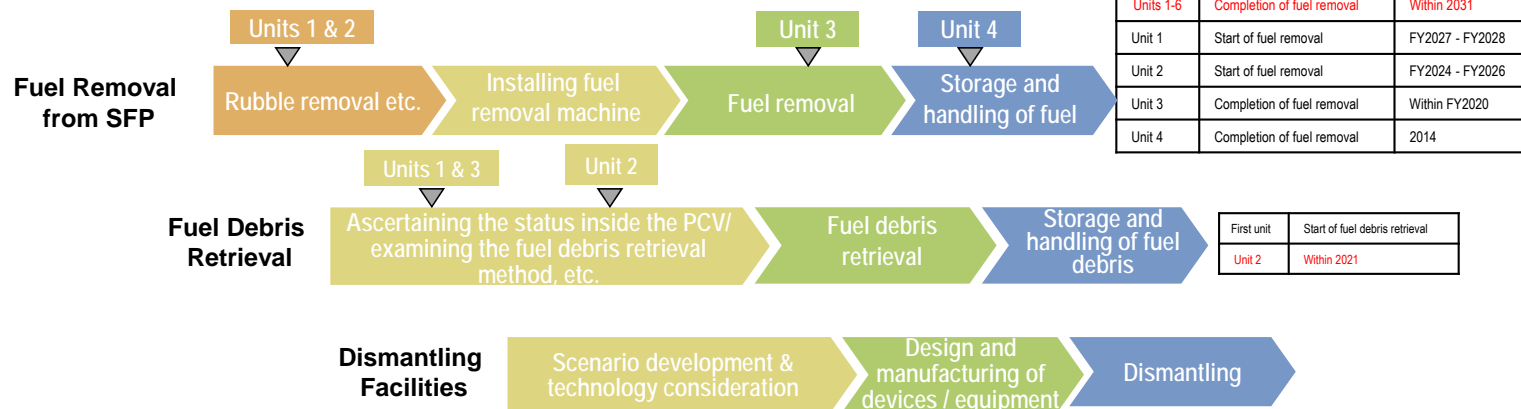


## Main decommissioning work and steps

Fuel removal from the spent fuel pool was completed in December 2014 at Unit 4 and started from April 15, 2019 at Unit 3. Dust concentration in the surrounding environment is being monitored and work is being implemented with safety first. Work continues sequentially toward the start of fuel removal from Units 1 and 2 and debris (Note 1) retrieval from Units 1-3.

(Note 1) Fuel assemblies having melted through in the accident.



## Fuel removal from the spent fuel pool

Fuel removal from the spent fuel pool started from April 15, 2019 at Unit 3. Rubble and fuel are being removed, with the aim of completing fuel removal by the end of FY2020.



Removed fuel (assemblies)  
**434/566**

Fuel removal (April 15, 2019) (As of November 26, 2020)

## Contaminated water management - three efforts -

### (1) Efforts to promote contaminated water management based on the three basic policies

- ① "Remove" the source of water contamination
- ② "Redirect" fresh water from contaminated areas
- ③ "Retain" contaminated water from leakage

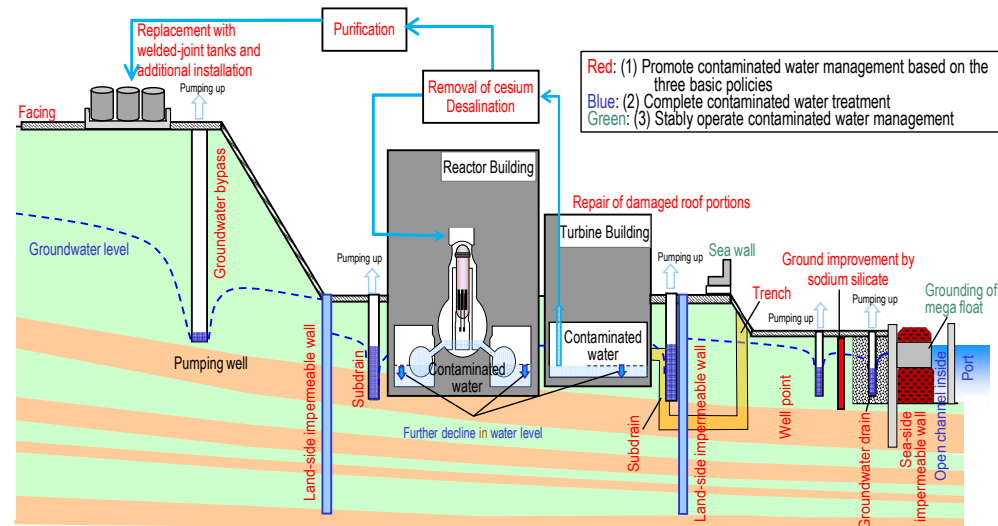
- Strontium-reduced water from other equipment is being re-treated in the multi-nuclide removal equipment (ALPS) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and subdrains, have stabilized the groundwater at a low level and the increased contaminated water generated during rainfall is being suppressed by repairing damaged portions of building roofs, facing onsite, etc. Through these measures, the generation of contaminated water was reduced from approx. 540 m<sup>3</sup>/day (in May FY2014) to approx. 180 m<sup>3</sup>/day (in FY2019).
- Measures continue to further suppress the generation of contaminated water to approx. 150 m<sup>3</sup>/day within FY2020 and 100 m<sup>3</sup>/day or less within 2025.

### (2) Efforts to complete contaminated water treatment

- To lower the contaminated water levels in buildings as planned, work to install an additional contaminated water transfer equipment is underway. At present, the floor surface exposure condition can be maintained except for the Unit 1-3 Reactor Buildings, Process Main Building and the High Temperature Incinerator Building.
- Treatment of contaminated water in buildings will be completed within 2020, excluding Unit 1-3 Reactor Buildings, Process Main Building and High-Temperature Incinerator Building. For Reactor Buildings, the amount of contaminated water there will be reduced from the level at the end of 2020 during the period FY2022-2024.
- For Zeolite sandbags on the basement floors of the Process Main Building and High-Temperature Incinerator Building, measures to reduce the radiation dose are being examined with stabilization in mind.

### (3) Efforts to stably operate contaminated water management

- To prepare for tsunamis, measures including closing building openings and installing sea walls are being implemented. For heavy rain, sandbags are being installed to suppress direct inflow into buildings while work to enhance drainage channels and other measures are being implemented as planned.



# Progress status

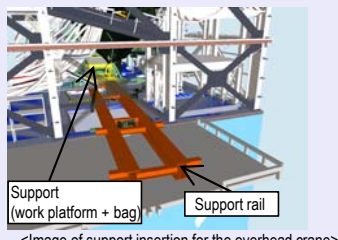
◆ The temperatures of the Reactor Pressure Vessel (RPV) and Primary Containment Vessel (PCV) of Units 1-3 have been maintained within the range of approx. 20-30°C<sup>1</sup> over the past month. There was no significant change in the concentration of radioactive materials newly released from Reactor Buildings into the air<sup>2</sup>. It was concluded that the comprehensive cold shutdown condition had been maintained.

\* 1 The values varied somewhat, depending on the unit and location of the thermometer.  
 \* 2 In October 2020, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated at less than 0.00007 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

## Unit 1 Installation of supports for the overhead crane completed

Among the measures to prevent and alleviate rubble falling, work to install supports to the Unit 1 overhead crane started from November 11 and was completed by November 24. This will minimize the risk of the overhead crane/fuel-handling machine shifting its position, becoming imbalanced and subsequently falling, as well as reducing the risk of affecting the soundness of fuel and others.

Work continues in preparation for installing the large cover over the Reactor Building.



## Unit 1 Progress toward PCV internal investigation and implementation of a test to suspend water injection into the reactor

As part of efforts toward the internal investigation of the Unit 1 Primary Containment Vessel (PCV), work to cut obstacles inside the PCV on the route for the investigation equipment is underway from May 26.

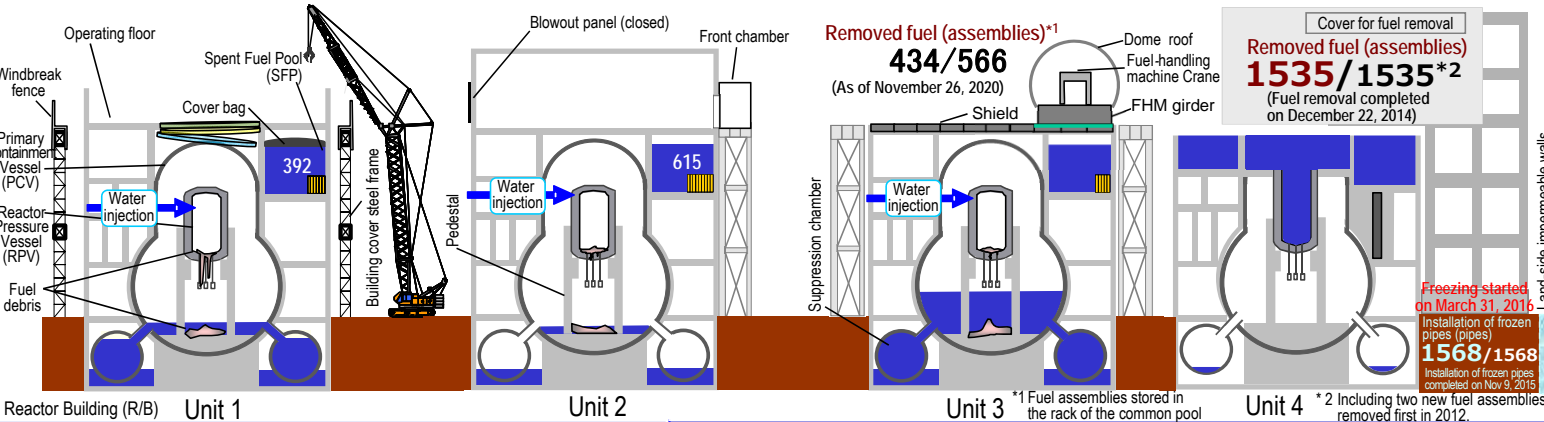
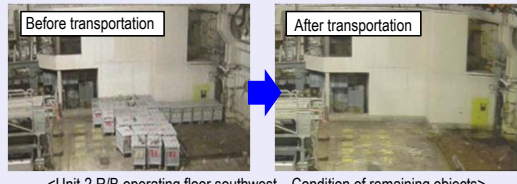
Preparation for cutting steel materials under the grating started from September 29. However, it was confirmed that there were instrumentation pipes for the Primary Loop Recirculation System under the cutting scope. After manufacturing a new camera to decide the exact cutting location, an investigation for the obstacles will be conducted.

During the period until the obstacle investigation, a test to suspend water injection into the reactor will be implemented from November 26 to December 16. (Water injection suspension period: for about five days from November 26 to December 1)

## Unit 2 Removal of remaining objects on the operating floor to be completed toward fuel removal

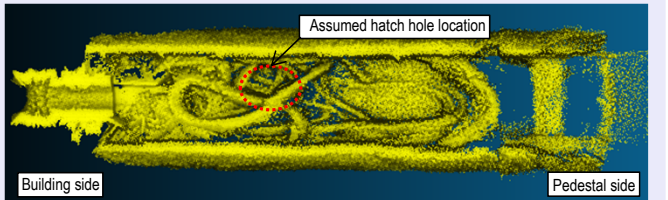
Transportation of remaining objects inside the operating floor of the Unit 2 Reactor Building started from August and will be completed by early December.

