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

December 27, 2019

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 work is being conducted along with periodic review of the roadmap.

In this revision, the method of fuel debris retrieval from the first unit is determined based on the proposal by the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (hereinafter referred to as "NDF"), as well as the situation of the site that became clear with progress of the measures for decommissioning and contaminated water management since the last revision (September 2017). In addition, while there has been gradual progress in the returning of residents and reconstruction efforts in the surrounding area, decommissioning should be based on the principle of "coexistence of reconstruction and decommissioning." Decommissioning should proceed with local communities and early risk reduction should be conducted to contribute to early reconstruction while giving priority to ensuring safety rather than keeping schedule. The Inter-Ministerial Council for Contaminated Water and Decommissioning Issues (hereinafter referred to as the "Inter-Ministerial Council") decided to publish herein the fifth revision of the Mid-and-Long-Term Roadmap, taking into account the opinions of local residents and experts, as well as international reviews by the IAEA Review Team.

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

Decommissioning of the Fukushima Daiichi NPS is a continuous risk reduction effort to protect people and the environment from radioactive materials. Proper actions according to the principles listed below will be taken.

[Principle 1]	Reduce risks systematically, under the concept of "coexistence of reconstruction and decommissioning," with consideration for the site conditions, rationality, promptness and certainty while placing top priority on the safety of locals, the surrounding environment and workers. There have been gradual progress in return of residents and reconstruction.
[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 thorough interactive communications with transparency.
[Principle 3]	Continuously update the Mid-and-Long-Term Roadmap in consideration of the site conditions, progress in the decommissioning and contaminated water management efforts, and the latest R&D results.
[Principle 4]	Promote concerted efforts of TEPCO, 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 safely and steadily.

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

While grasping the present status of the Fukushima Daiichi NPS, policies for reducing risks will be organized and efforts will be made toward safety.

3-1. Measures for decommissioning and contaminated water management

In proceeding with decommissioning work at the Fukushima Daiichi NPS, the stable state will be continuously managed and maintained and the necessary information will be provided to win the understanding of locals and other people concerned.

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

(1) Contaminated water management

Removal of contaminated water in the sea-side seawater pipe trench (Units 2 to 4) was completed in December 2015. Regarding contaminated water that results from mixing of cooling water for fuel debris with groundwater flowing into buildings, thanks to the operation of sub-drains, and the completion of freezing the land-side impermeable walls and other measures[1], the amount of generation has been suppressed. At buildings where 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.

Regarding the stagnant water in the buildings, achievements have been made such as exposing the bottom floor of the turbine building at Unit 1 by pumping up the stagnant water, as well as lowering of the water level due to the pumping up of stagnant water realized the completion of separating the connecting part between Unit 1 and 2 and between Unit 3 and 4.

All of the water that was purified by the purification facility was stored in welded tanks within FY 2018. As a result, the risk of leakage from water storage tanks has been significantly reduced.

In addition, by implementing measures such as the installation of sea-side impermeable walls to prevent the leakage of radioactive materials, the concentration of radioactive materials in seawater in the surrounding sea areas is maintained at a low level that is below the concentration limit[2] defined in the Notification and the level set out in WHO's guidelines for drinking water quality.

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[1] Besides that, measures against rainwater such as paving the site (facing) at 94 % of the planned area including the ground 2.5 m above sea level (seawall area) and repairing damaged parts of the roof.

[2] The regulatory concentration limit stipulated "Ministerial Ordinance for Commercial Nuclear Power Reactors concerning the Installation, Operation, etc.."

Water containing radioactive materials other than stagnant water in the buildings has been checked comprehensively for any risk of off-site impact, and measures such as removal of contamination sources and cleaning of drainage channels are being taken.

Figure 1: Land-side impermeable wall (Image)

Figure 2: Sea-side impermeable wall

Figure 3: High-performance multi-nuclide removal equipment (ALPS)

Figure 4: Welded-joint tanks

(2) Fuel removal from Spent Fuel Pool

Fuel in the spent fuel pools of Units 1, 3 and 4 may have been affected by hydrogen explosions. Among these units, removal 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. The removal of fuel from Unit 3 had started in April 2019. At Unit 1, the rubble removal work on the refueling floor which started in 2018 is ongoing. At Unit 2, in the second half of FY2018, investigation of the contamination status of the refueling floor was implemented and tidying of leftovers on the refueling floor has been progressing. In addition, it has been confirmed that the risk of fuel in the spent fuel pool is lower than ever, according to the results of the cooling stop test of circulation cooling equipment in the spent fuel pool in each of Units 1-3. In addition, a local company participates as a main contractor for the dismantle of exhaust stack of Unit 1/2, and started dismantling work in August 2019.

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

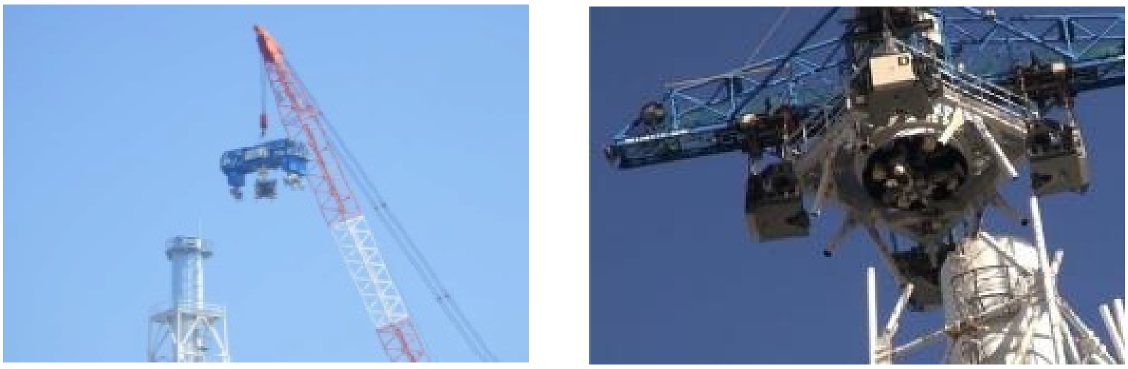

Figure 5: Dismantling of exhaust stack of Unit 1/2
（Started in August 2019）

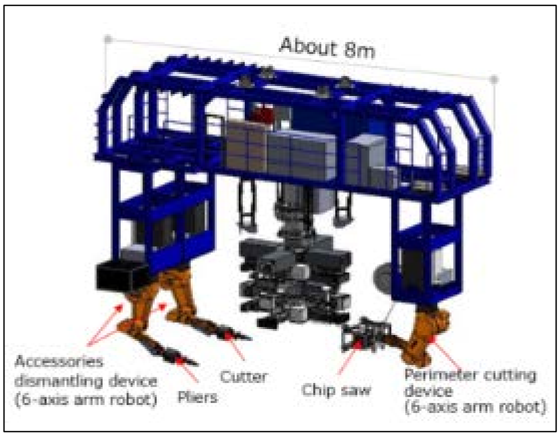

Figure 6: Exhaust stack shell dismantling equipment

Figure 7: Fuel removal from Unit 3 (Started in April 2019)

(3) Fuel debris retrieval

Fuel debris[4] has been cooled stably and a cold shutdown state has been maintained with no substantial fluctuations in temperatures inside the Primary Containment Vessels (PCVs) or radioactive releases.

Toward the fuel debris retrieval, the investigation inside the PCVs in Units 1-3 was started in January 2012 and has proceeded. At Unit 2, the internal investigation of PCV was conducted in February 2019 and it was confirmed that the fuel debris-like deposit can be picked up and lifted.

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

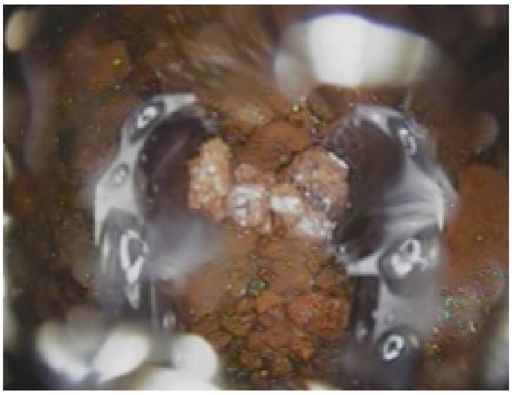

Figure.8　Internal investigation of PCV at Unit 2 (February 2019)

(4) Waste Management

In March 2016, TEPCO formulated the “Solid Waste Storage Management Plan of TEPCO’s Fukushima Daiichi NPS,” which estimates the amount of radioactive waste generated in about 10 years thereafter, and revised it according to progress made. In parallel, we took appropriate measures such as construction of additional facilities for solid waste storage and volume reduction, and volume reduction in an incinerator, in order to store and manage radioactive waste which increases as decommissioning proceeds.

