasks in the Mid-and-Long-Term Roadmap, which have been developed in consideration of the current risk levels or appropriate timing of implementation, are subject to change in light of future site conditions, progress in decommissioning and contaminated water management, and research and development (R&D) results. While giving the highest priority to safety and gaining the understanding of local citizens and the public at large, we will continuously verify and review the roadmap.

## 4-1. Phases defined in the Mid-and-Long-Term Roadmap

[Phase 1] From the completion of Step 2 (December 2011) to the start of fuel removal from the spent fuel pool of the first implementing unit (target period: within two years from the completion of Step 2)

- This phase ended on November 18, 2013, when fuel removal from the spent fuel pool of Unit 4 began.

[Phase 2] From the end of Phase 1 to the beginning of fuel debris retrieval from the first implementing unit (target period: within 10 years from the completion of Step 2)

- Toward fuel debris retrieval, many R&D activities will be conducted in full swing during this phase, and preliminary engineering will be conducted based on a policy on fuel debris retrieval. Also, treatment of stagnant water in buildings and fuel removal from the spent fuel pools will progress.
- In view of clarifying the control of progress during this phase, milestones (main target processes) will be set up (see Table 1) to show comprehensively the progress of decommissioning processes according to the Mid-and-Long-Term Roadmap.

[Phase 3] From the end of Phase 2 to the completion of decommissioning (target period: 30 to 40 years from the completion of Step 2)

- Implementation phase from fuel debris retrieval[8] to the completion of decommissioning
- At the beginning of Phase 3, small-scale fuel debris retrieval from the first

[8] The following work is called "fuel debris retrieval": the work to take out fuel debris generated due to core damage in Units 1 to 3 and subordinate necessary works to take out structures from the nuclear reactors. Beginning with small-scale retrieval that is started earlier than any other process based on the policy on fuel debris retrieval, there will be a series of working processes that are to be conducted integrally with internal investigation and on a step-by-step basis.

unit will begin, and preparations for enlarging the scale of retrieval will proceed concurrently.

Table 1: Milestones (main target processes) in the Mid-and-Long-Term Roadmap

| Area | Description | Timing |
|---|---|---|
| **1. Contaminated water management** | | |
| Reduction of contaminated water generation to about 150 $m^3$ / day | | Within 2020 |
| All purified water by purification equipment etc. is sotred in welding type tank | | FY2018 |
| Completion of stagnant water treatment | ①Separation of the penetrations between Units 1 and 2 and between Units 3 and 4 | Within 2018 |
| | ②Reduction of radioactive materials in stagnant water in buildings up to about one tenth of the end of FY 2014 | FY2018 |
| | ③Completion of treatment of stagnant water in buildings | Within 2020 |
| **2. Fuel removal from spent fuel pools** | | |
| ①Start of fuel retrieval from Unit 1 | | Estimate FY2023 |
| ②Start of fuel retrieval from Unit 2 | | Estimate FY2023 |
| ③Start of fuel retrieval from Unit 3 | | Mid FY2018 |
| **3. Fuel debris retrieval** | | |
| ① Determination of fuel debris retrieval methods for the first implementing unit | | FY2019 |
| ②Start of fuel debris retrieval at the first implementing unit | | Within 2021 |
| **4. Waste management** | | |
| Technical prospects concerning processing/disposal policies and their safety | | Around FY2021 |

## 4-2. Contaminated water management

### (1) Implementation of contaminated water management based on three principles

Multilayered, preventive measures have been taken based on the three principles on the issue of contaminated water ("Removing" the contamination source, "Isolating" groundwater from the contamination source, and "Preventing leakage" of contaminated water) presented in the "Basic Policy for the Contaminated Water Issue at TEPCO's Fukushima Daiichi NPS" determined in September 2013 and the "Additional Measures for the Decommissioning and Contaminated water Issues at TEPCO's Fukushima Daiichi NPS" determined in December 2013.

Necessary measures will continue to be taken according to the progress of our efforts, and such measures will be continued and managed properly to ensure that they will be put into effect.

1) "Removing" the contamination source

Water that has been treated by purification systems[9] will be treated again as necessary with multi-nuclide removal equipment, and additional effective doses at the site boundary due to radioactive materials from the entire facility will be maintained under 1 mSv/yr.

We will also continue to try to improve the performance of the multi-nuclide removal equipment.

We have conducted a technical assessment of how water stored after purification by the multi-nuclide removal equipment has been handled, for each choice of disposal method. In addition to technical points of view, we will continue comprehensive considerations, including from social standpoints to address such issues as harmful rumors.

2) "Isolating" groundwater from the contamination source

We will properly operate the groundwater bypass that has been in service since May 2014, while monitoring groundwater levels and water quality.

We will continue operating the subdrainage that has been in service since September 2015, while improving its pumping and processing capability for increased reliability.

Freezing of the land-side impermeable walls (frozen soil walls) has been completed on the sea side and we are starting to see their effects such as a decrease in amount of groundwater pumped up from the revetment area. We will proceed freezing of unfrozen parts on the mountain side, complete construction

[9] Referring to a multi-nuclide removal equipment, additional multi-nuclide removal equipment and high-performance multi-nuclide removal equipment (hereinafter referred to as "multi-nuclide removal equipment"), as well as a mobile strontium removal system, RO-concentrated water treatment equipment, cesium adsorption system and second cesium adsorption system.

of the walls rapidly, and use them effectively.

We will use the subdrainage and the land-side impermeable walls integrally to lower the level of groundwater in and around buildings as much as possible for stable management.

In addition, we will continue our measures against rainfall infiltration, starting with site pavement (facing). For the remaining areas on the sea side (outside of the land-side impermeable walls) of Units 1 to 4, site pavement will be provided as much as possible for the areas around the buildings, face of the slope between the area around the buldings and revetment area to maintain and improve our preventive measures for rainwater infiltration. Especially, we will manage properly the face of the slope and revetment area with the measures against rainfall infiltration by 2020. We will also implement preventive measures to rainwater penetration, such as removing rubble from the roofs of reactor and turbine buildings and waterproofing the roofs.

These efforts will help to suppress generation of contaminated water as a whole[10] by 2020, including water (including rainwater of average rainfall) flowing into buildings and the amount transferred from the ground 4m above sea level, thereby reducing the total amount of contaminated water to about 150m$^3$ par day,.

3) “Preventing leakage” of contaminated water

Stagnant water in buildings will be prevented from flowing out of the buildings by maintaining the water level in the buildings at levels lower than the surrounding groundwater levels.

Within FY2018, welded-joint tanks are used to store the entire amount of water purified by the purification systems. Flanged tanks that will be used before this storage is completed will be replaced to welded-joint tanks one after another with sealant protection and will undergo inspection and integrity assessment. We also plan to secure the required tank capacity by providing additional welded-joint tanks and scaling up or replacing the existing tanks[11].

In regards to ground stabilization using sodium silicate which was completed in March 2014 and the sea-side impermeable walls completely closed in October 2015, we will continue to conduct equipment maintenance and monitoring of the groundwater and the inside of the port.

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[10] Contaminated water is increasing because of rainwater and groundwater flowing into buildings, and because part of the groundwater pumped up from the ground 4m above sea level is transferred into buildings and water used in decommissioning activities (e.g. sprinking the operating floors, transferring stagnant water in trenches) is transferred into buildings. The Mid-and-Long-Term Roadmap revised in June 2015 set the goal of reducing the amount of inflow into the buildings to less than 100m$^3$ by the end of FY2016, which has been almost achieved.

[11] Based on current simulations, we expect to be able to secure a capacity of about 1,370,000 tons by 2020. (The figure may be revised depending on how much we will be able to reduce the rate of generation of contaminated water and such factors as rainfall).

### (2) Measures toward completion of stagnant water treatment

The water level within the buildings will be lowered as groundwater levels are lowered by the effects of the subdrain, the land-side impermeable walls (frozen soil walls) and site pavement. While the above process is being conducted, the inflow of groundwater will be controlled as we take measures to maintain the difference in the level between stagnant water in the buildings [12] and groundwater and to prevent the stagnant water in the buildings from leaking out.