After the transportation, in response to the altered environment, an investigation into measures to evaluate the dose more precisely and reduce the dose will start from December. The investigation will use remotely operated equipment to measure the air dose rate and surface contamination and take photos of the entire operating floor by a γ-camera.



## Unit 2 Investigation into deposits inside the PCV penetration

As a preparatory stage for the PCV internal investigation and the trial retrieval, a 3D scan investigation inside the penetration (X-6 penetration) was conducted on October 30, whereby information about the deposit distribution and others was obtained.



## Test to verify the secondary treatment performance of the ALPS-treated water follow-up report

For the high- and low-concentration areas (J1-C and -G), measurement of (1) 60 nuclides among those that must be removed except for Ni-63 and Cd-113m, (2) Carbon-14 and (3) tritium was completed. The results showed that the concentration of radioactive materials was reduced after the secondary treatment (sample tank).

The sum of the concentration required by law of 60 nuclides among those that must be removed except for Ni-63 and Cd-113m + Carbon-14  
 High concentration area (J1-C) [before] 2,406 → [after] 0.35  
 Low concentration area (J1-G) [before] 387 → [after] 0.22

Work continues to analyze and assessment each area, verify that the sum of the ratios of the concentrations required by law except for tritium is reduced below 1 by treatment, check the procedures and processes for the nuclide analysis and conduct others.



## Test operation of the additional Radioactive Waste Incinerator started

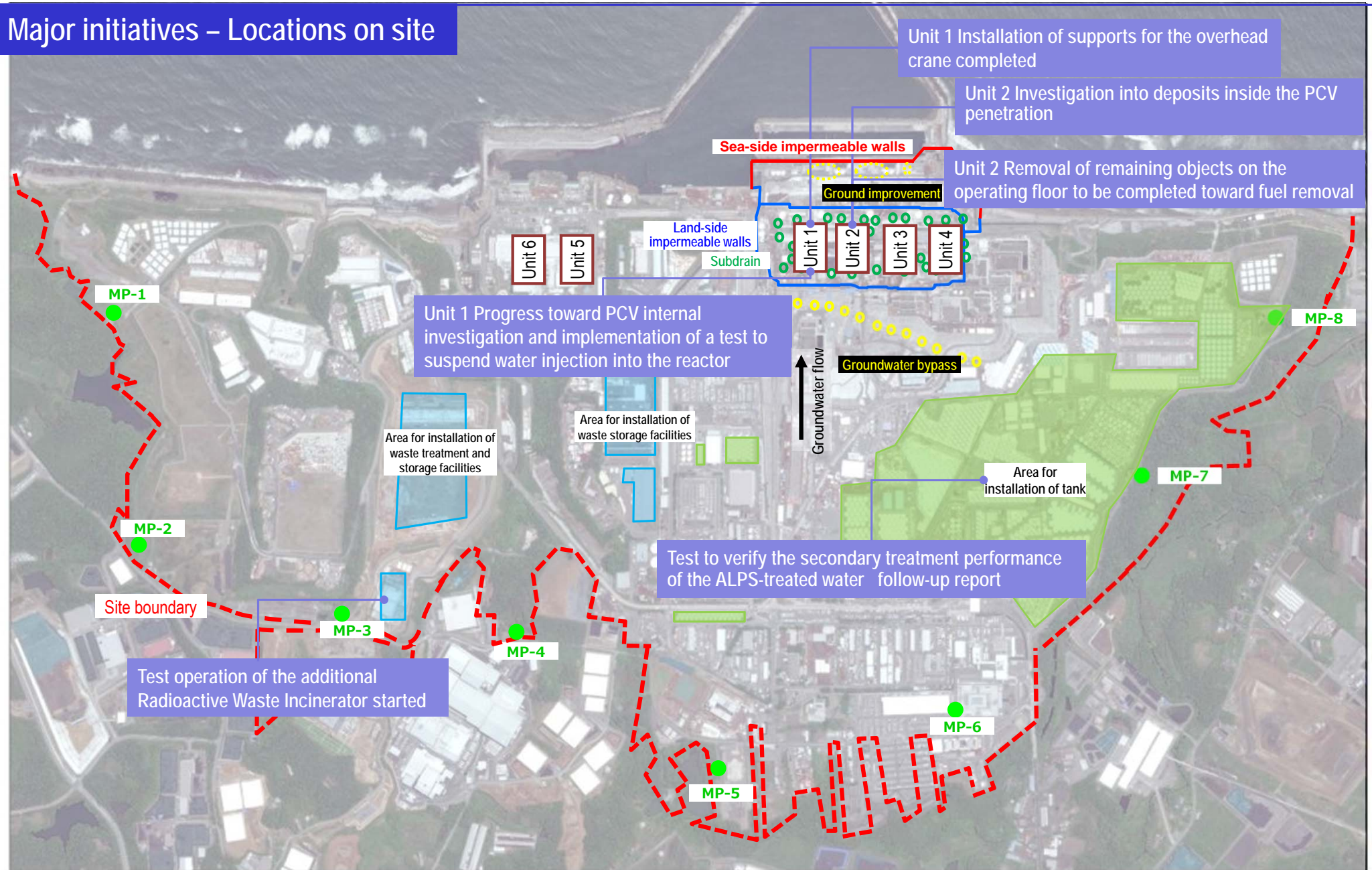
The outdoor storage of rubble and others (except for those to be recycled or reused) will be eliminated by within FY2028. For this purpose, after reducing the volume by incineration or other method, rubble and others will be stored in the solid waste storage facility. To incinerate combustible rubble (trees, packing materials, paper and others), work to install an additional Radioactive Waste Incinerator is underway.

Installation of the building and main equipment was completed, the initial burning ceremony was held on November 12 and the system test is currently being conducted.

After the cold test and the subsequent hot test, the installation will be completed by March 2021.



# Major initiatives – Locations on site



\* Data of Monitoring Posts (MP1-MP8.)

Data (10-minute values) of Monitoring Posts (MPs) measuring the airborne radiation rate around site boundaries showed 0.378 – 1.231  $\mu\text{Sv/h}$  (October 28 – November 24, 2020).

We improved the measurement conditions of monitoring posts 2 to 8 to measure the air-dose rate precisely. Construction work, such as tree-clearing, surface soil removal and shield wall setting, were implemented from February 10 to April 18, 2012.

Therefore, monitoring results at these points are lower than elsewhere in the power plant site.

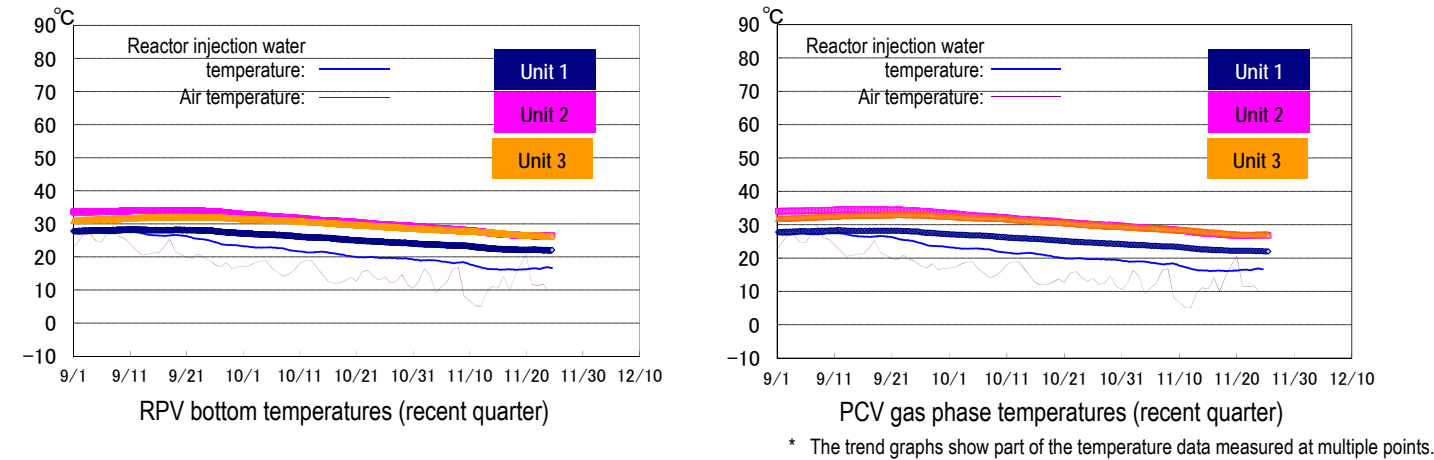
The radiation shielding panels around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, were taken off from July 10 - 11, 2013, since further deforestation, etc. had caused the surrounding radiation dose to decline significantly.

Provided by Japan Space Imaging Corp., photo taken on May 24, 2020  
Product (C) [2020] DigitalGlobe, Inc., a Maxar company

## I. Confirmation of the reactor conditions

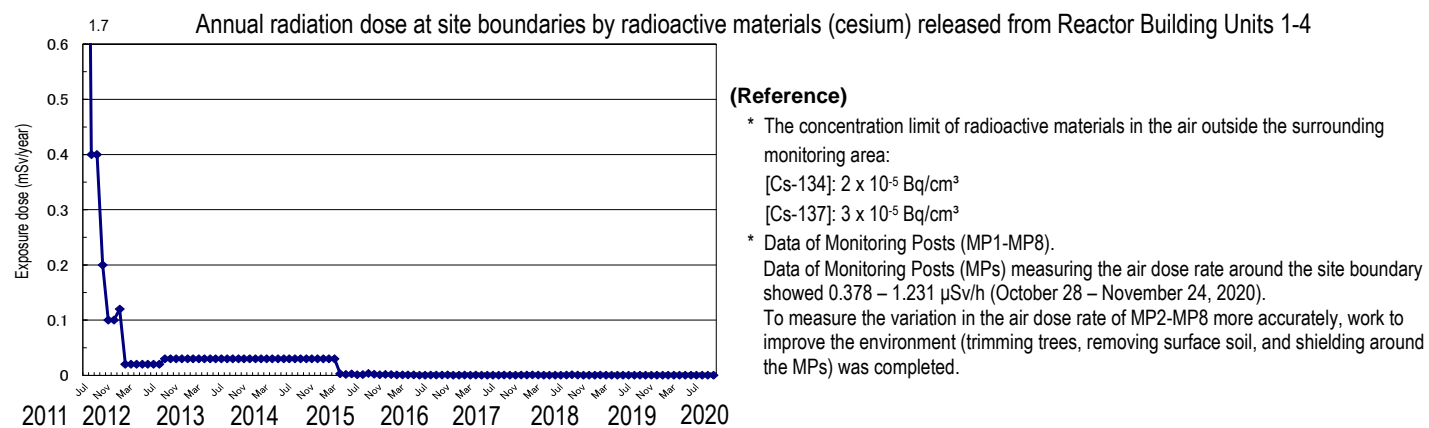
### 1. Temperatures inside the reactors

Through continuous reactor cooling by water injection, the temperatures of the Reactor Pressure Vessel (RPV) bottom and the Primary Containment Vessel (PCV) gas phase were maintained within the range of approx. 20 to 30°C for the past month, though it varied depending on the unit and location of the thermometer.



### 2. Release of radioactive materials from the Reactor Buildings

As of October 2020, the concentration of the radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx.  $3.4 \times 10^{-12}$  Bq/cm<sup>3</sup> and  $2.9 \times 10^{-12}$  Bq/cm<sup>3</sup> for Cs-134 and Cs-137 respectively, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00007 mSv/year.