(5) Improvement of the environment at the site

With regard to industrial safety and health, the working environment has been improved. For example, a meals supply center, a large rest house and a partner companies’ building were settled as well as workers becoming able to work wearing only general work clothes in most of the site area. Further improvement in safety standards and health management measures have been implemented.

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 contaminated water in tanks and other measures. The dose level of less than 1 mSv/yr will be kept and the efforts to lower the effective dose will be continued.

Figure.9 Site visit without wearing protective clothing

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. Risks to be reduced are, first of all, radiation safety risks for local residences and the surrounding environment and industrial safety risks for workers. Besides that, there are various risks such as social risks including reputational damage due to the occurrence of trouble and risks that affect to proper decommissioning work. It will become even more important to ensure safety under the situation that returning residents and reconstruction action in the surrounding area are gradually progressing.

To reduce risk, in particular that which affects locals and the environment, various measures are expected to be taken as promptly as possible. However, reducing risk often entails temporarily increasing risk in other areas, and excessive increase of risk may occur depending on the implementation method of risk reduction. Therefore, according to the potential sources of risk, it is essential to select optimum timing and methods of risk reduction to avoid the excessive increase of risks, even on a temporary basis.

Since the site conditions including the situation inside PCVs have become clearer as decommissioning progresses, we are getting a clearer picture on how to proceed with each task. In creating a detailed plan of each task, it is important to optimize the entire decommissioning project, through streamlining the entire project including coordinating each task, while giving top priority to safety. In addition, based on the progress of work in the limited premise, it is necessary to secure space for storage facilities for spent fuel and fuel debris which will be removed from units and welded tanks.

The decommissioning work of the Fukushima Daiichi NPS is an unprecedented undertaking. The work environment remains severe, as the situation inside the reactor PCVs is only beginning to become known, and there are many points with high dose rates around the reactor PCVs. 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.

Moreover, to reduce social risks such as reputational damage, we must explain our approaches thoroughly to locals and people concerned around the world and communicate extensively with them.

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

Therefore, we should implement the risk evaluation according to the sources of risk, and 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 both individual tasks and a big picture of the decommissioning to local community and society. These efforts will consequently lead to the early completion of decommissioning tasks.

3-3. Concept of efforts to ensuring safety according to risk sources 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 risk given high priority

Contaminated water and fuel in the spent fuel pools of 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 to the state of equipment and risk of dispersion and leakage of radioactive materials, exposure to workers, workplace accidents, possible reputational damages and other risks. In consideration of the fact that fuel in the spent fuel pool has been cooled and risk has been reduced greater than before, safe, reliable and careful measures will be taken.

Category 2) Risks unlikely to appear immediately but may increase due to haste

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, the external impact of radiation and radioactive materials during work, exposure to workers, workplace accidents, harmful rumors and other risks.

Category 3) Risks unlikely to increase in the future but appropriate decommissioning efforts are still necessary

Solid waste[6] falls into this category.

Actions should be taken on a long-term basis with due consideration of aging, dispersion and leakage of radioactive materials, exposure to workers, possible reputational damages and other risks.

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[5] In setting priorities, " Technical Strategic Plan 2019 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc." presented by NDF and the "Target Map for Reducing Mid-Term Risks at TEPCO's Fukushima Daiichi NPS" (March 2019 edition) presented by the Nuclear Regulation Authority are 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."

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

Other risks that may affect offsite areas will also be checked comprehensively on a periodical basis, and measures will be after 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 risk prediction capabilities of new plant workers using experience-based education and training facilities) should be taken and reviewed continuously. Medical preparedness should 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 should 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 each piece of equipment, so that such equipment can endure long 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 only by securing equipment safety, but by ensuring managerial and operational safety. As part of this, proper inspection, update, management and operation of the equipment should be planned, by formulating and periodically reviewing the long-term maintenance and management plan which takes into account the expected aging of properties as well as the risks which are extracted and prioritized from the measures for the decommissioning and contaminated water management.

(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 will be reviewed as appropriate according to changes in the site condition, while fuel removal from the spent fuel pool and retrieval of fuel debris are underway.

Liquid waste will be handled while gaining the understanding of local communities. No release into the sea will be conducted without approval from a competent government agency.

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.

(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 into 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 (NRA). TEPCO is therefore installing and operating equipment according to implementation plans approved by the NRA.

In conducting such unprecedented tasks, such as fuel debris retrieval, we need to examine detailed work plans and regulations to be observed. NDF, TEPCO, the Agency for Natural Resources and Energy (ANRE) and other organizations will cooperate with each other, communicate actively with NRA, and take appropriate action 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.

A sustainable decommissioning structure will be continued by properly responding to long-term funding needs necessary for the decommissioning[7] project, in accordance with the decommissioning reserve fund specified by the Nuclear Damage Compensation and Decommissioning Facilitation Corporation Law (hereinafter referred to as "the NDF Law").”

With this law, NDF will continue to 1) properly manage the funds relating to the decommissioning, 2) manage a proper decommissioning framework, and 3) provide sound work management based on the fund, as an entity in charge of managing and supervising TEPCO's decommissioning implementation.

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

TEPCO will also settle the concrete plan and review it as the decommissioning progresses, in order to achieve the goal described in the major milestones of this Mid-and-Long Term Roadmap and NRA’s “Measures for Mid-term Risk Reduction at

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

TEPCO's Fukushima Daiichi NPS." TEPCO will report the contents of the plan to the Government of Japan and NDF, and make it public.

Furthermore, TEPCO will strengthen the project management function, quality management, safety evaluation function, and ability for engineering work besides the review of organizational structure, in order to carry out complex and multi-layered large-scale projects safely and steadily.

In addition, regarding investigation and analysis of decommissioning and accidents at Fukushima Daiichi NPS, TEPCO, NDF, ANRE, and other related organizations together with NRA will share and check the policies of operations. Each task will proceed consistently by reviews and adjustment so that the goal of each task is achieved.

4. Specific mid- and long-term measures

This Mid-and-Long-Term Roadmap is 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 is 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 ensuring safety and through gaining understanding of locals and the public at large, we will continuously verify and revise 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 measures such as engineering and internal investigation will be conducted. Also, pump up and treatment of stagnant water in buildings and fuel removal from the spent fuel pools will progress.

[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

・The period from the start of fuel debris retrieval to the end of 2031 is designated as “Phase 3-(1).”

・In Phase 3-(1), in order to steadily carry out the full-fledged decommissioning work, multiple process will systematically proceed. Specifically, the completion of the removal of fuel from the spent fuel pool at all of Units 1-6 is expected. As for retrieval of fuel debris, a trial of retrieval will be started and the scale of retrieval will be gradually increased. As for contaminated water management, the amount of

[8] The following work is called “fuel debris retrieval”: the work to retrieve fuel debris generated due to core damage in Units 1 to 3 and corresponding 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.

contaminated water generated will be minimized and maintained stably. As for waste management, risk reduction will be promoted by eliminating temporary storage area for rubble and other materials.

In view of clarifying the management of progress during the period from Phase 2 to Phase 3-(1), milestones (main target processes) are set up (see Table 1) to show comprehensively the progress of decommissioning processes according to the Mid-and-Long-Term Roadmap (See Table 1).

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

Area	Description	Timing
1. Contaminated water management		
Contaminated water generation	Reduce to about 150m^3/day	Within 2020
	Reduce to about 100m^3/day or less	Within 2025
Completion of stagnant water removal / treatment	Complete stagnant water removal / treatment in buildings*	Within 2020
	Reduce the amount of stagnant water in reactor building to about a half of that in the end of 2020	FY 2022 - FY 2024
2. Fuel removal from spent fuel pools		
	Complete fuel removal from Unit 1-6	Within 2031
	Complete installation of the large cover at Unit 1	Around FY 2023
	Start fuel removal from Unit 1	FY 2027 − FY 2028
	Start fuel removal from Unit 2	FY 2024 − FY 2026
3. Fuel debris retrieval		
	Start fuel debris retrieval from the first implementing Unit (Start from Unit 2, expand the scale of retrieval gradually)	Within 2021
4. Waste management		
	Technical prospects concerning and the processing/disposal policies and their safety	Around FY 2021
	Eliminate temporary storage areas outside for rubble and other waste**	Within FY 2028

* Excluding the reactor buildings of Units 1-3, process main building and high-temperature incinerator building.