The part of the floor faces that will be separated from the reactor building and exposed along with decreasing the level of stagnant water in the buildings will be kept exposed by pumping up rainwater that flows in and providing water leak blockage at building connections, while controlling dust inside the building.

At Units 1 to 3, where circulation water is being injected, a circulation water system from which turbine buildings are separated will be developed and measures such as lowering the water level in a reactor building will be taken to create a situation in which stagnant water will not flow out of the reactor building into another building.

In accordance with such a scenario, the water level within the buildings will be sequantially lowered according to the floor level to separate the penetrations between Units 1 and 2 and between Units 3 and 4 with in FY 2018.

We plan to reduce the amount of radioactive materials in the stagnant water in the buildings to about one tenth[13] of FY2014 year end levels within FY2018 and complete the process within 2020 through these efforts[14].

## 4-3. Fuel removal from spent fuel pools[15]

### (1) Fuel removal from spent fuel pools

1) Unit 1

Fuel in the spent fuel pool of Unit 1 is stably managed in the state where the amount of decay heat generation gradually decreases and the cooling state is maintained by heat removal management. Toward removing fuel, we have already completed dismantling the roof and wall panels of its building covers, columns and beams and are now in the process of adding working platforms on the east, west and south sides of the building as measures against the fall of rubble, and installing wind fencing.

To prepare for the planned rubble removal, we are currently investigating the

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[12] Refer to stagnant water in the Unit 1 to 4 buildings, high-temperature incinerator (HTI) building, process buildings and seawater piping trenches.

[13] In the Mid-and-Long-Term Roadmap revised June 2015, we have decided to halve in FY2018 compared with the end of FY2014, which is almost achieved.

[14] The floor faces of the buildings other than the reactor building will be exposed and the water level within the reactor building lowered to no more than T.P. 1.1m. (Stagnant water will continue to exist in the reactor building as circulation water is injected into the reactor building for cooling).

[15] Removal of fuel from the spent fuel pools of Units 1 to 4 is referred to as “fuel removal.”

situation in the upper part of the operating floor. Many new things have come to light concerning the situation at the top of the operating floor, such as an overhead crane under the collapsed roof and a fuel exchanger at risk of dropping into the spent fuel pool at the time of removing rubble, the well plugs are out of position, the dose near the well is high, etc.

We will create a new plan so as to not increase safety risks to the local citezens, environment and workers based on the newly found situations and implement rubble removal while taking thorough measures to prevent dispersion of radioactive materials. We will take measures against the fall of rubble during rubble removal and exercise care in carrying out tasks while implementing measures for dust, decontamination and shielding. Further, we will additionally take measures to deal with the well plugs that have been found to be displaced.

Even after rubble removal is started, the condition of rubble and the spent fuel pool will be investigated if necessary and the work plans and processes will be reviewed continuously.

A fuel removal cover and fuel handling equipment will be installed thereafter and fuel removal will be carried out (See Figure 1).

Before starting fuel removal, operational risk assessment and management will be conducted to ensure that thorough safety measures including prevention of dispersion of radioactive materials will be put into place. The start timing of fuel removal is targeted for FY 2023.

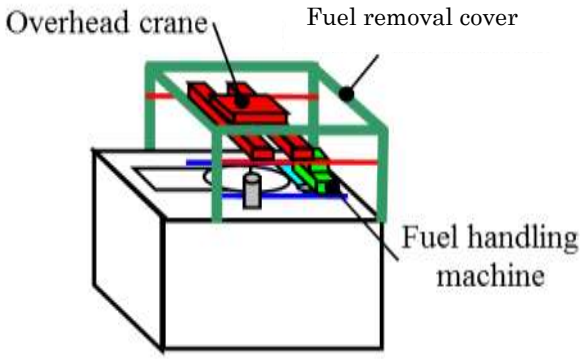



Figure 1: Fuel handling equipment of Unit 1 (conceptual illustration)

2) Unit 2

Similar to other units, the amount of decay heat generated in the spent fuel pool of Unit 2 is gradually decreasing. The cooling state is maintained by the heat removal management and is stably managed. In addition, Unit 2 was not affected by hydrogen explosion, and the soundness of the building was maintained.

For Unit 2, we completed installing a working platform for providing access to the operating floor, after conducting additional investigation for reducing the concentration of radioactive materials in the port during rainfall and measures

therefor as part of preparation activities for the working area around the reactor building for fuel removal.

As a result of the analysis of the rubble on the operating floor, it turned out that it was necessary to monitor the dose in detail.

For removal, the upper part of the building's operating floor will be totally dismantled. Before dismantling, we will investigate the dose and dust concentration etc. of the operating floor and thorough measures will be taken to prevent dispersion of radioactive materials so not to increase safety risks for local citizens, the surrounding environment, and workers. In addition, the working plan and processes will be continuously reviewed as risk management is conducted regarding the methods of dismantling the roofs and upper sections of the building's walls, decontamination and shielding, to ensure that sufficient care is exercised in doing the tasks.

Also, in parallel with the investigation of the operating floor and implementation of necessary countermeasures, we will improve the environment around Unit 2 (disassembly of Unit No. 1 and No. 2 exhaust pipe and measure to prevent sea contamination etc.). This optimizes the entire decommissioning work.

After dismantling of the upper part of the operating floor, fuel handling equipment will be installed in order to be ready to start fuel removal. The start timing of fuel withdrawal is targeted at FY 2023[16].

Since it is reasonable to determine the type of container for use in fuel removal in consideration of the time to start fuel removal and conditions under which debris retrieval will be carried out, the following two plans will be examined to choose between: Plan 1: share the same container for fuel removal and fuel debris retrieval at the appropriate timing; and Plan 2: install respective containers separately (See Figure 2).

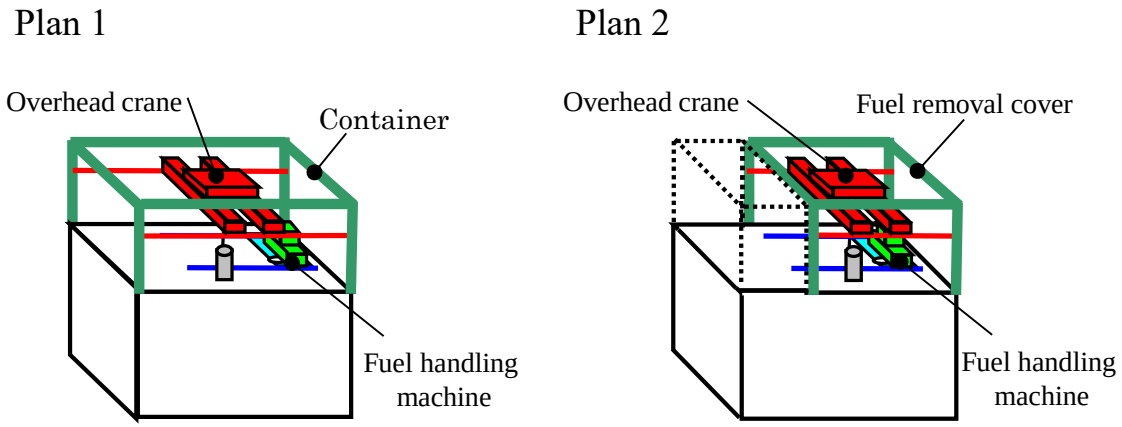



Figure 2: Fuel handling equipment of Unit 2 (conceptual illustration)

[16] If we decide to use Plan ①(sharing the same container for fuel removal and fuel debris retrieval at the appropriate timing), the time to start fuel removal will be targeted for FY2024.

3) Unit 3

We completed decommissioning and shielding the operation floor in order to reduce radiation doses to workers.

We will start fuel removal around the middle of FY2018 after installation of a fuel removal cover and fuel handling equipment (See Figure 3).