Note 1: Different formulas and coefficients were used to evaluate the radiation dose in the facility operation plan and monthly report. The evaluation methods were integrated in September 2012. As the fuel removal from the spent fuel pool (SFP) commenced for Unit 4, the radiation exposure dose from Unit 4 was added to the items subject to evaluation since November 2013. The evaluation has been changed to a method considering the values of continuous dust monitors since FY2015, with data to be evaluated monthly and announced the following month.

Note 2: Radiation dose was calculated using the evaluation values of release amount from Units 1-4 and Units 5 and 6. The radiation dose of Unit 5 and 6 was evaluated based on expected release amount during operation until September 2019 but the evaluation method was reviewed and changed to calculate based on the actual measurement results of Units 5 and 6 from October.

### 3. Other indices

There was no significant change in indices, including the pressure in the PCV and the PCV radioactivity density (Xe-135) for monitoring criticality, nor was any anomaly in the cold shutdown condition or criticality sign detected.

Based on the above, it was confirmed that the comprehensive cold shutdown condition had been maintained and the reactors remained in a stabilized condition.

## II. Progress status by each plan

### 1. Contaminated water management

*Based on the three basic policies: "remove" the source of water contamination, "redirect" fresh water from contaminated areas and "retain" contaminated water from leakage, multi-layered contaminated water management measures have been implemented to stably control groundwater*

### ➤ Status of contaminated water generated

- Multi-layered measures, including pumping up by subdrains and land-side impermeable walls, which were implemented to control the continued generation of contaminated water, suppressed the groundwater inflow into buildings.
- After "redirecting" measures (groundwater bypass, subdrains, land-side impermeable walls and others) were steadily implemented, the amount generated declined from approx. 470 m<sup>3</sup>/day (the FY2014 average) when the measures were first launched to approx. 180 m<sup>3</sup>/day (the FY2019 average).
- Measures will continue to further reduce the volume of contaminated water generated.

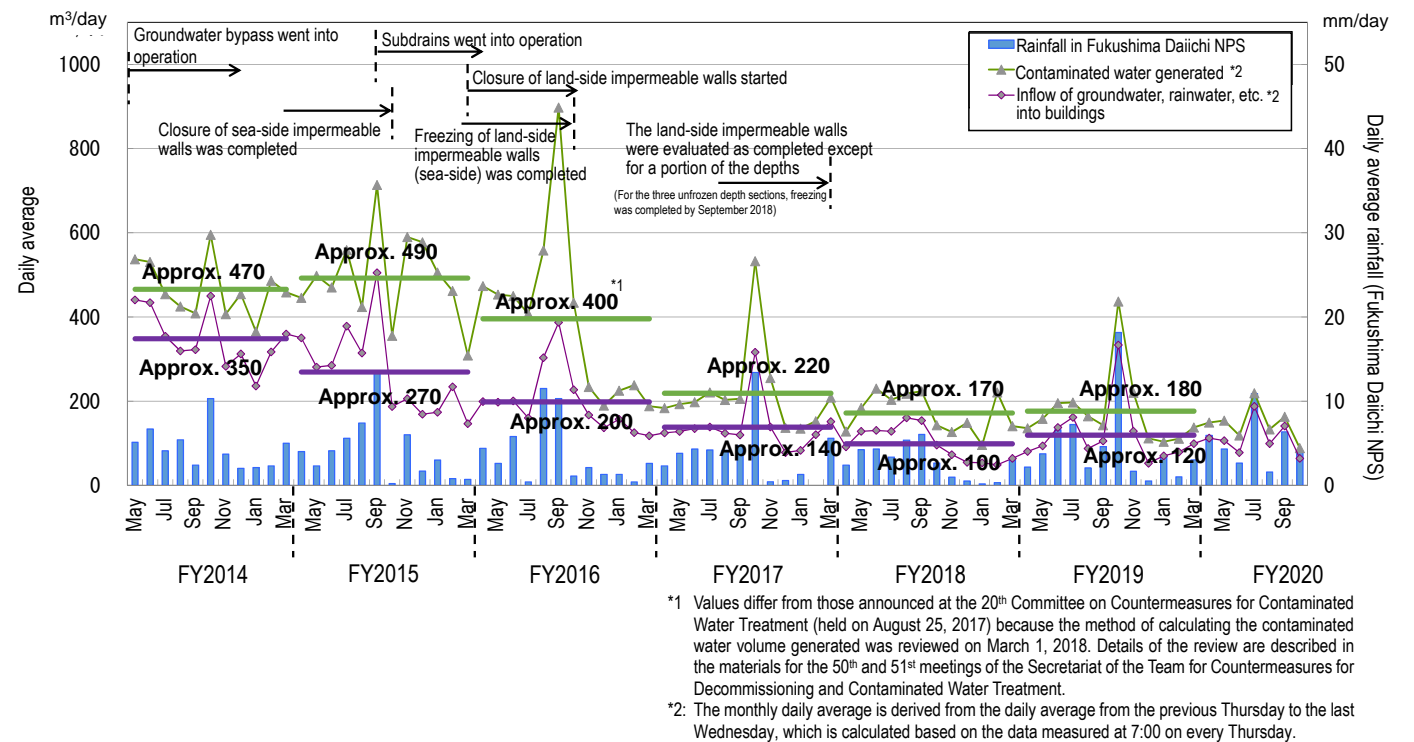


Figure 1: Changes in contaminated water generated and inflow of groundwater, rainwater, into buildings

### ➤ Operation of the groundwater bypass

- From April 9, 2014, the operation of 12 groundwater bypass pumping wells commenced sequentially to pump up groundwater. The release then started from May 21, 2014, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until November 24, 2020, 599,468 m<sup>3</sup> of groundwater had been released. The pumped-up groundwater was temporarily stored in tanks and released after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Pumps are inspected and cleaned as required based on their operational status.

### ➤ Operation of the Water Treatment Facility special for Subdrain & Groundwater drains

- To reduce the level of groundwater flowing into the buildings, work began to pump up groundwater from wells (subdrains) around the buildings on September 3, 2015. The pumped-up groundwater was then purified at dedicated facilities and released from September 14, 2015, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until November 23, 2020, a total of 1,020,660 m<sup>3</sup> had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the rising level of the groundwater drain pond after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until November 24, 2020, a total of approx. 255,311 m<sup>3</sup> had been pumped up and a volume of under 10 m<sup>3</sup>/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period October 22 – November 18, 2020).
- As one of the multi-layered contaminated-water management measures, in addition to a waterproof pavement that aims to prevent rainwater infiltrating, facilities to enhance the subdrain treatment system were installed and went into

operation from April 2018, increasing the treatment capacity from 900 to 1,500 m<sup>3</sup>/day and improving reliability. Operational efficiency was also improved to treat up to 2,000 m<sup>3</sup>/day for almost one week during the peak period.

- To maintain the groundwater level, work to install additional subdrain pits and recover those existing is underway. The additional pits are scheduled to start operation sequentially, from pits for which work is completed (12 of 14 new subdrain pits went into operation). To recover existing pits, work for all three pits scheduled was completed and all went into operation from December 26, 2018. Work to recover another pit (No. 49) started from November 2019 and it went into operation from October 9, 2020.
- To eliminate the need to suspend water pumping while cleaning the subdrain transfer pipe, the pipe will be duplicated. Installation of the pipe and ancillary facilities was completed.
- Since the subdrains went into operation, the inflow to buildings tended to decline to under 150 m<sup>3</sup>/day when the subdrain water level declined below T.P. 3.0 m but increased during rainfall.

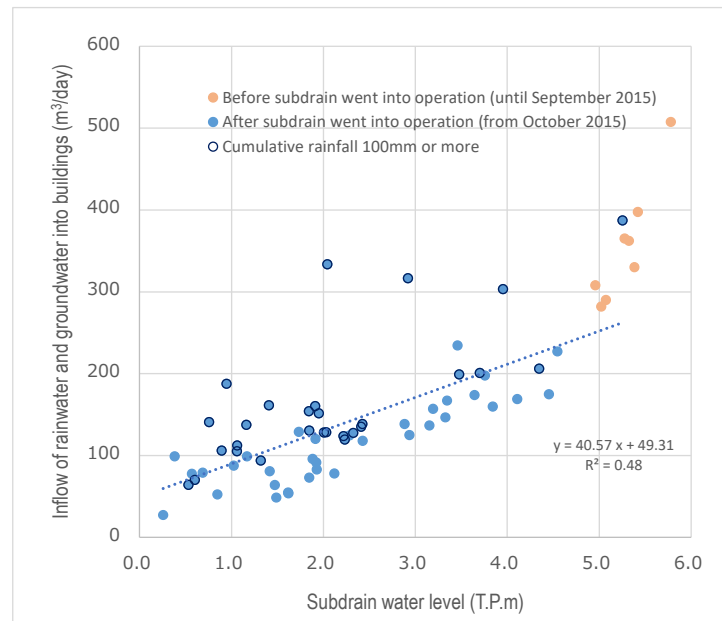


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 subdrains

#### ➤ Implementation status of facing

- Facing is a measure involving asphaltting of the on-site surface to reduce the radiation dose, prevent rainwater infiltrating the ground and decrease the amount of underground water flowing into buildings. As of the end of October 2020, 94% of the planned area (1,450,000 m<sup>2</sup> on site) had been completed. For the area inside the land-side impermeable walls, implementation proceeds appropriately after constructing a yard from implementable zones that do not affect the decommissioning work. As of the end of October 2020, 18% of the planned area (60,000 m<sup>2</sup>) had been completed.

#### ➤ Construction status of the land-side impermeable walls and status of groundwater levels around the buildings

- An operation to maintain the land-side impermeable walls and prevent the frozen soil from thickening further continued from May 2017 on the north and south sides and started from November 2017 on the east side, where sufficiently thick frozen soil was identified. The scope of the maintenance operation was expanded in March 2018.
- In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas, while on the mountain side, the difference in internal and external water levels increased to approx. 4-5 m. The 21st Committee on Countermeasures for Contaminated-Water Treatment, held on March 7, 2018, evaluated that alongside the function of subdrains and other measures, a water-level management system to stably control groundwater and redirect groundwater from the buildings had been established and allowed the amount of contaminated water generated to be reduced significantly.

- A supplementary method was implemented for the unfrozen depth and it was confirmed that the temperature of this portion had declined below 0°C by September 2018. From February 2019, a maintenance operation started throughout all sections.
- The groundwater level in the area inside the land-side impermeable walls has been declining every year. On the mountain side, the difference between the inside and outside was maintained, despite varying during rainfall. The water level of the groundwater drain observation well has been maintained at approx. T.P.+1.5 m, sufficiently below the ground surface (T.P. 2.5 m).