** Excluding the secondary waste from water treatment and waste to be reused.

4-2. Contaminated water management

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

Multilayered and preventive measures have been taken based on the three principles on the issue of contaminated water ("Removing" the contamination source, "Redirecting" 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.

The measures taken so far have shown steady effects. 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 ALPS, and additional effective doses at the site boundary due to radioactive materials from the entire facility will be maintained under 1 mSv/yr.

A technical assessment of the handling options for water stored after purification by the ALPS has been conducted. In addition to technical points of view, comprehensive considerations, including from social standpoints to address such as countermeasures for reputational damage, have been made and will be continued.

2) "Redirecting" groundwater from the contamination source

The groundwater level around the buildings should be managed stably as low as possible while maintaining the difference between the water level of the groundwater and that of stagnant water in the buildings, by surely operating a system, such as sub-drains and land-side impermeable walls (frozen ice walls), that stably controls groundwater and keeps groundwater away from buildings.

In addition, as a measure to prevent rainwater infiltration, TEPCO will continue to implement the paving of around 50% of the area inside of the land-side impermeable walls (frozen soil walls) around the Unit 1 to 4 buildings within FY2023, and then will pave the remaining areas gradually in coordination with other decommissioning works. Besides that, repair of damaged parts of the building roof will proceed to prevent rainwater inflow. By around FY2023, TEPCO aims to complete the repair of all buildings' rooves, by installing a large cover structure for Unit 1, which is currently under the rubble removal work.

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

Through these efforts, TEPCO aims to suppress the amount of contaminated water generation[10] to about 150m^3/day within 2020 and to less than 100 m^3/day within 2025, in average rainfall conditions.

3) “Preventing leakage” of contaminated water

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

All the water stored in welded tanks after purified by purification facilities. The risk of leakage from the tanks is greatly reduced. The necessary tank capacity will be secured in a planned manner, taking into account the constraints of the area of the site.

In regards to the sea-side impermeable walls, we will continue to conduct facility maintenance and monitoring of the groundwater and the seawater inside of the port.

(2) Measures toward completion of stagnant water removal / treatment

The water level within the buildings will be lowered as groundwater levels are lowered by the effects of the sub-drain, the land-side impermeable walls (frozen soil walls) and site pavement. While the above process is being conducted, the measures to suppress the inflow of groundwater and to prevent stagnant water[11] in the buildings from leaking will be taken, such as maintaining the water level between stagnant water in the buildings and groundwater.

Along with lowering the level of stagnant water in the buildings, part of the floor will be kept exposed by pumping up rainwater that flows in and providing water blockage at building connections, while suppressing 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 condition in which stagnant water will not flow out of the reactor building into other buildings.

Through those efforts, removal / treatment of stagnant water in the buildings, excluding the Unit 1 to 3 reactor buildings, the process main (PMB) building, and the high-temperature incinerator (HTI) building, is aimed to be completed[12] within 2020.

For the reactor building, α nuclides have been detected along with the progress of stagnant water removal / treatment. Based on that fact, in FY2022-FY2024, the amount

10 Contaminated water is increasing because of rainwater and groundwater flowing into buildings, and because part of the groundwater pumped up from the ground 2.5 m above sea level is transferred into buildings and water used in decommissioning activities (e.g. sprinkling the operating floors, transferring stagnant water in trenches) is transferred into buildings.

11 Refer to stagnant water in the Unit 1 to 4 buildings, high-temperature incinerator building, process main buildings and seawater piping trenches.

12 The water level within the reactor building lowered than T.P. -1740mm and under.

of stagnant water will be reduced to around half of that in the end of 2020, while removing α nuclides to lower concentration.

For the PMB building and HTI building, the completion of stagnant water removal / treatment is aimed at, by implementing dose mitigation for high-dose zeolite sandbags, which are located in the basement floor. In parallel with the stagnant water removal / treatment, the safety management measures for zeolite sandbags will be considered and the measures will be taken.

(3) Measures toward safety operation of contaminated water management

For the stable operation of contaminated water management, measures such as doubling of sub-drain purification system and capacity increase in pumping were implemented by 2018. In addition, necessary measures in preparation for large-scale natural disaster risks, such as seawalls against Tsunamis and reinforcement of drainage channels against heavy rain will be implemented in a planned manner. Besides which, the equipment will be regularly inspected and updated, in order to maintain effectiveness of the contaminated water management for a long time. Furthermore, considering the fact that fuel debris retrieval from the first Unit will start from Phase 3-(1) and the scale of retrieval will gradually increase, additional measures for contaminated water management will be considered if necessary.

4-3. Fuel removal from spent fuel pools[13]

(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.

In the investigations to date, it has been confirmed that building materials such as steel frames, which composed the upper part of the building, roof plate and overhead crane have collapsed on the refueling floor as rubble, and the well plugs have shifted greatly. More reliable dust scattering measures and careful work is necessary, in light of the situation where residents' return and reconstruction efforts are gradually progressing in the surrounding area, as well as the situation where overhead cranes and refueling machines may fall into the spent fuel pool or on the refueling floor at the time of removal.

Based on those situations, a new method for installing a large cover prior to the removal of rubble will proceed (See Figure 10 and 11). In particular, a large cover will be installed by around FY2023 prior to the removal of rubble in the south side of refueling floor. After that, removal of rubble and fallen ceiling cranes and dose mitigation of the refueling floor will be implemented, followed by installment of fuel

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13 Removal of fuel from the spent fuel pools of Units 1 to 6 is referred to as "fuel removal."

handling machine and other facilities.

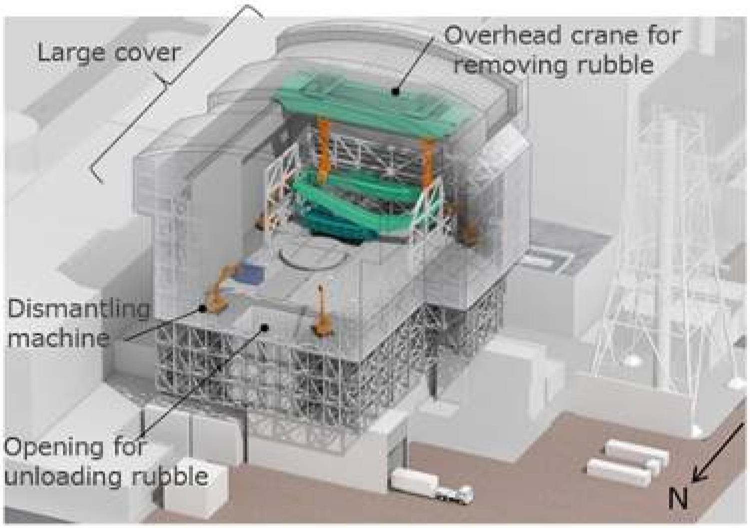

Figure 10: Method for fuel removal at Unit 1 (1) (Image)

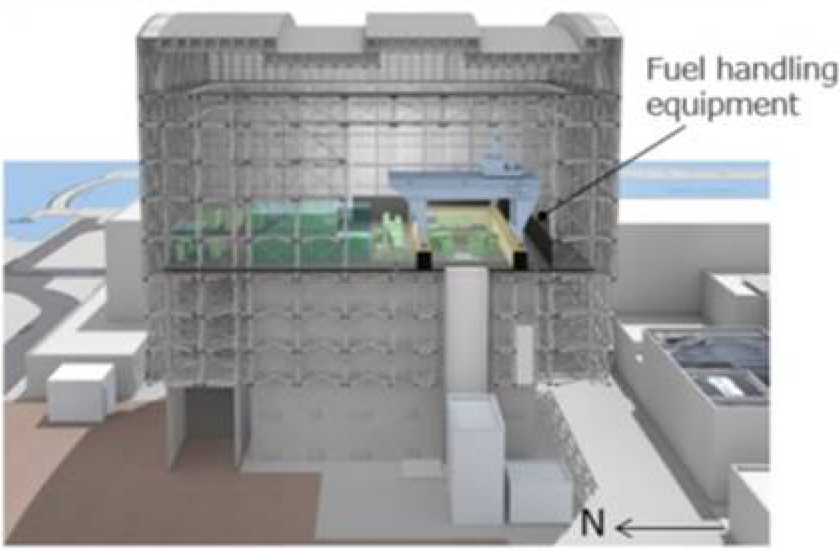

Figure 11: Method for fuel removal at Unit 1 (2) (Image)

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 heat removal management and is stably managed. In addition, Unit 2 was not affected by a hydrogen explosion, and the soundness of the building has been maintained.