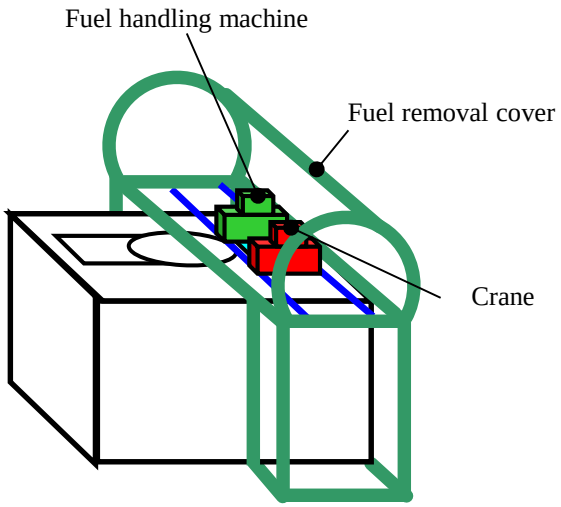



Figure 3: Fuel handling equipment of Unit 3 (conceptual illustration)

We will implemente the above work and aim for completion of fuel removal from spent fuel pools of Units 1 to 3 (see Fig. 4).

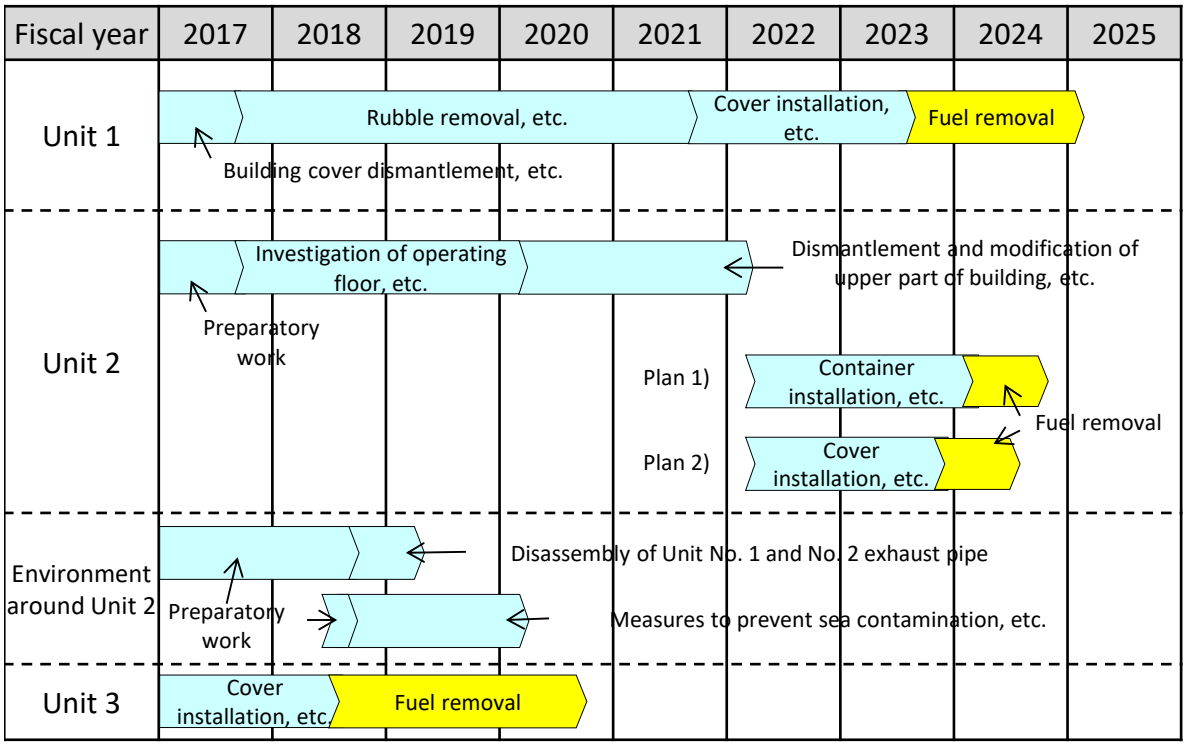



Figure 4: Plan of fuel removal from spent fuel pools of Units 1 to 3

Measures will be taken to prevent trouble related to large cranes that would have a huge impact on the entire work process, including introducing new large cranes or spare cranes, getting the maintenance yard ready for use, providing more maintenance personnel or providing resident maintenance personnel, overhauling, etc.

4) Unit 4

Fuel removal was completed in December 2014.

5) Units 5 and 6

The integrity of buildings and equipment is maintained in Units 5 and 6. These units are exposed to a lower risk of tsunami because of a higher site altitude than that of Units 1 to 4, and it is possible to conduct emergency operations in the buildings because of lower dose rates inside the buildings. For the time being, therefore, fuel will be stored appropriately in the spent fuel pools of Units 5 and 6. Fuel removal will be conducted later on within a scope that will not affect the operations at Units 1 to 3.

### (2) Handling of removed fuel

Fuel removed from the spent fuel pools of Units 1 to 4 will be stored in a common pool appropriately for the time being. In view of maintaining the capacity of the common pool, the fuel stored in the common pool will be transferred to a dry cask temporary storage facility. At the same time, long-term integrity of the fuel removed will be evaluated and future treatment will be discussed; based on such investigation, future treatment and storage methods will be decided in around FY2020.

## 4-4. Fuel debris retrieval

### (1) Policy on fuel debris retrieval

Regarding fuel debris retrieval, we will base our future efforts on the "Policy on Fuel Debris Retrieval" described below, while also examining the feasibility assesment of the methods the NDF used in its technical strategic plan[17] and suggestions based on it. While it is important to mitigate as early as possible a variety of risks resulting from the presence of the fuel debris, there is still only a limited amount of information about fuel debris and a limited amount of the technical development necessary for fuel debris retrieval. Therefore, seeing that there is still much uncertainty for us to consider retrieving the fuel debris now, we will constantly review our plan in consideration of new findings from

[17] Referring to the "Technical Strategic Plan 2015 for Decommissioning of the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station" and future revised versions of the Plan.

investigation and analysis and field work.

1) Step-by-step approach

We will adopt a step-by-step approach wherein we will set the method of fuel debris retrieval to be started first in order to reduce risks at an early stage and will adjust our direction flexibly based on information that comes out as retrieval proceeds.

Fuel debris retrieval, the investigation inside the primary containment vessel, and the investigation inside the reactor pressure vessel will be performed in a coordinated, integrated manner. The fuel debris retrieval starts from a small-scale task and the scale of retrieval will be stepped up as we review our operations flexibly based on new findings obtained from the nature of the fuel debris and working experience.

2) Optimization of entire decommissioning work

We will examine fuel debris retrieval as a comprehensive plan aimed at total optimization, from preparation to cleanup through retrieval work, discharge, processing and storage, including coordination with other construction work at the site.

3) Combination of multiple methods

We will combine optimum retrieval methods suitable for the part of each unit where fuel debris is expected to be present, instead of making an assumption that all the fuel debris is to be taken out using a single method.

At present we will examine how to combine methods from an accessibility standpoint, assuming that access is made to the bottom of the primary containment vessel from the side and that access is made to the inside of the reactor pressure vessel from the upper part of the vessel.

4) Approach focused on partial submersion method

Given the technical difficulty of stopping leaks at the upper of the primary containment vessel[18] and expected radiation doses during work, the full submersion method is technically difficult at present, so we will base our efforts on the partial submersion method that is more feasible.

However, given the advantages of the total submersion method, such as being effective in providing shielding against radiation, we might consider adopting the full submersion method in the future depending on the progress of R&D.

5) Prioritizing fuel debris retrieval by access to the bottom of the primary

[18] The primary containment vessel has a number of lines leading to the outside of the vessel, so submerging the inside of the vessel requires the lines at altitudes higher than the first floor of the reactor building to be repaired or sealed against leaks.

containment vessel from the side

According to an analysis, fuel debris is expected to be present in both the bottom of the primary containment vessel and the inside of the reactor pressure vessel of each unit, although their distribution varies among the units. In view of rapidly mitigating risks from fuel debris while minimizing any increase in risks that might be caused by retrieval, we will prioritize retrieval of fuel debris in the bottom of a primary containment vessel by access from the side by taking the following into account.