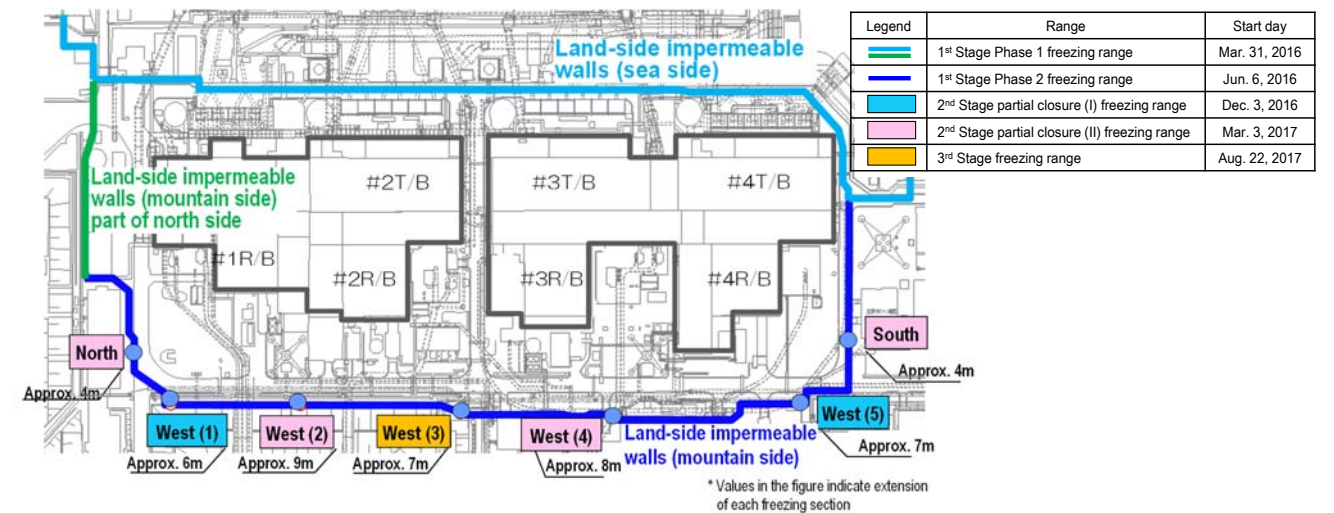


Figure 3: Closure parts of the land-side impermeable walls (on the mountain side)

#### ➤ Operation of multi-nuclide removal equipment

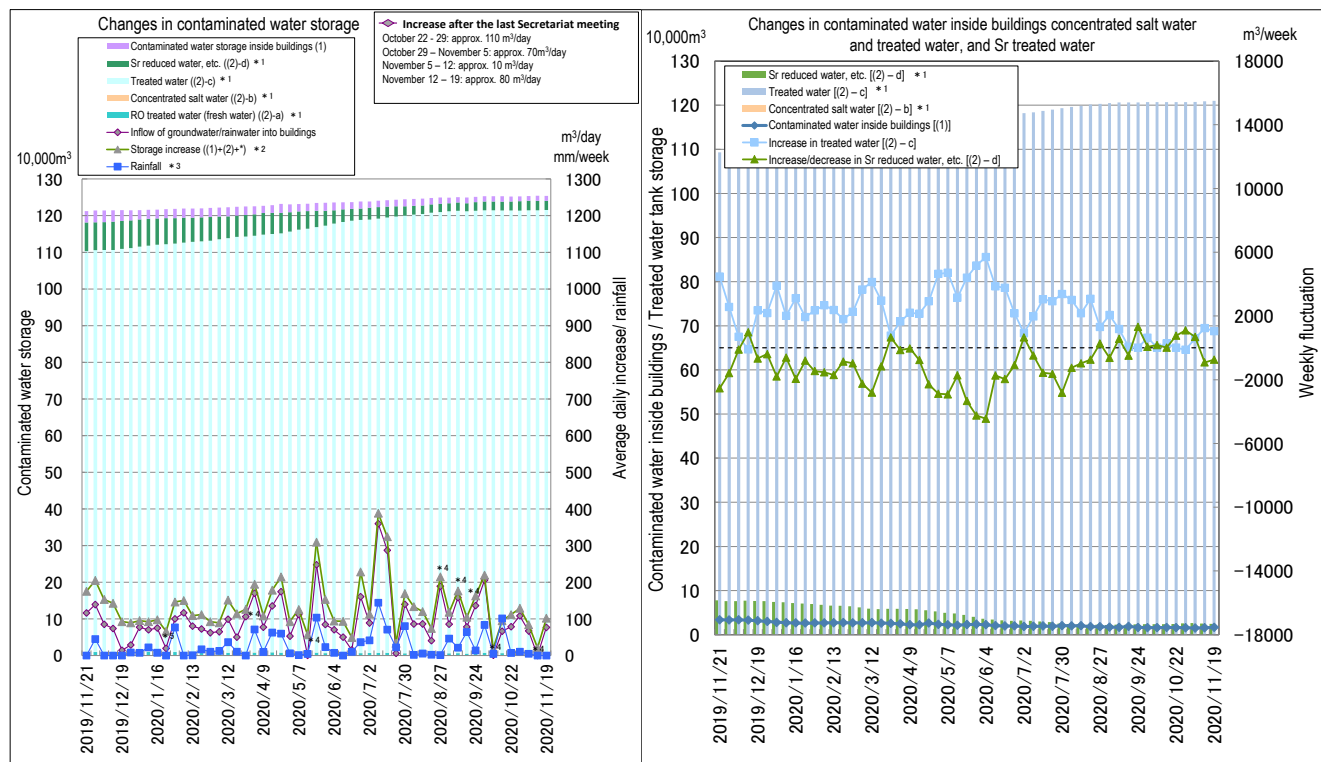
- Regarding the multi-nuclide removal equipment (existing and high-performance), hot tests using radioactive water are underway (for existing equipment, System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013; and for high-performance equipment, from October 18, 2014). The additional multi-nuclide removal equipment went into full-scale operation from October 16, 2017.
- As of November 19, 2020, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 456,000, 684,000 and 103,000 m<sup>3</sup>, respectively (including approx. 9,500 m<sup>3</sup> stored in the J1(D) tank, which contained water with highly concentrated radioactive materials at the System B outlet of the existing multi-nuclide removal equipment).
- To reduce the risks of strontium reduced water, treatment using existing, additional and high-performance multi-nuclide removal equipment has been underway (existing: from December 4, 2015; additional: from May 27, 2015; high-performance: from April 15, 2015). Up until November 19, 2020, approx. 766,000 m<sup>3</sup> had been treated.

#### ➤ Toward reducing the risk of contaminated water stored in tanks

- Treatment measures comprising the removal of strontium by cesium-absorption apparatus (KURION) (from January 6, 2015), the secondary cesium-absorption apparatus (SARRY) (from December 26, 2014) and the third cesium-absorption apparatus (SARRY II) (from July 12, 2019) are underway. Up until November 19, 2020, approx. 615,000 m<sup>3</sup> had been treated.

#### ➤ Measures in the Tank Area

- Rainwater accumulates and is collected inside the area of contaminated-water tanks. After removing radionuclides, the rainwater is sprinkled on the ground of the site, if the radioactivity level does not meet the standard for discharging into the environment since May 21, 2014 (as of November 23, 2020, a total of 171,361 m<sup>3</sup>).



\*1: Water amount for which the water-level gauge indicates 0% or more  
 \*2: To detect storage increases more accurately, the calculation method was reviewed as follows from February 9, 2017: (The revised method was applied from March 1, 2018)  
 [(Inflow of groundwater/rainwater into buildings) + (other transfer) + (chemical injection into ALPS)]  
 \*3: Changed from December 13, 2018 from rainfall in Namie to that within the site.  
 \*4: Considered attributable to the increased inflow of groundwater, rainwater, and others to buildings due to the decline in the level of contaminated water in buildings. (March 18, May 7-14, June 11-18, July 16-23, August 20-27, September 3-10 and 17-24, and October 1-8, 2020)  
 \*5: From the period January 16-23, 2019, amid a decline in the water level in Unit 4 R/B, system water in S/C flowing into R/B contaminated water is reflected in the inflow of groundwater and rainwater in addition to the transferred amount generated in decommissioning work.

Figure 4: Status of contaminated water storage

➤ Response to the Unit 1/2 exhaust stack drain sump pit

- In response to the water level in the pit confirmed as varying during rainfall, even after the lid was installed on the exhaust stack top, the inside of the pit was investigated to find an inflow route in July 2020. The investigation detected wet marks, which were considered traces of rainwater inflow from the south side of the pit. It was assumed that rainwater entered from the opening on the south side of the rain cover into the upper part of the pit and mainly flowed in from the south side of the pit.
- The radioactivity concentration of inflow water was estimated based on the level inside the pit. It was considered that in addition to the radioactivity around the south side of the pit being carried by rainwater, radioactivity having adhered within the pit or transfer system may contribute to the concentration. At the same time, the estimated concentration in inflow water had been declining. It was also considered that due to rainwater inflow, radioactivity adhesion in and around the pit and within the transfer system may be gradually declining.
- Measures to prevent rainwater inflow into the opening on the south side of the rain cover were planned and the work will be implemented in December 2020. After completing the work, an inspection will be conducted to check for any water-level variation during rainfall.

➤ Investigative results of the cross-flow filter for the additional ALPS

- Regarding the additional multi-nuclide removal equipment (additional ALPS) System B, the test of the secondary treatment (J1-C area) for the period September 18-23 detected slightly cloudy water in the rear stage of the cross-flow filter (CFF), which had been checked during the normal operation. Based on this result, when the operation resumed on October 27, the Ca concentration was measured for water sampled from the CFF secondary-side drain line, whereby a high Ca concentration and cloud were detected in three of six units.
- To check for potentially similar events occurring in Systems A and C for additional ALPS, the Ca concentration was

measured for water sampled from the secondary-side drain line of each CFF, as was done for System B. A high Ca concentration was detected in three of six units in System A, while no abnormality was identified in System C.

- In response to the assumed abnormality in the CFF of Systems A and B for the additional ALPS, the inside of the equipment will be inspected.
- As of November, daily water treatment can be accommodated by a single operation system for each of the existing/additional ALPS and has received no influence.

2. Fuel removal from the spent fuel pools

*Work to help remove spent fuel from the pool is progressing steadily while ensuring seismic capacity and safety. The removal of spent fuel from the Unit 4 pool commenced on November 18, 2013 and was completed by December 22, 2014*

➤ Main work to help spent fuel removal at Unit 1

- From March 18, 2019, the removal of small rubble in the east-side area around the spent fuel pool (SFP) started using pliers and suction equipment, while small rubble removal on the south side of the SFP started from July 9.
- The well plug, which was considered misaligned due to the influence of the hydrogen explosion at the time of the accident, was investigated for the period July 17 – August 26, 2019, by taking photos with a camera, measuring the air dose rate and collecting 3D images.
- A prior investigation on September 27, 2019 confirmed the lack of any obstacle which may affect the plan to install the cover over the SFP, the absence of any heavy object such as a concrete block on the fuel rack, as detected in Unit 3 and the fact that panel- and bar-shaped rubble pieces were scattered on the rack.
- After examining two methods: (i) installing a cover after rubble removal and (ii) initially installing a large cover over the Reactor Building and then removing rubble inside the cover, method (ii) was selected for safer and more secure removal.
- Before removing the fallen roof and other objects on the south side, to minimize the risk of the overhead crane/fuel-handling machine shifting its position, becoming imbalanced and subsequently falling, materials to support the fuel-handling machine from below will be installed.
- Among the measures to prevent and alleviate rubble falling, work to install supports to the Unit 1 fuel-handling machine started from October 6 and was completed by October 23.
- To install the support for the overhead crane, preparation started from October and the work was completed on November 24.
- Rubble removal and other work will proceed steadily with safety first, toward starting fuel removal during the period FY2027 to FY2028.