In the second half of FY2018, the investigation on the refueling floor was conducted and the air dose rate was found to have been reduced to some extent. Based on the situation inside and the outcome of the study on downsizing the fuel handling equipment, the method, in which the fuel handling equipment accesses from the south side of the building without dismantling the building, was adopted in order to further suppress dust scattering, (See Figure 12 and 13).

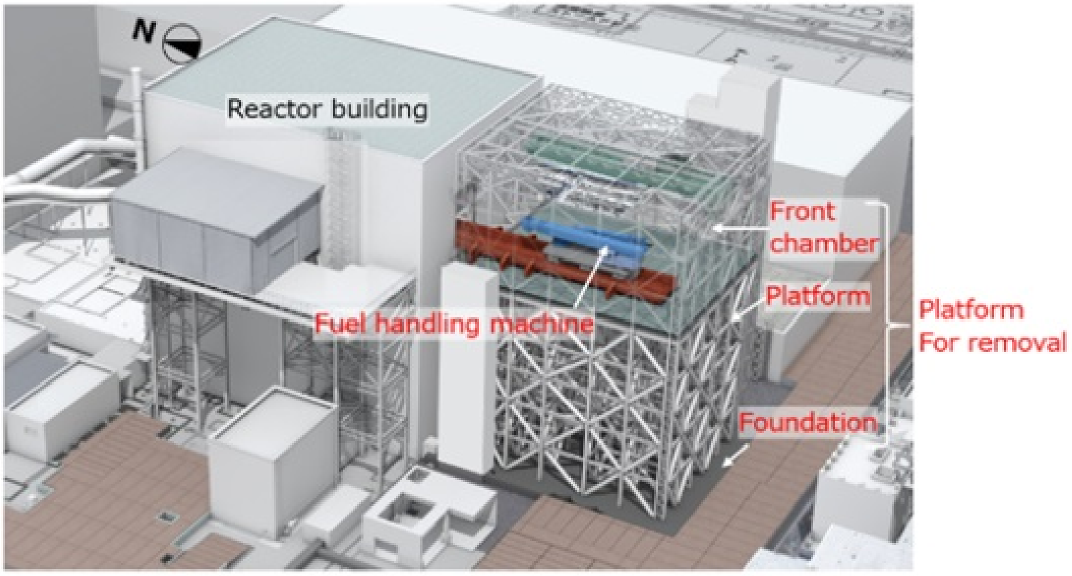

Figure 12: Method for fuel removal at Unit 2 (Image)

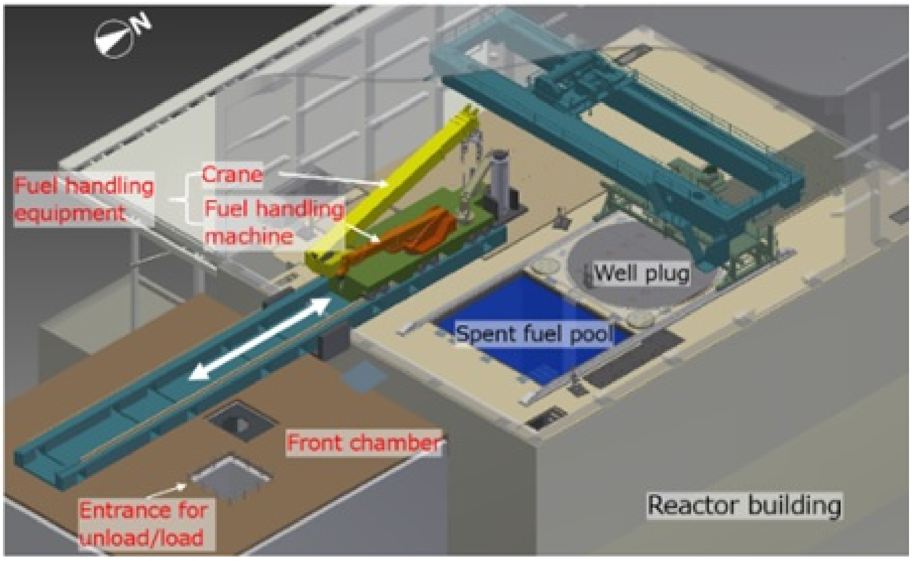

Figure 13: Fuel handling equipment for Unit 2 (Image)

3) Unit 3

The removal of fuel had started in April 2019. The work will be continued with highest priority given to ensuring safety.

4) Unit 4

Fuel removal was completed in December 2014.

5) Units 5 and 6

To complete fuel removal from all units 1 to 6, the fuel removal work will be started while the optimization of the whole process will be made taking into account the progress of fuel removal operation from Units 1 to 3.

6) Methods

The fuel removal from Unit 3 had started in April 2019. The removal work will be continued, aiming for completion of removal work within FY2020 with safety first.

As for the fuel removal of remaining units, optimization of the entire work will be conducted, such as securing vacant space in the common pool by transferring stored fuel from the common pool to a dry storage facility, while avoiding interference with fuel debris retrieval work. Specifically, at Unit 2, fuel removal will be started in FY2024-FY2026 with a goal to complete the work within 2 years. After that, fuel removal from Unit 1 will start in FY2027-FY2028, and it will take about 2 years to complete the removal. As for Unit 5 and 6, fuel removal work will be conducted within a range that the work does not interfere the operations at Unit 1 to 3.

By advancing those efforts, the completion of the fuel removal from all Units from 1 to 6 will be completed by the end of 2031.

(2) Handling of fuel

Fuel in the spent fuel pools of Units 1 to 4 will be removed from the spent fuel pools and 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. Toward the completion of fuel removal from all Units, the necessary space to temporarily store dry cask will be retained. At the same time, long-term integrity of the fuel removed will be evaluated and future treatment will be examined; based on such investigation, future treatment and storage methods will be decided.

4-4. Fuel debris retrieval

(1) Policy on fuel debris retrieval

Regarding fuel debris retrieval, measures has been conducted based on the following “Policy on Fuel Debris Retrieval” determined in September 2017. 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 research and development activities necessary for understanding the situation inside PCVs and fuel debris retrieval. At present, the fuel debris retrieval method still has high uncertainty, and will be continually reviewed based on new findings gained through future research and analysis as well as works at the site.

<u>1) Step-by-step approach</u>

In order to reduce risks at an early stage, a step-by-step approach will be adopted as a fuel debris retrieval method that should be started in advance, and it will be flexibly adjusted based on the information and experience that comes out as the retrieval gradually progresses.

Fuel debris retrieval, the investigation inside the PCV, and the investigation inside the reactor pressure vessel (RPV) 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 investigation operations are reviewed flexibly based on new findings obtained from the inside PCVs and working experience.

2) Optimization of entire decommissioning work

Fuel debris retrieval will be examined as a comprehensive plan aimed at total optimization, from preparation to taking out, processing, storage and cleanup through retrieval work, including coordination with other construction work at the site.

3) Combination of multiple methods

Optimum retrieval methods will be combined 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, from an accessibility standpoint, methods will be examined on the assumption that the bottom of the PCV will be assessed from the side and the inside of the RPV will be assessed from the upper part of the vessel.

4) Approach focused on partial submersion method

Given the technical difficulty of stopping leaks at the upper part of the PCV[14] and expected radiation doses during work, the full submersion method is technically difficult at present, so the partial submersion method is more feasible.

However, given the advantages of the total submersion method, such as being effective in providing shielding against radiation, the full submersion method will be considered in the future depending on the progress of R&D.

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

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

- ○ The bottom of the PCV is most accessible and a certain amount of knowledge has already been accumulated through the investigation inside the PCV;
- ○ 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.

[14] The PCV 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.

(2) Fuel debris retrieval method for the first implementing Unit

As for fuel debris retrieval from the first Unit, the future task will be conducted based on the following "Fuel debris retrieval method for the first Unit," along with the policy on fuel debris retrieval mentioned above, the contents proposed by NDF in its Strategic Plan, and the results of examination by TEPCO correspondents with the method and the policy.

Trial fuel debris retrieval will be started within 2021 from the first implementing unit safely and steadily. By swiftly starting a series of work which will gradually increase its scale of retrieval, necessary information and experience will be obtained toward further expansion of the scale of retrieval.