- The bottom of the primary containment vessel is most accessible and a certain amount of knowledge about it has already been accumulated through the investigation inside the primary containment vessel;
- There is a possibility that fuel debris retrieval could be started earlier;
- Fuel debris retrieval could be performed at the same time as spent fuel removal.

**(2) Immediate actions to be taken based on policy on fuel debris retrieval**

Based on the policy on fuel debris retrieval, TEPCO will start preliminary engineering[19] and we will continually conduct internal investigation, and speed up and prioritize R&D.

1) Implementation of preliminary engineering

In order to find out how the results of R&D so far, such as a conceptual examination of the fuel debris retrieval system, are actually applicable to field work, as a preparation for actual retrieval work, we will determine the details of actual work processes for fuel debris retrieval.

When examining applicability to field work, we will minimize reworking from the basic design, e.g. by examining the applicability after due consideration of the site conditions, regarding the ease of maintenance, layout and traffic line of the facility needed for fuel debris retrieval. We will also review the method of fuel debris retrieval as necessary based on the results of the preliminary engineering.

2) Continued internal investigation and speed-up and prioritization of R&D

To start fuel debris retrieval, we will continually conduct internal investigation and speed up and prioritize necessary R&D.

We will conduct meticulous internal investigations in which we will use larger measuring instruments than in the investigations inside the primary containment vessel so far. We will also develop methods for investigation inside the reactor pressure vessel.

[19] Examination of engineering aspects for preliminarily determining the feasibility of construction work prior to basic designing that is normally carried out first for construction work

In order to realize the partial submersion method, we will develop a management system (negative pressure management system or circulation cooling system) for sealing radioactive materials. We will also develop techniques for stably controlling water levels as there is the need to properly set the level of water at the bottom of the primary containment vessel according to the condition of each unit even when the partial submersion method is applied.

To enable accessing fuel debris from the side, radiation doses at the workplace need to be reduced from the begining. In particular, Units 1 and 3 have high radiation doses on the first floor of the reactor building compared to Unit 2, remote control will be used to further reduce radiation doses during work.

For Unit 3, an access route for fuel debris retrieval will be established, e.g. by lowering the current water level in the primary containment vessel so that access from the side is enabled.

Further, a technique for securing the confinement of radioactive materials by connecting airtight cells to the sides of the primary containment vessel will be established.

In addition, we will prepare a system for containing, transferring and storing fuel debris which will determine the operating efficiency of fuel debris retrieval, and conduct R&D for wastes resulting from the retrieval work.

Regarding the method of fuel debris retrieval for the first unit to begin the operation, which will start within 2021 by determining the method of containing, transfer and storage (by FY2019) after due consideration of the results of the preliminary engineering and R&D. Starting from a small scale, the retrieval work will be scaled up in steps while flexibly adjusting the direction based on gradually obtained information. We will build an approach to safeguard against fuel debris before retrieval and storage.

A processing and disposal method of retrieved fuel debris should be decided in Phase 3 after the start of fuel debris retrieval, while pushing ahead with a study of necessary technologies with an eye to active use of facilities, now under design, for analysis and research of radioactive materials.

## 4-5. Waste management

In accordance with the basic policies below, nationwide concerted efforts will be devoted to management of solid waste, with each relevant organization playing their respective role. To carry out this, the NDF is playing a central role in conducting an expert study on integrated measures, including characterization, processing and disposal of solid waste.

- Solid waste management should be implemented thoroughly, with containment

and isolation of radioactive materials to prevent their dispersion/leakage and human access to them, in order not to cause harmful radiation exposure.

- The amount of solid waste generated by decommissioning is reduced as much as possible in order to ease the burden of solid waste management[20].
- To proceed with study on processing and disposal method of solid waste, characterization of solid waste such as nuclide composition and radioactive concentration is needed. In addition to the fact that solid waste of the Fukushima Daiichi NPS is large in volume, and have varied nuclide compositions, it is necessary to address an increase in the number of analysis samples and proceed their characterization properly.
- To dispose of solid waste, it is essential to understand the volumes and characteristics of the solid waste, and to establish specifications of disposal facilities and technical requirements for waste packages (technical requirements for disposal). However, the volumes and characteristics of solid waste will become clear step by step, with the future clarification of progress and plan of decommissioning. Therefore, the solid waste generated should be stored safely and reasonably according to characteristics of solid waste. Storage capacity should be secured to ensure that the waste can be stored within the site of the Fukushima Daiichi NPS.
- In order to safely store solid waste, the system for selecting the method of processing for stabilization and immobilization (preceding processing) will be established, and selecting the method of the preceding processing, before the technical requirements of disposal are established..
- To efficiently proceed with R&D concerning solid waste management, close cooperation should be realized between R&D fields such as waste characterization, processing and disposal. Issues and discussions on R&D should be shared between parties, and necessary planning made with a bird's-eye-view of overall solid waste management, should be progressed collectively.
- In order to continue safe and steady solid waste management, the continuous operational framework system including development of adequate facilities and human resources, which are concerned with solid waste management, must be undertaken.
- To steadily proceed with solid waste management, it is important to ensure the safety and health of workers. Therefore, radiation exposure control, safety management and healthcare programs should be implemented thoroughly based on the relevant laws/regulations.

**(1) Storage**

Solid waste is contained through measures such as storage in containers or immobilization in order to prevent dispersion / leakage. Solid waste is isolated

[20] All the measures from generation of solid waste to disposal through storage and processing.

by through appropriate storage policies and effectiveness is secured through careful management practices, such as continuous monitoring.

To reduce the volume of solid waste, efforts are made to control material that will turn into solid waste, and reuse/recycling effort are carried out.

TEPCO has estimated a physical amount of solid waste expected to be generated in the coming 10 years or so and taken necessary measures to suppress generation and reduce the volume of solid waste. Based on these efforts, TEPCO has release the Solid Waste Storage Management Plan on the premise of adopting storage in a temporary storage area, systematic introduction of facilities equipped with shielding/dipersion prevention functions, and appropriate storage supported by continuous monitoring. Since situations will vary depending on the progress and plan of decommissioning, TEPCO will review the Solid Waste Storage Management Plan and, if necessary, update the estimated physical amount once every year.

Regarding the storage of solid waste, when further measures become needed, and review of their contents will be undertaken.

If secondary waste from water treatment is highly fluidic (e.g. slurry from such apparatus as the Advanced Liquid Processing System and waste sludge from the Simplified Active Water Retrieve and Recovery System), preceding processing such as stabilization and immobilization will be considered, in order to further reduce storage risks.

The storage methods for solid waste to be generated by fuel debris retrieval are carried out with the study on fuel debris retrieval/storage methods.

**(2) Processing and disposal**

It is necessary to understand the characteristics of solid waste in order to figure out how processing and disposal should be done. Since the amount of waste is large and the nuclide compositions are varied, the number of analytical samples will increase. To address this, analysis facilities and equipment for radioactive materials should be established, and training undertaken to ensure personnel capable of conducting analysis.

It is beneficial to establish a method for understanding the characteristics of solid waste by complimentarily combining analysis data of characteristics with evaluation data based on model. In addition, more accurate waste characterization can be performed, by R&D on the optimization of the numbers of analyzed samples and analytical methods.

For each specification of solid waste on which preceding processing is applied, the safety against some disposal methods is evaluated, and based on the results, the system for selectiong the processing methods is established.

Then, prospects of a processing/disposal method and technology related to its safety should be made clear in NDF's Technical Strategic Plan by around FY2021.

In parallel with the above, TEPCO will present, as soon as possible, its

policy on how to secure safety during storage and measurement data useful for characteristics to properly address the above needs.