➤ Main work to help spent fuel removal at Unit 2

- On November 6, 2018, before investigating with a work plan to dismantle the Reactor Building rooftop and other tasks in mind, work to move and contain the remaining objects on the operating floor (1st round) was completed.
- On February 1, 2019, an investigation to measure the radiation dose on the floor, walls and ceiling inside the operating floor and confirm the contamination status was completed. After analyzing the investigative results, the “contamination concentration distribution” throughout the entire operating floor was obtained, based on which the air dose rate inside the operating floor could be evaluated. A shielding design and measures to prevent radioactive material scattering will be examined.
- From April 8, 2019, work to move and contain the remaining objects on the operating floor (second round) started, such as materials and equipment which may hinder installation of the fuel-handling facility and other work. The second round mainly included moving the remaining small objects and placing them in the container. It also included cleaning the floor to suppress dust scattering and was completed on August 21.
- From September 10, 2019, work got underway to move and contain the remaining objects on the operating floor (third round), such as materials and equipment which may hinder the installation of the fuel-handling facility and other work. The third round mainly included moving the remaining large objects and placing them in the container.

- After completing the training to practice work skills for transportation, preparatory work inside the operating floor started from July 20, 2020. Containers housing the remaining objects during the previous work will be transported to the solid waste storage facility from August 26, and will be completed by early December.
- For fuel removal methods, based on the investigative results inside the operating floor from November 2018 to February 2019, a method to access from a small opening installed on the south side of the building was selected with aspects such as dust management and lower work exposure in mind (the method previously examined had involved fully dismantling the upper part of the building).

#### ➤ Main process to help fuel removal at Unit 3

- From April 15, 2019, work got underway to remove 514 spent fuel assemblies and 52 non-irradiated fuel assemblies (566 in total) stored in the spent fuel pool. Seven non-irradiated fuel assemblies were then loaded into the transportation cask and transported to the common pool on April 23. The first fuel removal was completed on April 25.
- The periodical inspection of the fuel-handling facility, which started on July 24, 2019, was completed on September 2, 2019. Some defective rotations of the tensile truss and mast were detected during the following adjustment work toward resumption of the fuel removal. In response, parts were replaced and the operation checked to confirm no problem.
- Fuel removal work was resumed from December 23, 2019 and has proceeded as planned.
- By February 14, 2020, a visual check of all fuel handles was completed.
- The inspection of the fuel-handling machine and other equipment and additional training for added workers, which had been conducted since March 30, 2020, were completed without issue by May 23, whereupon fuel removal resumed from May 26.
- On September 2, 2020, a cable indicating the opening/closure and seating conditions of the gripper was damaged when material was caught near the wall on the south side of the pool while fuel assemblies within the pool were being transferred. The damaged cable was replaced with a spare, but a subsequent operation check detected an abnormality in the signals indicating the seating condition of the gripper or others. The circuit inside the gripper was repaired.
- On September 19, damage to the crane hydraulic hose was also detected, whereupon it was replaced with a spare.
- On November 18, after seating an empty transportation cask inside the Unit 3 SFP, the main hoisting of the crane did not rise when it was raising.
- An investigation detected an abnormality in the main hoisting motor and inverter, which will be replaced with spares. The method to replace them and the installation period required are currently being examined.
- At present, 434 of 566 fuel assemblies have been removed with the nine assemblies remaining, for which rubble needs to be removed from the fuel top.
- On August 24, a lifting test was conducted for one fuel assembly with a deformed handle, which was excluded from the previous lifting test in May and one fuel assembly, with which a deformed handle was detected after the previous lifting test. Based on the test results it was confirmed that both fuel assemblies could be lifted.
- On October 23, a lifting test was conducted for three assemblies with a deformed handle, which previous tests confirmed as impossible to lift. The results showed that one of them could be lifted several centimeters from the fuel rack.
- After removing rubble between the channel box and storage rack using a small-rubble removal tool, a test was conducted for the three assemblies on November 13, which confirmed that one assembly could be lifted. For the remaining two assemblies that could not be lifted, another lifting test will be implemented after applying the small-rubble removal tool again and during downtime of the fuel assembly removal work.

### 3. Retrieval of fuel debris

- Analytical results of samples related to the Unit 1-3 PCV internal investigations and others
  - With the progress of decommissioning, samples from the inside of the Unit 1-3 PCV, which could not be obtained before due to the high dose environment and other issues, became available, and analysis is underway.

- The analysis focused on Uranium-containing particles where it had emerged that the main factor of  $\alpha$ -ray contained in the contaminated water was particles which could be filtered out.
- In addition, other information expected to facilitate analysis of the accident progress, such as useful to estimate cooling rate inside the reactor, was also obtained.

### 4. Plans to store, process and dispose of solid waste and decommission of reactor facilities

*Promoting efforts to reduce and store waste generated appropriately and R&D to facilitate adequate and safe storage, processing and disposal of radioactive waste*

#### ➤ Management status of the rubble and trimmed trees

- As of the end of October 2020, the total storage volume for concrete and metal rubble was approx. 305,000 m<sup>3</sup> (+1,900 m<sup>3</sup> compared to at the end of September with an area-occupation rate of 74%). The total storage volume of trimmed trees was approx. 134,400 m<sup>3</sup> (slight increase, with an area-occupation rate of 77%). The total storage volume of used protective clothing was approx. 31,000 m<sup>3</sup> (+1,200 m<sup>3</sup>, with an area-occupation rate of 45%). The increase in rubble was mainly attributable to work around the Unit 1-4 buildings, transfer for general waste on site and area arrangements, decontamination work of flanged tanks, work related to the port, removal of crushed stones and work around the Unit 5 and 6 buildings, while the increase in used protective clothing was attributable to the suspended operation of the incinerator.

#### ➤ Management status of secondary waste from water treatment

- As of November 5, 2020, the total storage volume of waste sludge was 426 m<sup>3</sup> (area-occupation rate: 61%), while that of concentrated waste fluid was 9,356 m<sup>3</sup> (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and other vessels, was 4,958 (area-occupation rate: 78%).

### 5. Reactor cooling

*The cold shutdown condition will be maintained by cooling the reactor by water injection and measures to complement the status monitoring will continue*

#### ➤ Removal of the Unit 1 Primary Containment Vessel nitrogen injection line (inert gas system)

- To install a large cover over the Unit 1 Reactor Building, the road for the large crane will be widened (construction of a yard).
- Before the construction, potential interference of the Primary Containment Vessel nitrogen injection line (inert gas system) was identified and work to remove the line started from November 19. The work will be implemented carefully with safety first and taking sufficient time.
- The nitrogen supply function will be maintained by other lines.

#### ➤ LCO deviation event caused by stoppage of all exhaust fans for the Unit 1 PCV gas control system

- On November 12, all exhaust fans for the Unit 1 PCV gas control system stopped. None of the systems were then capable of monitoring the radiation detector for the facility and the facility could not satisfy the limiting condition for operation (LCO).
- It was confirmed that a partner company worker, who was inspecting the facility server equipment, mistakenly pushed the emergency stop button of the exhaust fan. Subsequently, the exhaust fan restarted. After confirming that there was no abnormality in the operation condition and the detector, the operation was restored from the LCO deviation.
- Causes for mistakenly pushing the emergency stop button of the exhaust fan will be investigated and recurrence prevention measures implemented immediately after identifying the cause.

## 6. Reduction in radiation dose and mitigation of contamination

### *Effective dose reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment*

#### ➤ Status of groundwater and seawater on the east side of Turbine Building Units 1-4

- In the Unit 1 intake north side area, the H-3 concentration was below the legal discharge limit of 60,000 Bq/L at all observation holes and remained constant or has been declining. The concentration of total β radioactive materials had remained constant overall but increased temporarily from April. The trend will continue to be monitored.
- In the area between the Unit 1 and 2 intakes, the H-3 concentration has remained below the legal discharge limit of 60,000 Bq/L at all observation holes. It increased temporarily at No. 1-14 but remained constant or been declining at many observation holes overall. The concentration of total β radioactive materials has remained constant or been declining at many observation holes overall except for No.1-6, at which an increase has been observed.
- In the area between the Unit 2 and 3 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained almost constant or been declining, though it has been increasing or decreasing at No. 2-3. The concentration of total β radioactive materials has remained almost constant or been declining overall.
- In the area between Unit 3 and 4 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained constant or been declining. The concentration of total β radioactive materials has also remained constant or been declining overall.
- The concentration of radioactive materials in drainage channels has remained constant, despite increasing during rainfall.
- In the Units 1-4 open channel area of seawater intake for Units 1 to 4, the concentration of radionuclides in seawater has remained below the legal discharge limit, despite increases in Cs-137 and Sr-90 noted during rainfall. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The concentration of Cs-137 has remained slightly higher in front of the south side impermeable walls and slightly lower on the north side of the east breakwater since March 20, 2019, when the silt fence was transferred to the center of the open channel due to mega float-related construction.
- In the port area, the concentration of radionuclides in seawater has remained below the legal discharge limit, despite increases in Cs-137 and Sr-90 observed during rainfall. They have remained below the level of those in the Units 1-4 intake open channel area and been declining following the completed installation and connection of steel pipe sheet piles for the sea-side impermeable walls.
- In the area outside the port, regarding the concentration of radioactive materials in seawater, those of Cs-137 and Sr-90 declined and remained low after steel pipe sheet piles for the sea-side impermeable walls were installed and connected.