1) Method for the fuel debris retrieval

Without changing the on-site situation significantly, a trial retrieval will be started by inserting the retrieval equipment from the existing opening that leads into the PCV and by gripping or suctioning the fuel debris.

After the start of the retrieval, the fuel debris crushing at the time of the retrieval will be planned based on the obtained information and experience.

2) Method for the containment, transfer and storage of fuel debris

The retrieved fuel debris will be contained in a container and transferred to a storage facility in the Fukushima Daiichi NPS and stored in a dry state.

3) The first Unit for fuel debris retrieval

"The first Unit" will be Unit 2, from the viewpoint of optimization of the entire decommissioning work including safety, certainty and quickness of the fuel debris retrieval work, in addition to the avoidance of interference with spent fuel removal work.

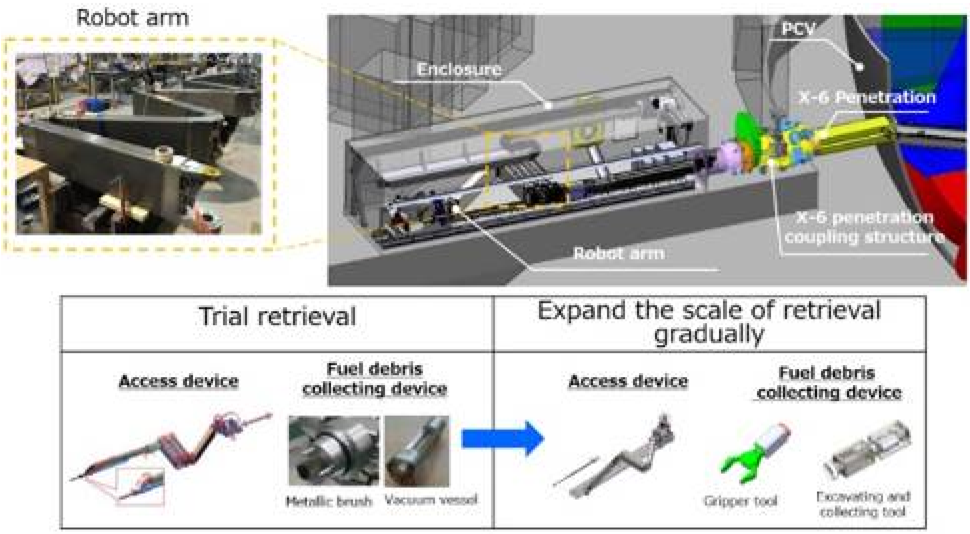

Figure 14: Image of fuel debris retrieval equipment

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

Based on the policy on fuel debris retrieval and the fuel debris retrieval method for the first Unit, TEPCO will continue engineering work and will continually conduct internal investigations and R&D. At the same time, the maintenance of the on-site environment such as dose reduction, water level reduction, and securing a working place will proceed.

1) Conducting engineering work

In order to find out applicability of the R&D results to date, such as conceptual examination of the fuel debris retrieval system, the detailed work processes of fuel debris retrieval will be determined as a preparation work. Moreover, specification and design of the system and safety evaluations will be conducted for the application on the site.

In order to minimize the risk of rework at the application phase, detail of the facilities, such as easiness of maintenance, placement and flow, should be examined based on the on-site situation.

The method for the fuel debris retrieval will be reviewed as necessary, based on engineering results.

2) Continued internal investigation and R&D

Toward the fuel debris retrieval, the internal investigation and R&D will be conducted continuously.

More detailed internal investigation will be carried out in which large-scale measuring devices are introduced. Besides that, the development of methods for investigating the inside of RPVs, as well as the development of analysis and estimation technology for characterization of fuel debris will be advanced. In the investigation and analysis, the viewpoint of ascertaining the causes of the accident of Fukushima Daiichi NPS will be sufficiently taken into account.

In the enlargement of the scale of retrieval, the management systems (negative pressure management systems, circulating cooling systems, etc.) will be developed, in order to realize the partial submersion method. For the partial submersion method, it is also necessary to set the water level at the bottom of the PCVs properly, according to the situation of each units. For that reason, technology to stably control the water level such as water intake technology from the PCVs will be developed.

In addition, the technology for connecting a large airtight cell to the side of PCVs and ensuring the radioactive material confinement function will be established.

Furthermore, technology for streamlining the fuel debris retrieval work including obstacle removal and for preventing the diffusion of dust derived from fuel debris will be developed.

Moreover, the preparation of a system for containment, transfer and storage of fuel debris that will stipulate the work efficiency of fuel debris retrieval, and R&D on methods for sorting fuel debris and waste will be conducted.

3) Maintenance of the site environment such as dose reduction, lowering water level, and retaining the space

In order to realize fuel debris retrieval by side access, it is necessary to reduce the dosage rates at the work site, first. To do so, the radiation sources will be investigated and removed at the 1st floor of reactor buildings in each Unit.

For Unit 3, an access route for fuel debris retrieval will be ensured by lowering the current water level inside PCV so that side access can be possible.

To further expand the scale of retrieval, establishment of facilities such as a large retrieval equipment, a management system for confining radioactive materials and storage facilities will be examined. Site areas needed for these facilities will be also secured, considering the progress and site use of other decommissioning work.

The method for further expansion of the retrieval scale, including the method of containment, transfer, and storage will be examined, while carefully assessing the progress of the maintenance of the site environment such as radiation dose reduction, lowering the water level and securing site area, as well as information and experience obtained through fuel debris removal from the first Unit, engineering work, internal investigations and R&D.

Approach to safeguards measures for fuel debris will be established until the retrieval and storage are conducted.

After starting fuel debris retrieval, the processing and disposal method for the retrieved fuel debris will be determined in Phase 3 after analyzing the properties of fuel debris.

4-5. Waste management

(1) Basic concept

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 this out, 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[15].

- To proceed with study on processing/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 said 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, generated solid waste 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/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 structure 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.

(2) Storage

Solid waste should be contained by placing it into containers or immobilization in order to prevent dispersion/leakage. Solid waste has been kept isolated in proper storage areas and has been managed properly by continuous monitoring.

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

To suppress the volume of solid waste, efforts should be made to prevent material that will turn into solid waste from carrying-in, and to reuse/recycle/reduce its volume of the material.

TEPCO has estimated an 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. TEPCO has released the Solid Waste Storage Management Plan, in which the estimated amount of solid waste which will be generated in the coming 10 years, the necessary measures to suppress generation and reduce the volume of solid waste, storage situation at temporary storage areas, the development plan for necessary facilities with shielding/anti-dispersion functions, and proper storage of waste with continuous monitoring, are described. Since situations will vary depending on the progress and plan of decommissioning, TEPCO will review update the estimated the amount every year and revise the Solid Waste Storage Management Plan, if necessary.

Based on the Plan, TEPCO will develop and install solid waste incineration facility and waste volume suppression facility. Within FY2028, TEPCO will eliminate temporary storage area outside for all solid waste (fallen tree, rubble and others, soil, used protective clothing and others) except for secondary waste from water treatment and waste to be used for reuse/recycle[16], in order to lessen the workers' risk such as radiation dose risk.

For secondary waste from water treatment, risk of leakage should be largely reduced. Slurry generated at ALPS and other water purification system will be dewatered. Waste sludge generated at the water purification system in PMB building will be retrieved and transferred to the high place. In parallel, storage building for secondary waste from water treatment (adsorbent tower and others) will be installed. Through these measures, temporary storage area for secondary waste will be eliminated to possible extent and risks will be decreased as soon as possible.

The storage methods for solid waste to be generated along with fuel debris retrieval will be carried out as per the study on fuel debris retrieval/storage methods.

(3) 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 will be undertaken to ensure personnel capable of conducting analysis.

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

[16] Rubble with a surface dose rate of less than 0.005 mSv/h.

of the numbers of samples to be analyzed and analytical methods.

For each specification of solid waste on which preceding processing is applied, the safety against several disposal methods will be evaluated, and based on the results, the system for selecting the processing methods will be 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: Present measures toward reducing the volume of solid waste; develop analytical and evaluation method for efficient characterization and; develop methods to reasonably select safe processing and disposal methods at the time when the necessary information such as solid wastes' properties are proven.

In parallel with the above, TEPCO will present, as soon as possible, its policy on how to secure safety during storage and provide measurement data useful for characterization to properly address the above needs.