In accord with these efforts, specifications and production methods of the waste packages should be determined in Phase 3. Then, a processing system should be installed in the Fukushima Daiichi NPS. After establishing the prospects of disposal, production of waste packages should be started, and then carried out.

## 4-6. Other specific measures

### 1) Sustaining of reactor cold shut down status

In order to sustain the stable status, parameter monitoring of temperature inside the primary containment vessels should be continued, and nitrogen injection should be kept so as to reduce a risk of hydrogen explosion. With these actions, reliability should be maintained and improved through maintenance and management.

Based on the policy on fuel debris retrieval, a study should be made on reactor cooling water injection lines during fuel debris retrieval, including the feasibility of circulation cooling of the containment vessel by the intake of water from the primary containment vessel.

### 2) Radiation dose reduction and contamination expansion prevention all over the power station

1) Prevention of sea contamination expansion

The outflow of concentration of radioactive materials into the port should be lowered as much as possible so that the concentration of radioactive materials in the port remains stably below the concentration limit defined in the Notification. Measures to reduce the concentration of radioactive materials in the drainage channels that flow into the port, including measures to manage rainwater flowing in from the rooftops of buildings and paving around the buildings, should be continued in order to control the concentration of radioactive materials in the port from rising during rainfall.

2) Management of gas and liquid waste

Monitoring of gas and liquid waste should be continued and its emission should be strictly controlled to ensure that the concentration limits defined in the Notification is strictly observed and that their concentrations are made as low as possible based on a reasonable method.

3) Dose reduction through site decontamination

In areas other than the rubble storage area and the areas around Units 1 to 4 that are significantly affected by radiation from the plants, the radiation dose should be kept below an average of 5μSv/hr.

4) Comprehensive risk review

Comprehensive risk review was conducted with focus on risks with a potential of having an impact outside the site, to clarify the needs for additional measures mainly concerning liquid and dust containing radioactive materials (April 2015). As a result, concrete measures should be considered for risks that need additional measures, while prioritizing the risks, and measures for reducing risks that might have an impact outside the site should be continued steadily. Follow-up should be appropriately conducted regarding these measures.

Since risks change as the environment changes with the progress of the decommissioning, management of the risks extracted should be continued in a manner that reflects those changes, and periodic reviews should be done to address other risks that might arise.

**(3) Plan for decommissioning reactor facilities**

TEPCO should formulate, in Phase 3, a decommissioning plan aimed at completion of the decommissioning in 30 to 40 years, in the light of the progress of fuel debris retrieval and other decommissioning-related operations as well as related R&Ds. On this occasion, the NDF should provide multifaceted and expert advice and guidance with wisdom and intelligence from around the world.

As for Units 5 and 6, spent fuel removal should be carried out with reference to progress of works in Units 1 to 4, and then, decommissioning plans should be formulated for Units 5 and 6.

## 5. Development of system and environment to facilitate work

To successfully accomplish the decommissioning that would extend over the long term, it is necessary to continuously secure and develop human resources to be in charge of field work. For this reason, an expected number of workers required for the work should be estimated. And, toward improvement of the working environment, radiation doses should be reduced as much as possible and an industrial safety and health level should be continually enhanced, in addition to observance of the legal radiation dose limits (100 mSv/5 years and 50 mSv/year).

### (1) Prospect on the required number of workers and their stable securement

The number of workers estimated to be required in the coming three years is presented below for each type of action (see Figure 5).

Measures such as active use of optional contracts giving due consideration to mid- and long-term securement of workers will be continued in order to secure proper worker deployment and stable employment, with an eye to continuous securement and development of human resources. In addition, a policy giving due considerations to local employment will be maintained.

The estimated number of workers required will be updated as necessary every time the Mid-and-Long-Term Roadmap is revised.(Reference: Figure 6)