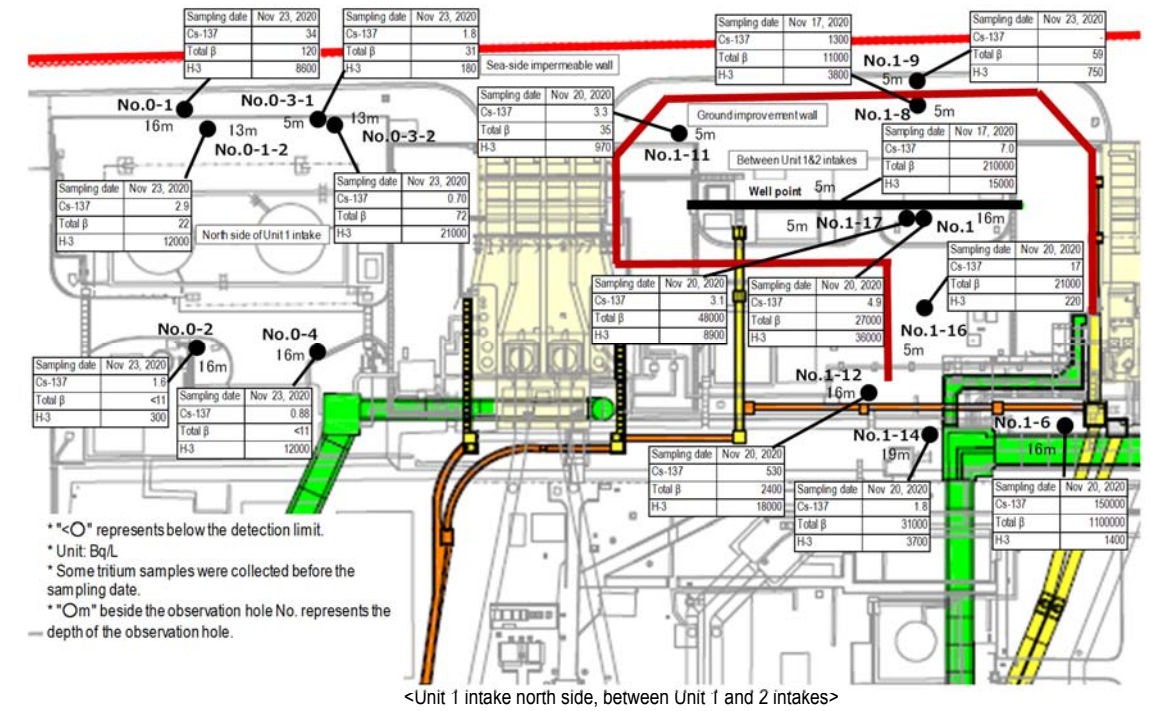


Figure 5: Groundwater concentration on the Turbine Building east side

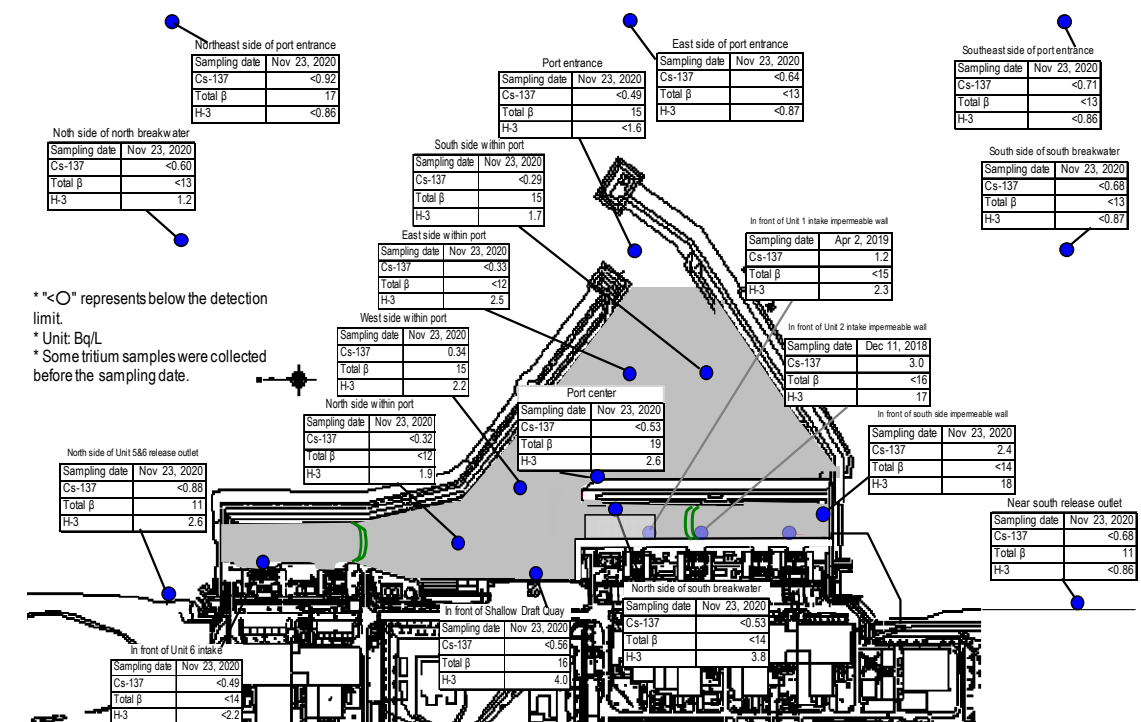


Figure 6: Seawater concentration around the port



## 7. Outlook of the number of staff required and efforts to improve the labor environment and conditions

*Adequate number of staff will be secured in the long-term while firmly implementing radiation control of workers. The work environment and labor conditions will be continuously improved by responding to the needs on the site.*

### ➤ Staff management

- The monthly average total of personnel registered for at least one day per month to work on site during the past quarter from July to September 2020 was approx. 8,700 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (approx. 6,500). Accordingly, sufficient personnel are registered to work on site.
- It was confirmed with the prime contractors that the estimated manpower necessary for the work in December 2020 (approx. 3,900 per day: TEPCO and partner company workers) would be secured at present. The average numbers of workers per day per month (actual values) were maintained, with approx. 3,400 to 4,400 since FY2018 (see Figure 7).
- The number of workers from within Fukushima Prefecture slightly increased while those from outside remained constant. The local employment ratio (TEPCO and partner company workers) as of October 2020 also remained constant at around 65%.
- The monthly average exposure doses of workers remained at approx. 0.22, 0.20 and 0.21 mSv/month during FY2017, FY2018 and FY2019, respectively. (Reference: Annual average exposure dose 20 mSv/year  $\div$  12 months = 1.7 mSv/month)
- For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

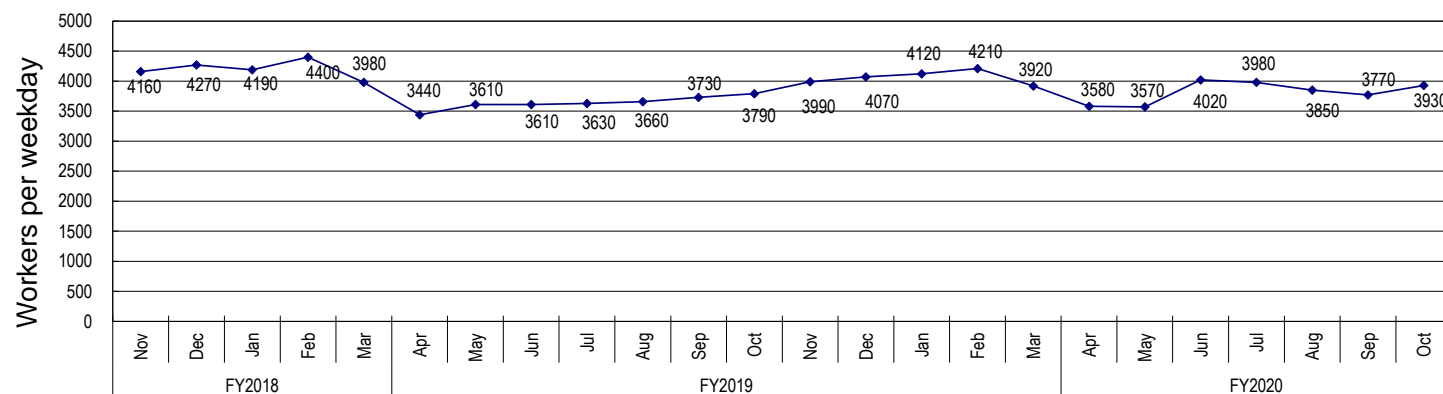


Figure 7: Changes in the average number of workers per weekday for each month of recent 2 years (actual values)

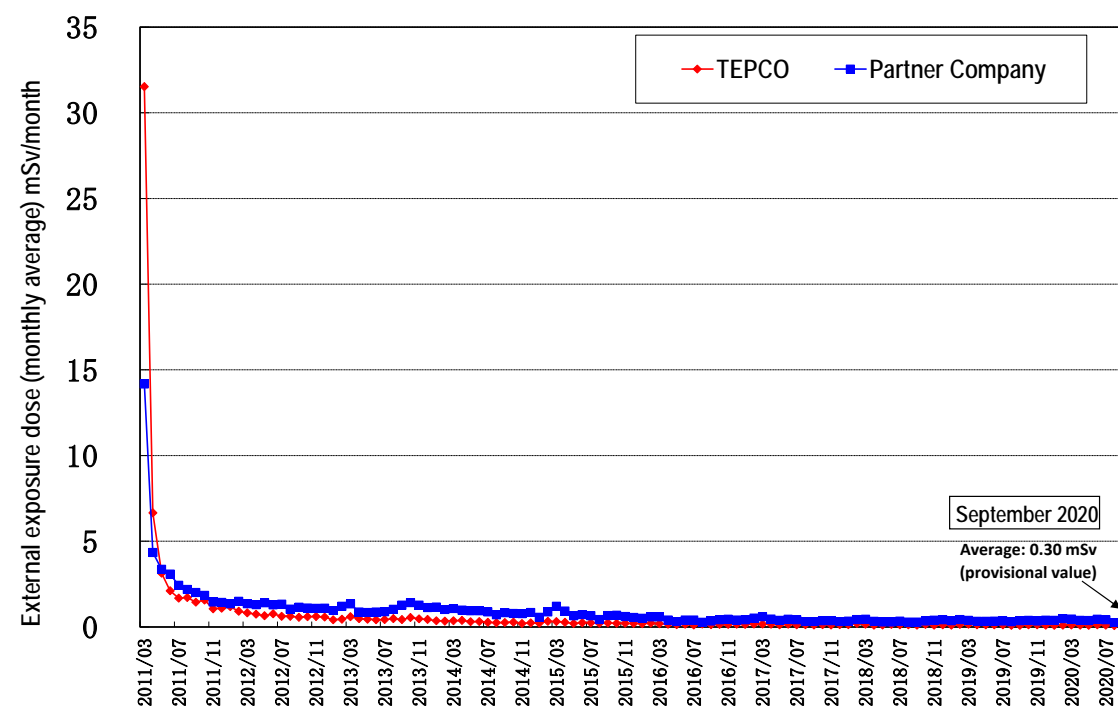


Figure 8: Changes in monthly individual worker exposure dose (monthly average exposure dose since March 2011)

### ➤ Status of heat stroke cases

- Measures to further prevent heat stroke commenced from April 2020 to cope with the hottest season.
- In FY2020, 11 workers suffered heat stroke due to work up until November 23 (in FY2019, 13 workers up until the end of October). Continued measures will be taken to prevent heat stroke.
- This fiscal year, the WBGT\* value remained almost the same as the past year. However, the management of work with full-face masks was enhanced, such as implementing a moderate work plan (work hours) for workers over 40 whose physical strength was declining, new entrants and those with a medical history. Moreover, a new refrigerant which almost tripled the cooling effect of the conventional one was introduced. Consequently, the number of heat stroke cases declined compared to that in FY2019.
- In FY2021, as well as continuing ongoing measures, the necessary prevention rules will be reviewed and the method to call attention will be examined based on the factors and characteristics of heat stroke occurrence in FY2020 to further improve the work environment.

\* WBGT (heat index): Index using three perspectives of humidity, radiation heat and temperature, which significantly affect the heat balance of human bodies

### ➤ Measures to prevent infection and expansion of influenza and norovirus

- Since November, measures for influenza and norovirus have been implemented, including free influenza vaccinations (subsidized by TEPCO HD) at medical clinics around the site (from October 12, 2020 to January 28, 2021) for partner company workers. As of November 18, 2020, a total of 2,722 workers had been vaccinated. In addition, a comprehensive range of other measures is also being implemented, including daily actions to prevent infection and expansion (measuring body temperature, health checks and monitoring infection status) and response after detecting possible infections (swift exit of possible patients and control of entry, mandatory wearing of masks in working spaces, etc.).

### ➤ Status of influenza and norovirus cases

- Until the 47th week of 2020 (November 16-22, 2020), no influenza infections and no norovirus infections were recorded. The totals for the same period for the previous season showed five cases of influenza and no norovirus infections.

Note: The above data is based on reports from TEPCO and partner companies, which include diagnoses at medical clinics outside the site. The subjects of this report were workers of partner companies and TEPCO in Fukushima Daiichi and Daini Nuclear Power Stations.

### ➤ COVID-19 infectious disease prevention countermeasures at the Fukushima Daiichi NPS

- At the Fukushima Daiichi Nuclear Power Station (NPS), countermeasures according to the local infection status will continue to prevent the COVID-19 infection spreading, such as requiring employees to take their temperature prior to coming to the office, wear masks at all times and avoid the "Three Cs" (Closed spaces, Crowded places, Close-contact settings) by shift-use of the rest house, etc.
- As of November 24, 2020, no TEPCO HD employees or cooperative firm laborers of the Fukushima Daiichi NPS had contracted COVID-19, nor was any significant influence on decommissioning work, such as a delay to the work processes, identified.