In accordance 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 a stable status, parameter monitoring of temperature inside the PCVs should be continued, and nitrogen injection should be kept so as to reduce the risk of hydrogen explosion. With these actions, reliability should be maintained and improved through maintenance and management based on the newly established long-term maintenance and management plan.

(2) Reduction of radiation dose and prevention of further contamination

1) Prevention of further sea contamination

The concentration of radioactive materials in the water which flows 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, such as countermeasures to rainwater flow from the rooftops of buildings and paving around the buildings, should be continued in order to suppress the rise in the concentration of radioactive materials in the port at the time of 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). To date, almost all the investigation and around 70% of the necessary measures have been completed. 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, risks extracted should be continuously managed considering those changes, and periodic reviews should be done to address other risks that might arise.

(3) Issues related to decommissioning reactor facilities

TEPCO should determine the contents related to decommissioning in Phase 3, with aiming the 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 R&Ds. On this occasion, 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, contents of decommissioning should be determined for Units 5 and 6.

5. Securing human resources and working environment toward smooth decommissioning 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 site 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) Expected number of workers required

The estimated number of workers required in the coming three years is presented below for each task (See Figure 15).

Measures such as active use of optional contracts which gives due consideration to mid- and long-term securement of workers will be continued, in order to secure proper staffing 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 the time of the Mid-and-Long-Term Roadmap revision. (Reference: Figure 16)

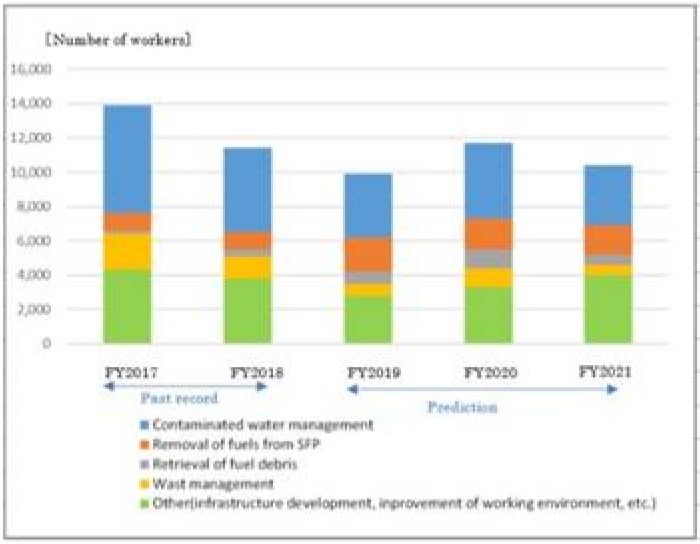


Figure 15: Estimate of the number of workers required for the coming three years[17]

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

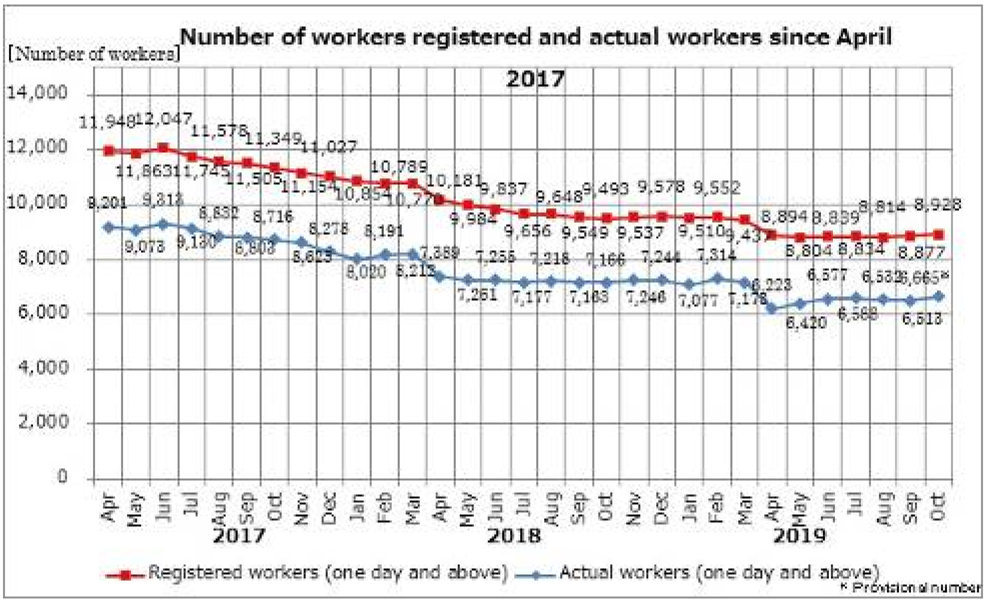


Figure 16: Comparison of the number of actual workers and registered workers[18]

(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 96% of the entire site area in May 2018 (See Figure 18). Efforts to improve the working environment will be continued, including utilization of the meal preparation center, large rest house and Partner Companies' buildings. To improve the working environment at the high dose areas where future work will be expected, work plans will be properly implemented to be compatible with progress in the decommissioning work.

B. TEPCO and the prime contractors will cooperate to establish and appropriately operate the system for industrial safety and health management that is based on the status of the decommissioning operations. All the contractors involved will also cooperate to secure worker safety.

C. From the stage of placing orders, measures for exposure dose reduction, which relate to the construction methods, equipment, facilities and construction machine, will be examined to be incorporated to the execution scheme. By that, effective dose reduction measures will be implemented. TEPCO will centrally manage exposure dose information for all the workers in the premise and provide necessary information, guidance and advice to all the involved contractors including the prime contractors for thorough radiation management. (Reference: Figure 18)

D. To raise the level of industrial safety and health, TEPCO and all the involved contractors will conduct risk assessments. In addition, TEPCO and cooperative companies will utilize sensory education and training facilities, patrol the workplace and coordinate different operations.

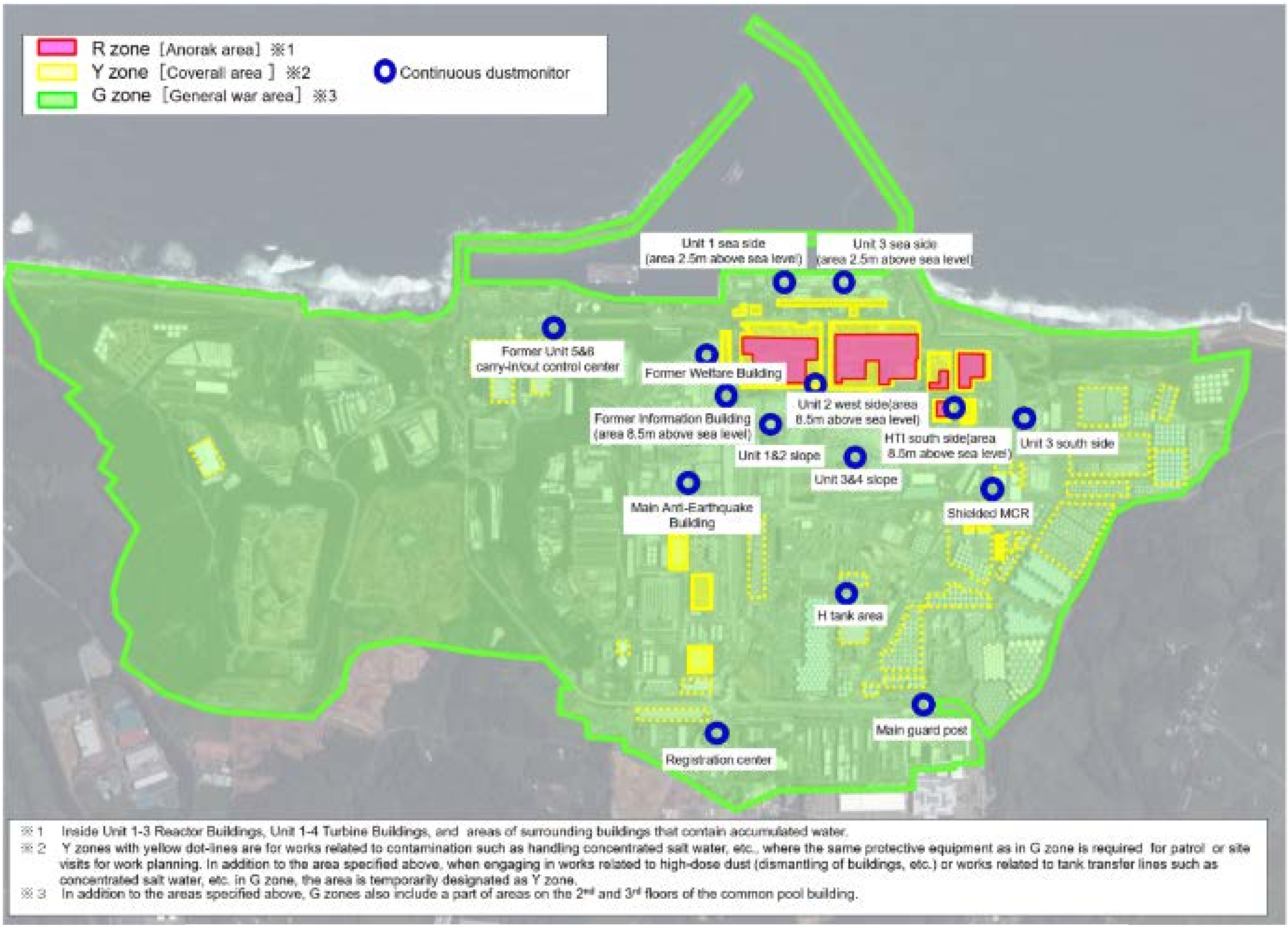
[18] On a monthly basis, the number of registered workers has a certain margin for the actual number of workers.