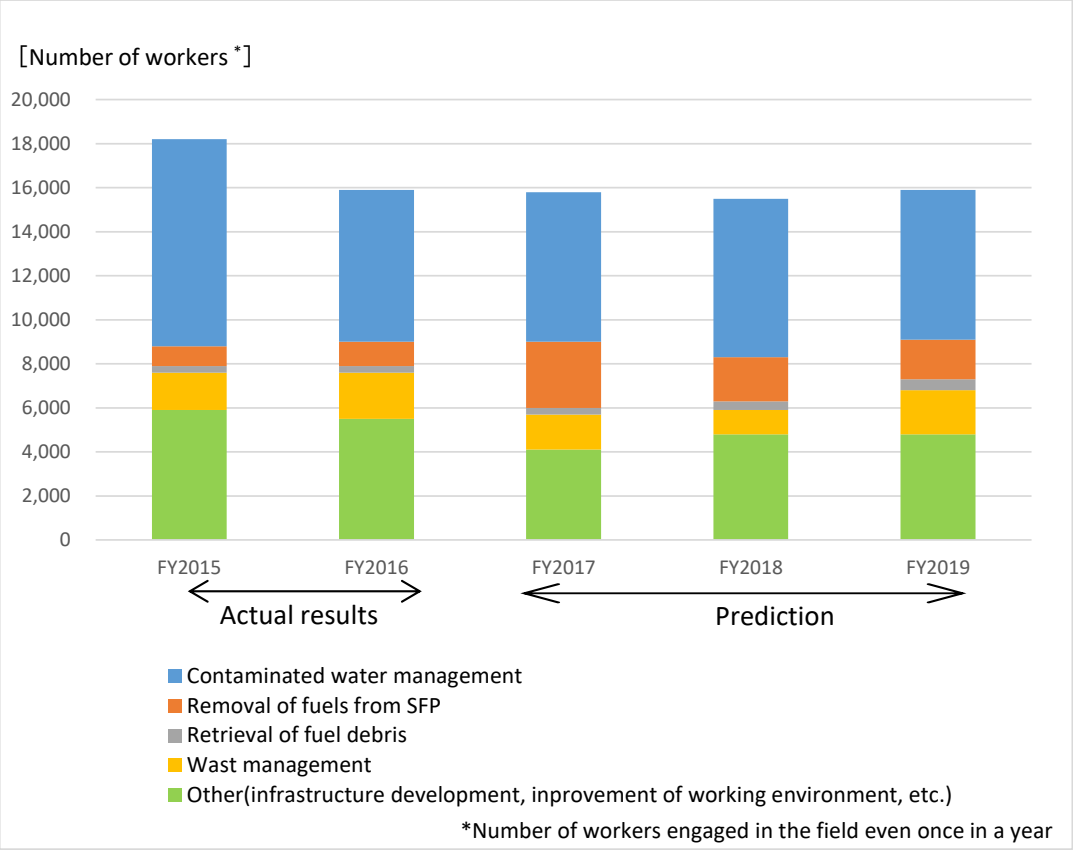



Figure 5: Estimate of the necessary number of workers in 3 years

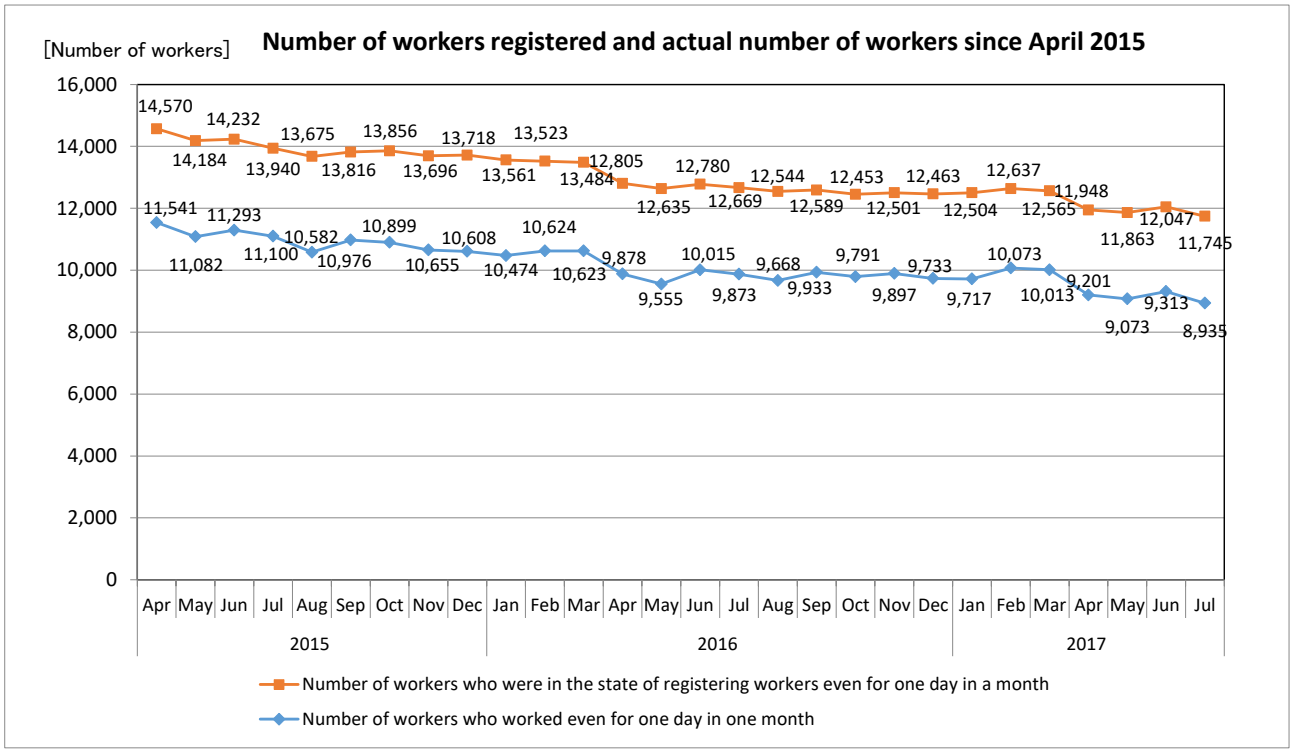



Figure 6: Comparison of the number of actual workers and registered workers

**(2) Actions toward improvement of working environment and conditions**

A. The areas where personnel are allowed to work in ordinary clothing were expanded to about 95% of the entire site area in March 2017 (See Figure 7). Efforts to improve the working environment will be continued, including utilization of the meal preparation center, large rest areas and contractors' buildings. Operation of an appropriate work plan that matches the progress of the decommissioning operations to brace for work at high doses is expected to take place.

B. TEPCO and the prime contractors will cooperate to establish and appropriately operate the system for industrial safety and health management that will closely monitor the status of the decommissioning operations, and all the contractors involved will also cooperate to secure labor safety.

C. From the stage of placing an order for construction, study measures of exposure dose reduction concerning construction methods, equipment, facilities, construction machines, etc. And, by putting these measures into construction plan, implement effective measures to reduce exposure doses. TEPCO will centrally manage exposure dose information for all the workers in the premises of the NPS and provides necessary information, guidance and advice to all the involved contractors including the prime contractors for thorough radiation management.

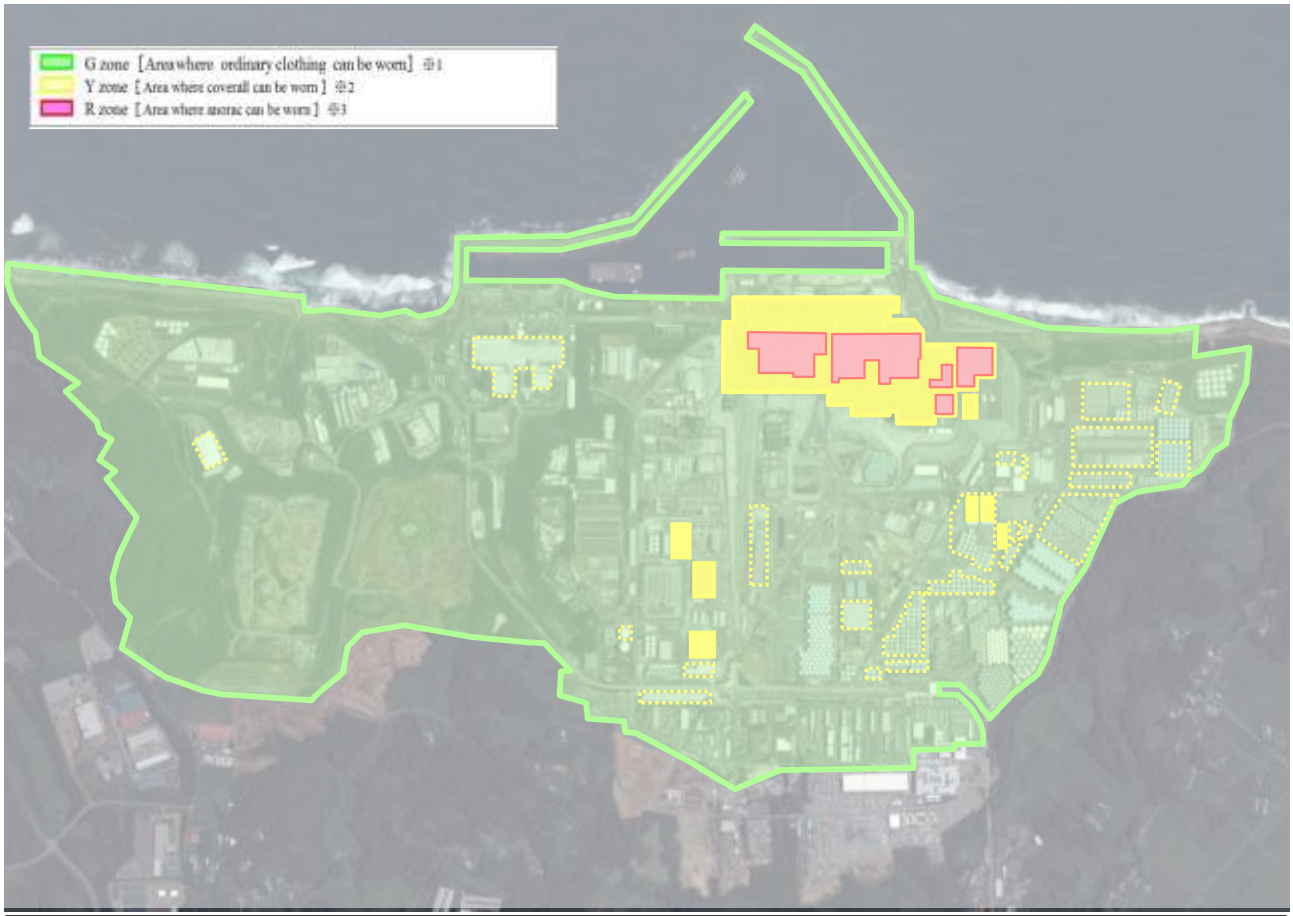
D. TEPCO and all the involved contractors will conduct risk assessments, and

TEPCO and cooperative companies will utilize sensory education and training facilities, patrol the workplace and coordinate different operations to raise the level of industrial safety and health.

E. As a measure for health management, TEPCO and the prime contractors will continue to utilize a framework for ensuring that all cooperative companies provide necessary measures after health checkups, and will take preventive measures for heatstroke and infectious diseases such as influenza. Workers will be encouraged to use the "Health Support Consultation Desk for Decommissioning Workers." Further, an existing emergency medical system will be maintained.

F. To ensure appropriate working conditions, continuously pursue promoting dissemination and enlighten activities on working conditions, such as holding lecture meetings, and responding to requests received at the consulting service, and other related efforts on an ongoing basis.

G. Inquire about the employment contracts of all workers, through the prime contractors if necessary. Conduct a survey to find out if workers have appropriate social insurance through the prime contractors if necessary.