## Status of seawater monitoring around outside of the port (comparison between the highest values in 2013 and the latest values)

Unit (Bq/L); ND represents a value below the detection limit; values in ( ) represent the detection limit; ND (2013) represents ND throughout 2013

(The latest values sampled during November 16-23)

Summary of TEPCO data as of November 24, 2020

	Legal discharge limit	WHO Guidelines for Drinking Water Quality
Cesium-134	60	10
Cesium-137	90	10
Strontium-90 (strongly correlate with Total β)	30	10
Tritium	60,000	10,000

【Northeast side of port entrance (offshore 1 km)】

Cesium-134	: ND (H25)	→	ND(0.60)
Cesium-137	: ND (H25)	→	ND(0.92)
Total β	: ND (H25)	→	17
Tritium	: ND (H25)	→	ND(0.86)

【East side of port entrance (offshore 1 km)】

Cesium-134	: ND (H25)	→	ND(0.44)
Cesium-137	: 1.6 (H25/10/18)	→	ND(0.64) Below 1/2
Total β	: ND (H25)	→	ND(13)
Tritium	: 6.4 (H25/10/18)	→	ND(0.87) Below 1/7

【Southeast side of port entrance (offshore 1 km)】

Cesium-134	: ND (H25)	→	ND(0.69)
Cesium-137	: ND (H25)	→	ND(0.71)
Total β	: ND (H25)	→	ND(13)
Tritium	: ND (H25)	→	ND(0.86)

Cesium-134	: ND (H25)	→	ND(0.57)
Cesium-137	: ND (H25)	→	ND(0.60)
Total β	: ND (H25)	→	ND(13)
Tritium	: 4.7 (H25/8/18)	→	1.2 Below 1/3

【North side of north breakwater (offshore 0.5 km)】

Cesium-134	: 3.3 (H25/12/24)	→	ND(0.48) Below 1/6
Cesium-137	: 7.3 (H25/10/11)	→	ND(0.49) Below 1/10
Total β	: 69 (H25/8/19)	→	15 Below 1/4
Tritium	: 68 (H25/8/19)	→	ND(1.6) Below 1/40

【Port entrance】

【South side of south breakwater (offshore 0.5 km)】

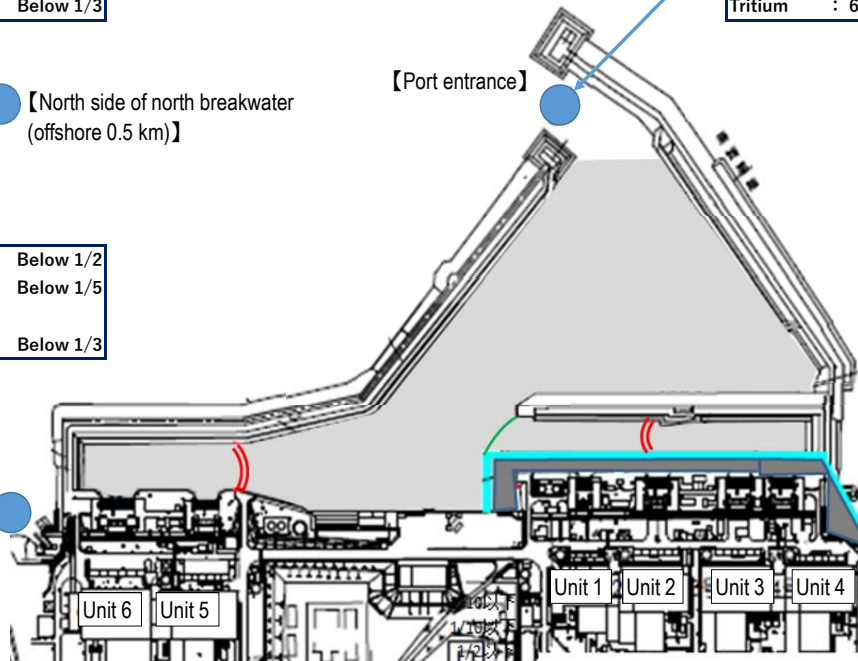
Cesium-134	: ND (H25)	→	ND(0.71)
Cesium-137	: ND (H25)	→	ND(0.68)
Total β	: ND (H25)	→	ND(13)
Tritium	: ND (H25)	→	ND(0.87)

Cesium-134	: 1.8 (H25/6/21)	→	ND(0.88) Below 1/2
Cesium-137	: 4.5 (H25/3/17)	→	ND(0.88) Below 1/5
Total β	: 12 (H25/12/23)	→	11
Tritium	: 8.6 (H25/6/26)	→	2.6 Below 1/3

Cesium-134	: ND (H25)	→	ND(0.63)
Cesium-137	: 3 (H25/7/15)	→	ND(0.68) Below 1/4
Total β	: 15 (H25/12/23)	→	11
Tritium	: 1.9 (H25/11/25)	→	ND(0.90) Below 1/2

【North side of Unit 5 and 6 release outlet】

Sea side impermeable wall	
Silt fence	
Silt fence for construction	



【Near south release outlet】

Note: The Total β measurement values include natural potassium 40 (approx. 12 Bq/L). They also include the contribution of yttrium 90, which radioactively balance strontium 90.

Note: Because safety of the sampling points was unassured due to the influence of Typhoon No. 10 in 2016, samples were taken from approx. 330 m south of the Unit 1-4 release outlet. Samples were also taken from a point approx. 280m south from the same release outlet from January 27, 2017 and approx. 320m from March 23, 2018

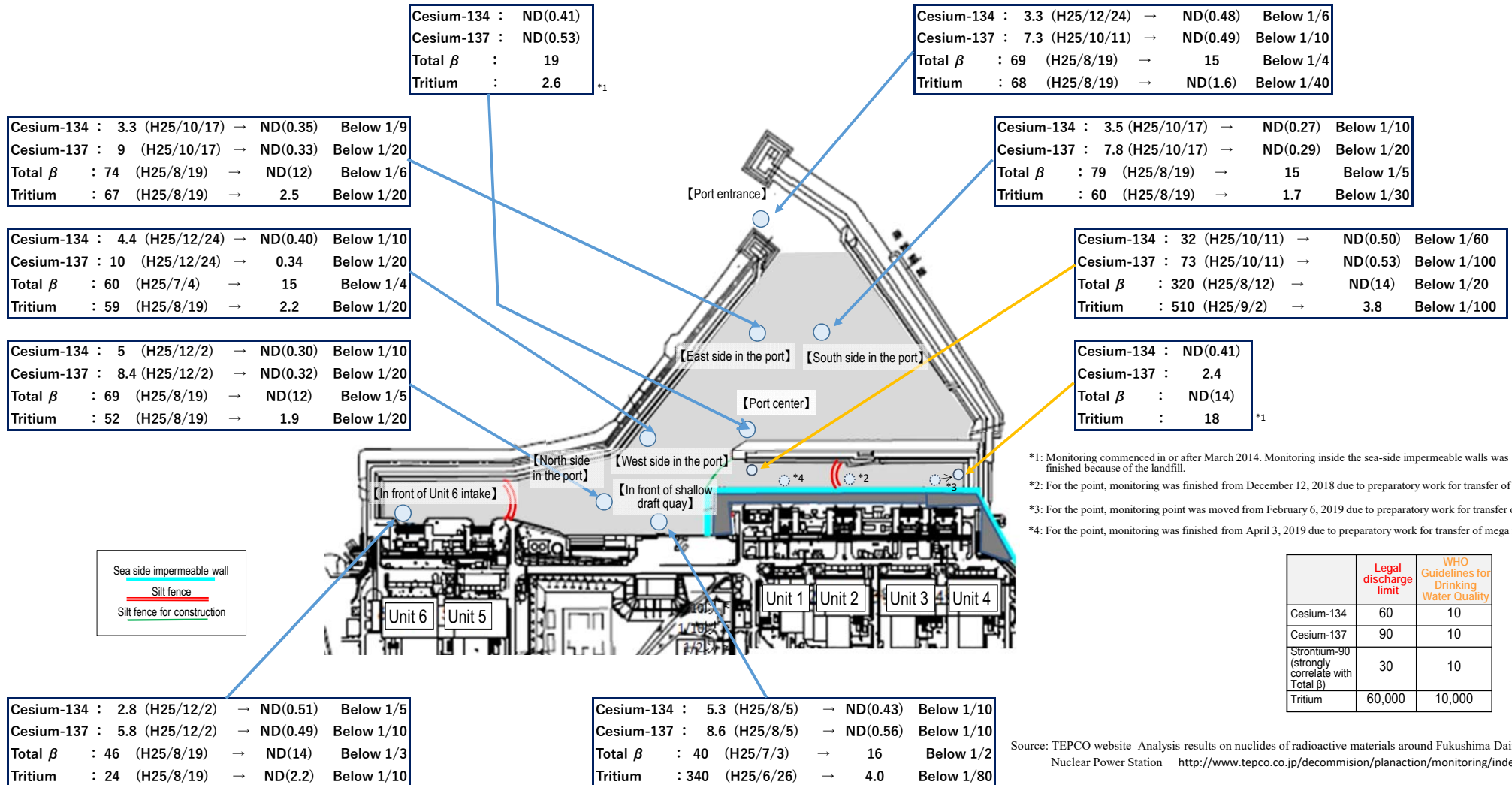
Source: TEPCO website, Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station <http://www.tepco.co.jp/decommission/planaction/monitoring/index-j.html>

## Status of seawater monitoring within the port (comparison between the highest values in 2013 and the latest values)

"The highest value" → "the latest value (sampled during November 16-23)"; unit (Bq/L); ND represents a value below the detection limit

Summary of TEPCO data as of November 24, 2020

Note: The Total β measurement values include natural potassium 40 (approx. 12 Bq/L). They also include the contribution of yttrium 90, which radioactively balance strontium 90.



Source: TEPCO website Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station <http://www.tepco.co.jp/decommission/planaction/monitoring/index-j.html>



## Progress toward decommissioning: Fuel removal from the spent fuel pool (SFP)

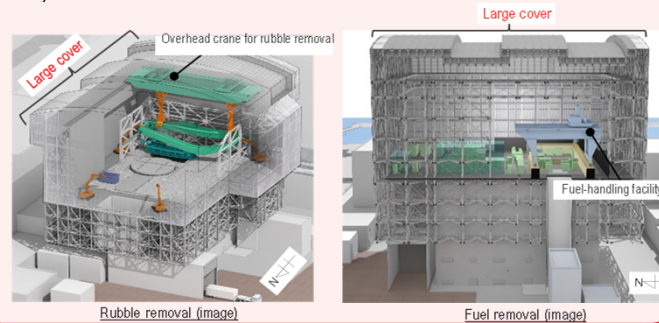
**Immediate target** Commence fuel removal from the Unit 1-3 Spent Fuel Pools

### Unit 1

Toward fuel removal from the Unit 1 spent fuel pool, investigations have been implemented to ascertain the conditions of the fallen roof on the south side and the contamination of the well plug. Based on the results of these investigations, "the method to initially install a large cover over the Reactor Building and then remove rubble inside the cover" was selected to ensure a safer and more secure removal. Work continues to complete installation of a large cover by around FY2023 and start fuel removal from FY2027 to FY2028.

<Reference> Progress to date

Rubble removal on the north side of the operating floor started from January 2018 and has been implemented sequentially. In July and August 2019, the well plug, which was misaligned from its normal position, was investigated and in August and September, the conditions of the overhead crane were checked. Based on the results of these investigations, as the removal requires more careful work taking dust scattering into consideration, two methods were examined: installing a cover after rubble removal and initially installing a large cover over the Reactor Building and then removing rubble inside the cover.