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 information 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.

Figure 17: Large rest house (Cafeteria)



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

Figure 18: Areas where workers are allowed to work in ordinary clothing in Fukushima Daiichi NPS (G zone)

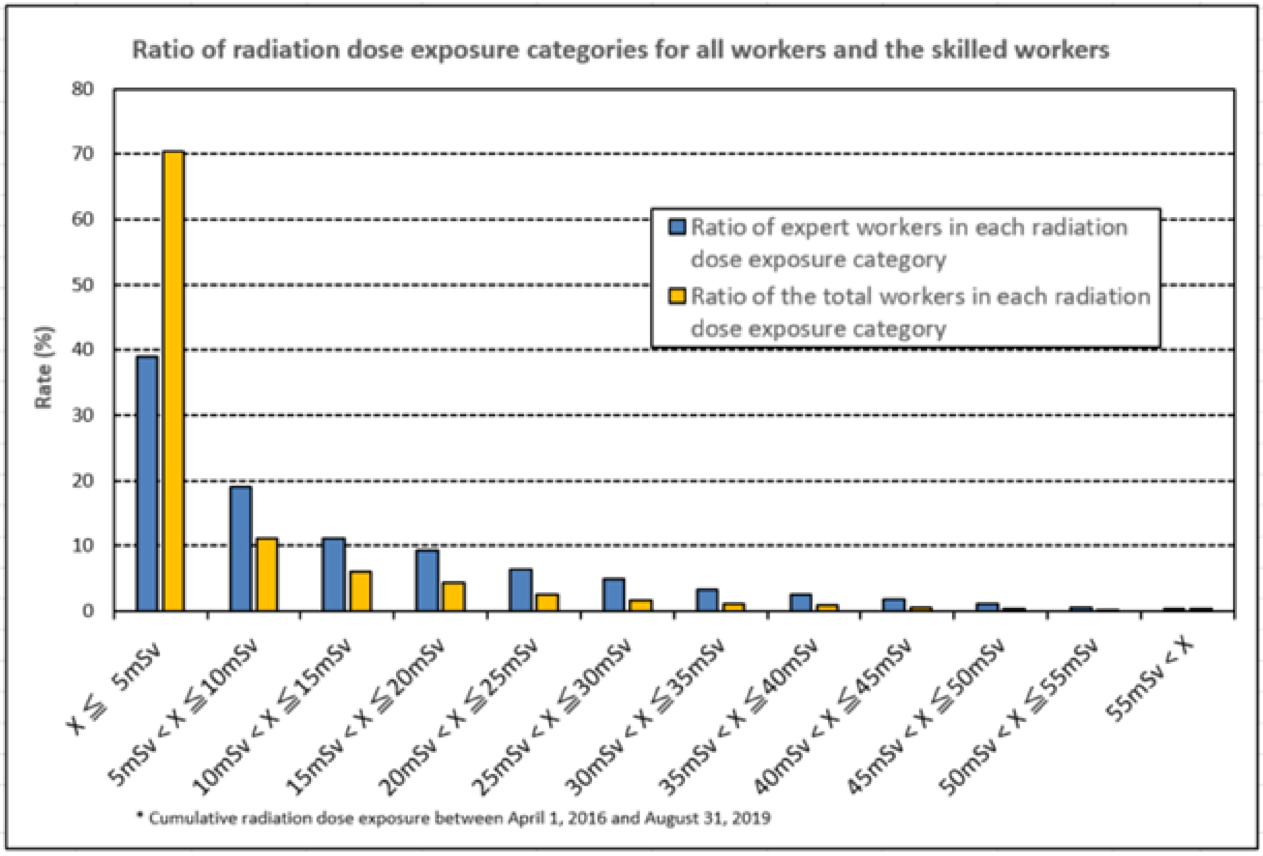


Figure 19: Ratio of radiation dose exposure categories for all workers and the skilled workers[19]

[19] The radiation dose exposure for all workers is lower than the regulatory radiation dose exposure. It is important to suppress exposure as low as possible in order to retain workers in the mid and long term.

6. Research and development and human resources development

(1) Research and Development (R&D)

It is important to customarily review R&D content so as to reflect the latest site conditions, domestic and international expertise, progress of works, and others, so that outcomes of R&D will become useful for the decommissioning and contaminated water management. Multilayered developing activities as well as the developing activities considering safety regulations will be promoted as necessary. In that case, it is also important that TEPCO plans and manages R&D under the project management system based on the needs from the site and the results of engineering.

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 from overseas, in addition to relevant undertakings by IRID[20], JAEA[21], and TEPCO.

NDF will continue to play a central role of managing R&D from fundamental research to applications. Based on discussions at the Decommissioning R&D partnership Council in NDF, measures to develop, secure and mobilize human resources, such as making occasion for sharing information to match the R&D needs for decommissioning with the basic R&D (seeds) in universities and research institutions, sharing research results at forums and symposiums, and providing opportunity for site visits will be strengthened. As an organization leading such efforts, JAEA’s Collaborative Laboratories for Advanced Decommissioning Science (CLADS) will enhance its functions. In addition to the international collaborative research building built in Tomioka Town, Fukushima Prefecture, Naraha Remote Technology Development Center (mock-up test facility) and Okuma Analysis and Research Center (facility for analysis and research of radioactive materials) will also be utilized for collaborative research with international universities and research institutions. 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 proactively disclosing the needs through open innovation platforms such as “TEPCO CUUSOO”.

JAEA will continue to develop 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 verify of the remote control equipment and apparatus needed for decommissioning. As for the “Okuma Analysis and Research Center” (facility for analysis and research of radioactive materials), facility management building has started its operation in March 2018. The development and construction of the first and the second building will be continued toward the establishment of an analysis system utilizing the center. Furthermore,

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

21 The Japan Atomic Energy Agency (JAEA).

researchers at the international collaborative research building will lead research at the CLADS.

(2) Human resource development

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

For this, with cooperation from the organizations concerned, measures such as fostering researchers and engineers at higher education institutions, creating a network between government, industry and academia, coordinating institutions for challenging research, sharing research results using a variety of forums and symposiums, and providing field experience will be enforced.

Meanwhile, NDF will utilize the Decommissioning R&D partnership Council to gain and share an overall undertaking toward fostering and developing human resources at each organization concerned in order to promote cooperation among the organizations, which will turn into securing human resources.

As one of these efforts, NDF provides training opportunity to acquire basic knowledge on decommissioning of Fukushima Daiichi NPS. Through those efforts, NDF will contribute to local human resource development.

Further, TEPCO has established the “Fukushima Decommissioning Engineer Training Center” as a training facility where employees of local companies can learn basic knowledge and skills. TEPCO will proceed with consideration toward step-by-step expansion of training content.

7. Cooperation with international society

Gathering and utilizing wisdom and intelligence from around the world, including experience of decommissioning, are important to conduct the decommissioning and other measures efficiently and effectively. Taking into account 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. It is important to provide data obtained through decommissioning and management of contaminated water as well as to receive advice and assessments through bilateral and multi-lateral frameworks.

The Government of Japan will provide thorough information to foreign governments and international organizations, utilize international joint research projects and conduct open international applications for R&D projects. In addition, in order to foster an accurate international understanding of the situation in Fukushima, it is necessary to cooperate with international organizations and international society, in a timely and appropriate manner.