※1 In addition to G zone in the figure, partial area of the common pool building 2nd, 3rd floors are also covered.
※2 Within the yellow dotted line of Y zone, works involving contamination such as works on concentrated salt water etc. is performed. Patrols and on-site surveys at the time of work planning, etc. shall be equipped for G zone. Other than the above figure, in case of working on high concentration dust work (building dismantling etc.), on transfer tank of concentrated brine etc. in G zone, Y zone will be set temporarily.
※3 In Units 1 to 3 reactor building, turbine building of Units 1 to 4, area surrounding residence water in peripheral building

| **G zone** (the area for ordinary clothing) | **Y zone** (the area for protective clothing) | **R zone** (the area for anorak) |
|---|---|---|
| Disposable dust mask  | Full mask or half mask   | Full mask  |
| Ordinary clothing  Premises-only clothing  | Coverall  | Anorak on a coverall or duble coveralls  |

Figure 7 Areas in the Fukushima Daiichi NPS where workers are allowed to work in ordinary clothing (G zone)

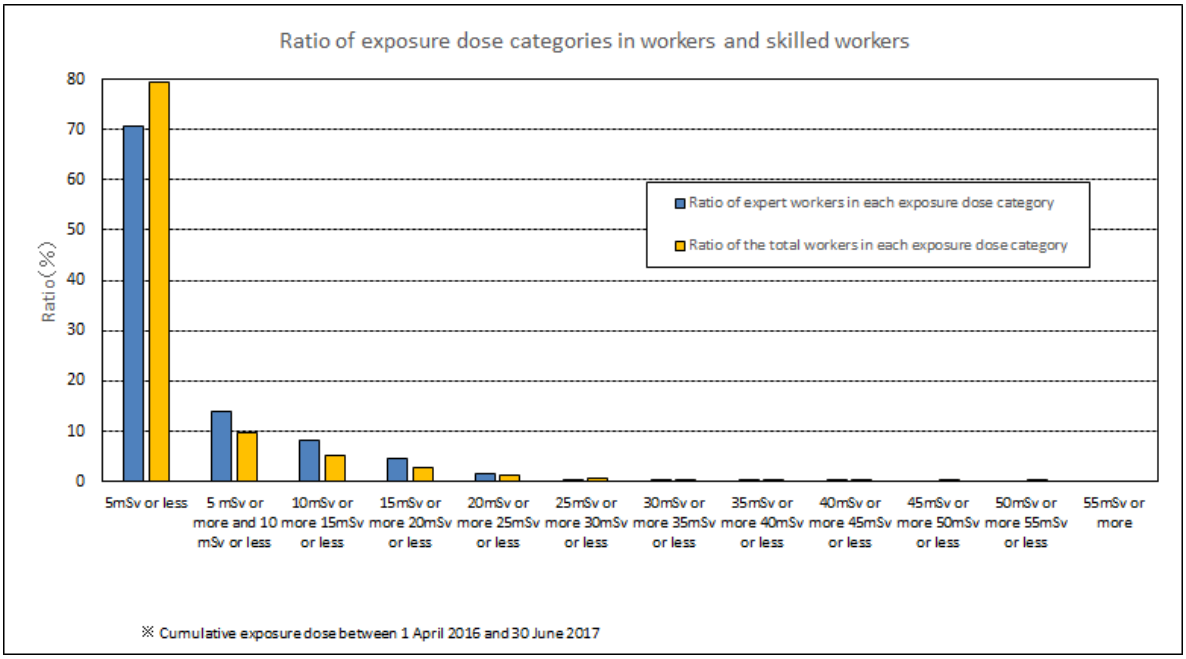



Figure 8 Ratio of exposure dose categories in workers and skilled workers[21]

[21] The exposure dose of workers and skilled workers is lower than the legal exposure dose limits. In order to secure workers over the medium to long term, it is important to keep exposure doses as low as possible.

# 6. Research & development and human resources development

## (1) Research & Development

It is important to customarily review R&D so as to reflect the latest site conditions, knowledge obtained in Japan and overseas, progress of works, etc., so that results of R&D will become practically useful for the decommissioning and contaminated water management. In addition, if needed, multilayered undertakings or developing activities with an emphasis on response to safety regulation should be promoted.

R&D should be driven with concerted efforts through gathering wisdom and intelligence from around the world by drawing on results of basic research in universities and other research bodies, technologies and experiences possessed by foreign countries, in addition to relevant undertakings by IRID[22], JAEA[23], and TEPCO.

The NDF will continue to play a central role managing R&D from fundamental research to applications. More specifically, based on discussions at the Committee for Cooperation in R&D of Decommissioning that was established in the NDF, we will increase our efforts, including building venues for releasing and sharing information for matching the R&D (needs) needed for decommissioning with the basic R&D (seeds) conducted in universities and research institutions and for conducting activities, holding a variety of forums and symposiums to share research results, providing opportunity for site visits to develop, secure and mobilize human resources, etc. As an organization leading such efforts, JAEA's Collaborative Laboratories for Advanced Decommissioning Science will have enhanced its functions, and collaborative research with domestic and international universities and research institutions, including Naraha Remote Technology Development Center (mock-up test facility) and Okuma Analysis and Research Center (facility for analysis and research of radioactive materials) as well as the international collaborative research building built in Tomioka Town, Fukushima Prefecture, will be promoted. In this way, all the organizations concerned will collaborate to create a center of excellence for international decommissioning research.

We will also continue our efforts to gather applicable knowledge and technologies from around the world by utilizing open innovation platforms such as "TEPCO CUUSOO" to proactively disclose our needs.

JAEA will continue to streamline and utilize decommissioning-related facilities involved in the Fukushima Innovation Coast Scheme. The Naraha Remote Technology Development Center (mock-up test facility) will develop and experiment with the remote control equipment and apparatus needed for decommissioning. For analysis and research of radioactive materials, the

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[22] International Research Institute for Nuclear Decommissioning (IRID): executing agency for technology development for decommissioning of nuclear power plants. Established in August 2013.

[23] The Japan Atomic Energy Agency (JAEA).

Okuma Analysis and Research Center (facility for analysis and research of radioactive materials) will go into operation within FY2017 and will be utilized to start building a framework for doing analysis targeted toward 2021 when fuel debris retrieval begins. Furthermore, researchers at the international collaborative research building will lead research at the Collaborative Laboratories for Advanced Decommissioning Science.

**(2) Human resource development**

In order to set forward the decommissioning operation estimated to take 30 to 40 years, systematic development of human resources should be promoted from a mid- and long-term perspective.

For this, we will continue to seek cooperation from the organizations concerned, in terms of training researchers and engineers at higher education institutions, creating a network between government, industry and academia, coordinating institutions for very difficult research, sharing research results using a variety of forums and symposiums, and providing field experience.

Meanwhile, the NDF will utilize the Committee for Cooperation in R&D of Decommissioning to gain an overall understanding of how every organization will go about developing human resources and share information with the organizations concerned to promote cooperation among the organizations to help secure human resources.

Further, TEPCO will cooperate with the cooperating companies to plan and build training centers geared toward field engineers.

## 7. Cooperation with international society

Gathering and using wisdom and intelligence from around the world, including adequately utilizing knowledge and experience of decommissioning projects in other countries, is important to conducting the decommissioning and other measures efficiently and effectively. Taking into account of Japan's responsibility to the international society, as a country where the Fukushima Daiichi NPS accident occurred, it is important to carry out the decommissioning project in a manner open to the international society. Activities through bilateral and multi-lateral frameworks, such as providing data obtained through decommissioning and management of contaminated water as well as receiving advice and assessments will be important.

In addition, cooperating with international organizations, etc., in a timely and appropriate manner, will be necessary in fostering an accurate understanding of the situation in Fukushima around the world.

The Japanese government will provide thorough information to foreign governments and international organizations, utilize international joint research projects and accept international applications for R&D projects.

The NDF will continue hosting international forums on the decommissioning of the Fukushima Daiichi NPS (1st: April 2016, 2nd: July 2017) to gather and utilize wisdom from around the world and will provide for interactive information communications in planning the technical strategy and so on.,

TEPCO will proactively provide information such as data, share data on decommissioning and the needs of the workplace, seek technical seeds overseas, and utilize knowledge proactively.