NDF will continue gathering wisdom from around the world to utilize in planning the technical strategy, as well as enhancing mutual communication between local residents and decommissioning organizations through activities such as the international forum on the decommissioning of the Fukushima Daiichi NPS.

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

The government, NDF, TEPCO and research institutions will closely cooperate for those international efforts. Sharing information on the status of the Fukushima Daiichi NPS to the international community will be continued in a transparent manner. Specific measures are: providing explanations to governments including embassies in Tokyo and providing information at side events of the IAEA General Conference, as well as utilization of PR materials such as English websites, short films and brochures.

8. Symbiosis with local communities and Strengthen communication

Since decommissioning takes a long time to complete, it is necessary to promote symbiosis with local communities and strengthen communication with placing the highest priority on further risk reduction and ensuring safety, under the principle of “coexistence of reconstruction and decommissioning.”

(1) Symbiosis with local communities

To further coexist with local communities, it is important to contribute to the recovery and promotion of local industries and employment through efforts for decommissioning. To proceed with safe and steady decommissioning work, and looking ahead to the reconstruction of the region, TEPCO should play a central role in actively calling for wide range of local vendors to participate in the decommissioning work and expanding procurement from them. In this regard, TEPCO will develop a comprehensive plan in collaboration with related companies.

As a whole, the Government of Japan, Fukushima Prefecture and related organizations, will support local companies to enter the decommissioning work and improve their technical capabilities.

When setting up facilities that can contribute to works at the site, 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 in promotion of recruitment and procurement from the local communities, recovery of surrounding trade areas, and improvement and development of living environments.

(2) Strengthening communication

We must gain the understanding of the local communities and society toward decommissioning efforts that take a long time to complete by responding to their anxieties or questions, while trying to explain clearly. NDF and TEPCO will strengthen courteous information sharing, utilizing websites and brochures, on the preparation and the actual status of the decommissioning work which is expected to flexibly make adjustments based on the site conditions. It is also important to enhance two-way communication with people in various positions, including the local community. For this reason, TEPCO will expand occasions such as the visit to Fukushima Daiichi NPS or community events in which they can directly respond to the interests and questions of the public.

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. Information will be shared properly and proactively while paying full attention to avoid 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

To realize evacuated residents' returning to their homes as early as possible and to remove anxieties of the local communities and the public, the mid-and long-term efforts toward decommissioning 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 Decommissioning and Contaminated Water Management and will be continuously reviewed while hearing opinions from local parties concerned at the Fukushima Advisory Board on Decommissioning and Contaminated Water Management and the Coordination Council for On-site Management of Decommissioning and Contaminated Water Countermeasures.

These undertakings will be carried forward toward completion of the decommissioning while taking necessary countermeasures for safety and security and for newly encountered events.

The Sequence of Events

In May 2011, in the wake of the accident in the Fukushima Daiichi NPS, the Government of Japan 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 decline,” of Step 1 in the said Roadmap was achieved; in December 2011, 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,” established under 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 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 Agency for Natural Resources and Energy (ANRE), and the Nuclear and Industrial Safety Agency (NISA, 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 NISA (now defunct), formulated a concrete plan (hereinafter called the “Plan to Increase Reliability”) that specified items to be preferentially conducted for mid- and long-term reliability improvement. On July 25, 2012, the NISA (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”)[22] for the purpose of reinforcing an R&D structure toward fuel debris retrieval and other works and building an organization to carry out progress management of decommissioning work and R&D activities in a unified manner. On March 7, 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 present the “revised Roadmap” within June 2013. On June 27, 2013, the Council for Decommissioning adopted

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

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, the Nuclear Emergency Response Headquarters decided the “Basic Policy for the Contaminated Water Issue” in September 2013. And an Inter-Ministerial Council was formed for the reason that the Government of Japan 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 Decommissioning and Contaminated Water Management under the Nuclear Emergency Response Headquarters to strengthen the structure 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 headquarters and reinforce the organization control.

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

On August 18, 2014, in order to more steadily promote the decommissioning and contaminated water management, 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).

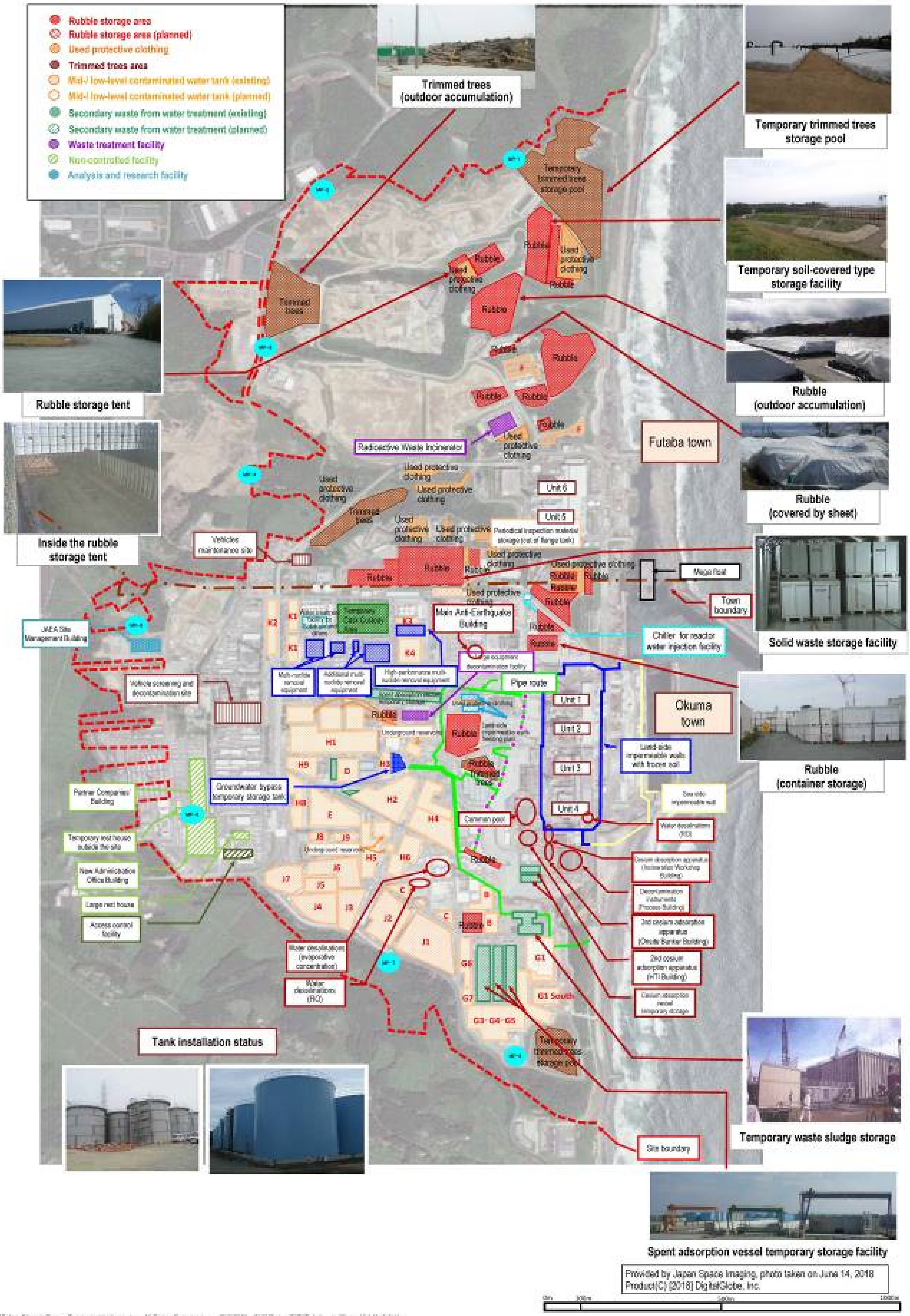
On June 12, 2015, the Inter-Ministerial Council made a third revision to the Mid-and-Long-Term Roadmap taking into account the progress of the measures for the decommissioning and contaminated water management and the opinions of locals.

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

On September 26, 2017, the Inter-Ministerial Council made a fourth revision to the Mid-and-Long-Term Roadmap taking into account the progress of the measures for decommissioning and contaminated water management and the opinions of the locals, and underpinning the basic policy for debris retrieval.

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout

As of December 19, 2019



Provided by Japan Space Imaging, photo taken on June 14, 2018
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