The government, the NDF, TEPCO and research institutions will closely cooperate to go about those international efforts.

## 8. Coexistence and further strengthening communication with local communities

Since decommissioning takes a long time to complete, we need to foster an accurate understanding among the local communities about what is really going on at the plant. Failure to provide accurate information could result in harmful rumors.

To avoid this, we need to quickly provide, in a precise and easy to understand manner, information about measures for safety towards to reducing risks, the progress of the decommissioning, and all radiation data and measurements of the airborne concentration of radioactive materials taken by TEPCO at the Fukushima Daiichi NPS, while exercising enough care to avoid harmful rumors. Further, we will further strengthen a relationship of trust with the local communities by

improving PR activities toward visitors, thus addressing the concerns and anxieties of the local communities.

**(1) Coexistence with local communities**

To further coexistence with local communities, as a part of implementation for decommissioning, TEPCO should continue to place greater emphasis on purchase of goods local vendors can provide and conclusions of service contracts local businesses can offer. In addition, TEPCO should encourage its business partners to purchase materials from local suppliers.

When setting up facilities that can contribute to field work, TEPCO should make much account of close integration with the local communities and TEPCO's contribution to them. In addition, TEPCO should lead these efforts to promotion of recruitment and procurement from the local communities, recovery of surrounding trade areas, and improvement and development of living environment.

**(2) Communication improvement**

We must gain the understanding of the local communities and the society toward our decommissioning efforts that take a long time to complete by responding to their anxieties or questions. For this, it is important that we improve our interactive communications with various parties including local citizens. More specifically, in addition to the Fukushima Advisory Board on Decommissioning and Contaminated Water Management that was founded in February 2014, we will establish good communications with the local communities and the society at large. Since the NDF and TEPCO are expected to flexibly make adjustments to how decommissioning work should be done according to the site conditions, information sharing on the preparation and the actual working status should be further improved.

Further, information such as implementation of safety measures for risk reduction, progress on relevant work and radiation data will be provided to the media, foreign governments, and international organizations in order to share necessary information domestically and internationally including around the Fukushima Daiichi NPS. We share information properly while paying full attention to avoiding harmful rumors, e.g. by not just being quick and accurate in providing information but by also fully explaining the meaning of the data disclosed.

## 9. Conclusions

Wishing for evacuated residents' returning to their homes as early as possible and removing anxieties of the local communities and the Japanese public, the mid-and long-term efforts toward decommissioning and other measures will be steadily put

forward based on this Mid-and-Long-Term Roadmap.

In addition, progress of this Mid-and-Long-Term Roadmap will be periodically made public and confirmed in the meeting at the secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment and will continuously reviewed in the Fukushima Advisory Board on Decommissioning and Contaminated Water Management and the Coordination Council for On-site Management of Decommissioning and Contaminated Water Countermeasures, while hearing comments from local parties concerned.

Without interruption, these undertakings will be carried forward toward completion of the decommissioning and other measures while taking necessary countermeasures for safety and security and against newly encountered events.

## The Sequence of Events

In May 2011, in the wake of the accident in the Fukushima Daiichi NPS, the Government and TEPCO formulated the "Roadmap for Immediate Actions for the Verification of and Restoration from the Accident at Fukushima Daiichi NPS" so as to promote undertakings toward early settlement of the accident.

In July 2011, the target, namely a state that "the amount of radiation is in a state of steady declining," of Step 1 in the said Roadmap was achieved; in December 2011, and the target, namely a state that "discharge of radioactive materials is controlled and the amount of radiation is kept at a significantly low level," of Step 2 in the said Roadmap was achieved.

Mid- and long-term undertakings after Step 2 were summarized by the "Expert Group for Study Mid-and-long-Term Action at TEPCO Fukushima Daiichi NPS," installed in the Atomic Energy Commission of Japan in August 2011, as "the target period needed before the start of fuel debris retrieval should be within 10 years" and "it is estimated to take more than 30 years before all the decommissioning measures are completed." In November 2011, the Minister of Economy, Trade and Industry and the Minister of State for Nuclear Emergency Preparedness issued an instruction to TEPCO, the Resources and Energy Agency, and the Nuclear and Industrial Safety Agency (now defunct) to formulate a mid-and-long-term roadmap for decommissioning. Accordingly, on December 21, 2011, the first version of the "Mid-and-Long-Term Roadmap" was adopted in the Government/TEPCO Mid-and-Long-Term Response Council held in the Nuclear Emergency Response Headquarters.

Subsequently, facing troubles such as water leakage after the completion of Step 2 (December 2011), TEPCO responding to an instruction from the Nuclear and Industrial Safety Agency (now defunct) formulated a concrete plan (hereinafter called the "Plan to Increase Reliability") that specified items to preferentially tackle for mid- and long-term reliability improvement. On July 25, 2012, the Nuclear and Industrial Safety Agency (now defunct) announced evaluation results on the plan. In response to this, on July 30, 2012, the first revision of the "Mid-and-Long-Term Roadmap" was adopted in the Government/TEPCO Mid-and-Long-Term Response Council held in the Nuclear Emergency Response Headquarters to reflect progress of Plan to Increase Reliability and the undertakings so far achieved.

On February 8, 2013, the Nuclear Emergency Response Headquarters established the Council for Decommissioning TEPCO's Fukushima Daiichi NPS (hereinafter called the "Council for Decommissioning")[24] for the purpose of reinforcing an R&D system toward fuel debris retrieval and building an organization to carry out progress control of field work and R&D activities in a unified manner. On March 7,

[24] Accordingly, the Government/TEPCO Mid-to Long-Term Response Council was abolished.

2013, in the (first) meeting of the Council for Decommissioning, the chairman, namely the Minister of Economy, Trade and Industry, issued an instruction to study a prospect for accelerating the fuel debris retrieval schedule and to prepare the "revised Roadmap" so that a target time limit could be June of that year. On June 27, 2013, the Council for Decommissioning adopted the second revision of the Mid-and-Long-Term Roadmap.

In response to a trouble of contaminated water leakage in an amount of about 300 $m^3$ from contaminated water storage tanks, which was detected on August 19, 2013, on September 3 of that year, the Nuclear Emergency Response Headquarters decided the "Basic Policy for the Contaminated Water Issue." And an Inter-Ministerial Council was formed for the eason that the Government should tackle the decommissioning and contaminated water issues with all its capability toward fundamental solution instead of simply committing the challenge to the businesses concerned. On September 10, 2013, the Inter-Ministerial Council set up the Team for Contaminated Water and Decommissioning Issue under the Nuclear Emergency Response Headquarters to intensify the system to carry out the countermeasures dealing with the decommissioning and contaminated water issues.

On December 10, 2013, the Committee on Countermeasures for Contaminated Water Treatment under the Council for the Decommissioning formulated "Preventive and Multilayered Countermeasures for Contaminated Water in TEPCO's Fukushima Daiichi NPS," and accordingly on December 20, 2013, the Nuclear Emergency Response Headquarters adopted the "Additional Measures for the Decommissioning and Contaminated Water Issues." Together with this measure, the Council for the Decommissioning was integrated into the Inter-Ministerial Council to unify functions as headquarter and reinforce the organization control.

On February 17, 2014, the Fukushima Council on Decommissioning and Contaminated Water was set up in order to swiftly respond to local needs concerning the countermeasures for decommissioning and contaminated water through improving information provision for, and communications with, local parties concerned.

On August 18, 2014, in order to more steadily promote the countermeasures for decommissioning and contaminated water, decommissioning support work was added to the functions of the Nuclear Damage Liability Facilitation Fund, and the Fund was reorganized as the Nuclear Damage Compensation and Decommissioning Facilitation (NDF).

On June 12, 2015, the Inter-Ministerial Council made a third revision to the Mid-and-Long-Term Roadmap taking into account the progress of the measures for the decommissioning and contaminated water issues and the opinions of the local citizens.

On May 10, 2017, an amendment to the Corporation Law was passed and a reserve fund for managing funds relating to decommissioning was founded in the NDF.