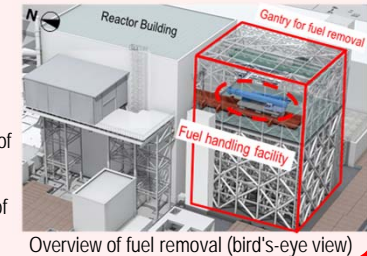


### Unit 2

Toward fuel removal from the Unit 2 spent fuel pool, based on findings from internal operating floor investigations from November 2018 to February 2019, instead of fully dismantling the upper part of the building, the decision was made to install a small opening on the south side and use a boom crane. Examination continues to start fuel removal from FY2024 to FY2026.

<Reference> Progress to date

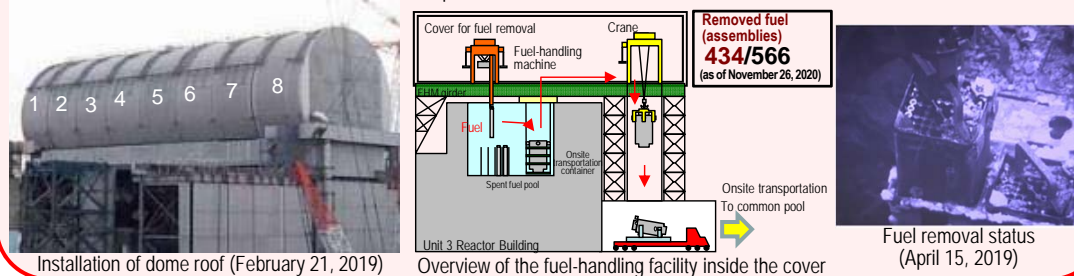
Previously, potential to recover the existing overhead crane and the fuel handling machine was examined. However, the high radiation dose inside the operating floor meant the decision was taken to dismantle the upper part of the building in November 2015. Findings from internal investigations of the operating floor from November 2018 to February 2019 underlined the potential to conduct limited work there and the means of accessing from the south side had been examined.



### Unit 3

Prior to the installation of a cover for fuel removal, removal of large rubble from the spent fuel pool was completed in November 2015. To ensure safe and steady fuel removal, training of remote control was conducted at the factory using the actual fuel-handling machine which will be installed on site (February – December 2015). Measures to reduce dose on the Reactor Building top floor (decontamination, shields) were completed in December 2016. Installation of a cover for fuel removal and a fuel-handling machine is underway from January 2017. Installation of the fuel removal cover was completed on February 23, 2018.

Toward fuel removal, the rubble retrieval training inside the pool, which was scheduled in conjunction with fuel removal training, started from March 15, 2019, and started fuel removal from April 15, 2019.



### Unit 4

In the Mid- and Long-Term Roadmap, the target of Phase 1 involved commencing fuel removal from inside the spent fuel pool (SFP) of the 1<sup>st</sup> Unit within two years of completion of Step 2 (by December 2013). On November 18, 2013, fuel removal from Unit 4, or the 1<sup>st</sup> Unit, commenced and Phase 2 of the roadmap started.

On November 5, 2014, within a year of commencing work to fuel removal, all 1,331 spent fuel assemblies in the pool had been transferred. The transfer of the remaining non-irradiated fuel assemblies to the Unit 6 SFP was completed in December 22, 2014. (2 of the non-irradiated fuel assemblies were removed in advance in July 2012 for fuel checks)

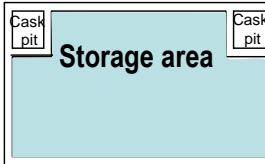
This marks the completion of fuel removal from the Unit 4 Reactor Building. Based on this experience, fuel assemblies will be removed from Unit 1-3 pools.

\* A part of the photo is corrected because it includes sensitive information related to physical protection.



Fuel removal status

### Common pool

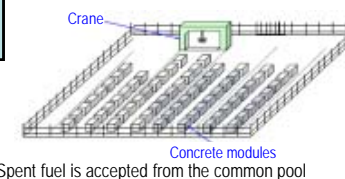


An open space will be maintained in the common pool (Transfer to the temporary cask custody area)

Progress to date

- The common pool has been restored to a condition allowing it to re-accommodate fuel to be handled (November 2012)
- Loading of spent fuel stored in the common pool to dry casks commenced (June 2013)
- Fuel removal from the Unit 4 spent fuel pool began to be received (November 2013 - November 2014)
- Fuel removal from the Unit 3 spent fuel pool began to be received (from April 2019)

### Temporary cask custody area



Operation commenced on April 12, 2013; from the cask storage building, transfer of 9 existing dry casks completed (May 21, 2013); fuel stored in the common pool sequentially transferred.

<Glossary>

- (\*) Operating floor: During regular inspection, the roof over the reactor is opened while on the operating floor, fuel inside the core is replaced and the core internals are inspected.
- (\*) Cask: Transportation container for samples and equipment, including radioactive materials.

**Immediate target** Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

### Investigation into TIP Room of the Unit 1 Reactor Building

- To improve the environment for future investigations inside the PCV, etc., an investigation was conducted from September 24 to October 2, 2015 at the TIP Room<sup>(1)</sup>. (Due to high dose around the entrance in to the TIP Room, the investigation of dose rate and contamination distribution was conducted through a hole drilled from the walkway of the Turbine Building, where the dose was low)
- The investigative results identified high dose at X-31 to 33 penetrations<sup>(2)</sup> (instrumentation penetration) and low dose at other parts.
- As it was confirmed that work inside the TIP room would be available, the next step will include identification of obstacles which will interfere the work inside the TIP Room and formulation of a plan for dose reduction.

### Investigation in the leak point detected in the upper part of the Unit 1 Suppression Chamber (S/C<sup>(3)</sup>)

Investigation in the leak point detected in the upper part of Unit 1 S/C from May 27, 2014 from one expansion joint cover among the lines installed there. As no leakage was identified from other parts, specific methods will be examined to halt the flow of water and repair the PCV.



Leak point

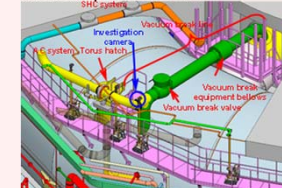
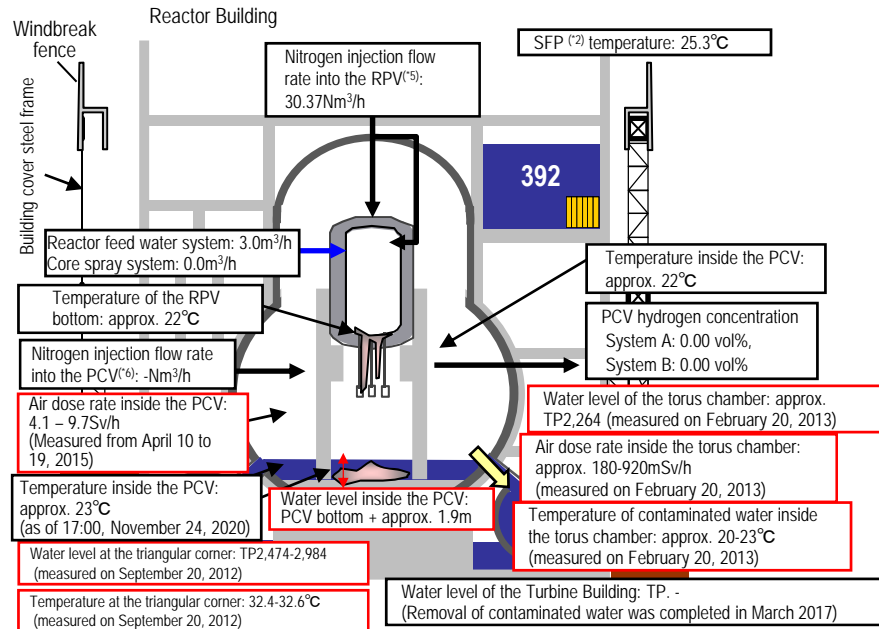


Image of the S/C upper part investigation

### Unit 1

Air dose rate inside the Reactor Building:  
 Max. 5,150mSv/h (1F southeast area) (measured on July 4, 2012)



\* Indices related to the plant are values as of 11:00, November 25, 2020

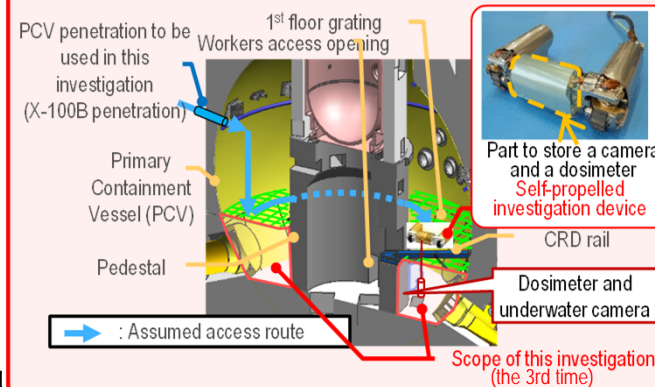
Investigations inside PCV	1st (Oct 2012)	2nd (Apr 2015)	3rd (Mar 2017)
	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling contaminated water - Installing permanent monitoring instrumentation	- Confirming the status of PCV 1st floor - Acquiring images - Measuring air temperature and dose rate - Replacing permanent monitoring instrumentation	- Confirming the status of PCV 1st basement floor - Acquiring images - Measuring air temperature and dose rate - Sampling deposit - Replacing permanent monitoring instrumentation
Leakage points from PCV	- PCV vent pipe vacuum break line bellows (identified in May 2014) - Sand cushion drain line (identified in November 2013)		

### Status of investigation inside the PCV

Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris.

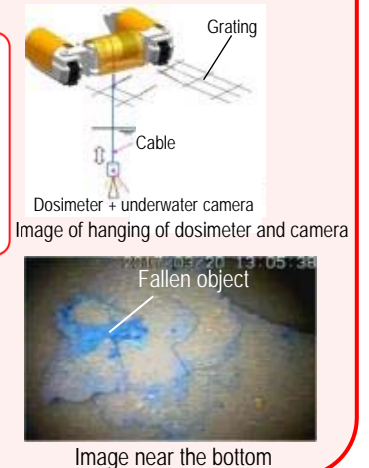
[Investigative outline]

- In April 2015, a device, which entered the inside of the PCV through a narrow access opening (bore:  $\phi$  100 mm), collected information such as images and airborne dose inside the PCV 1st floor.
- In March 2017, the investigation using a self-propelled investigation device, conducted to inspect the spreading of debris to the basement floor outside the pedestal, took images of the PCV bottom status for the first time. The status inside the PCV will continue to be examined based on the collected image and dose data.



### Capturing the location of fuel debris inside the reactor by measurement using muons

Period	Evaluation results
Feb - May 2015	Confirmed that there was no large fuel in the reactor core.



<Glossary>  
 (\*1) TIP (Traversing In-core Probe)  
 (\*2) Penetration: Through-hole of the PCV  
 (\*3) S/C (Suppression Chamber): Suppression pool, used as the water source for the emergent core cooling system.  
 (\*4) SFP (Spent Fuel Pool):  
 (\*5) RPV (Reactor Pressure Vessel)  
 (\*6) PCV (Primary Containment Vessel)

# Progress toward decommissioning: Works to identify the plant status and toward fuel debris retrieval

November 26, 2020

Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

3/6

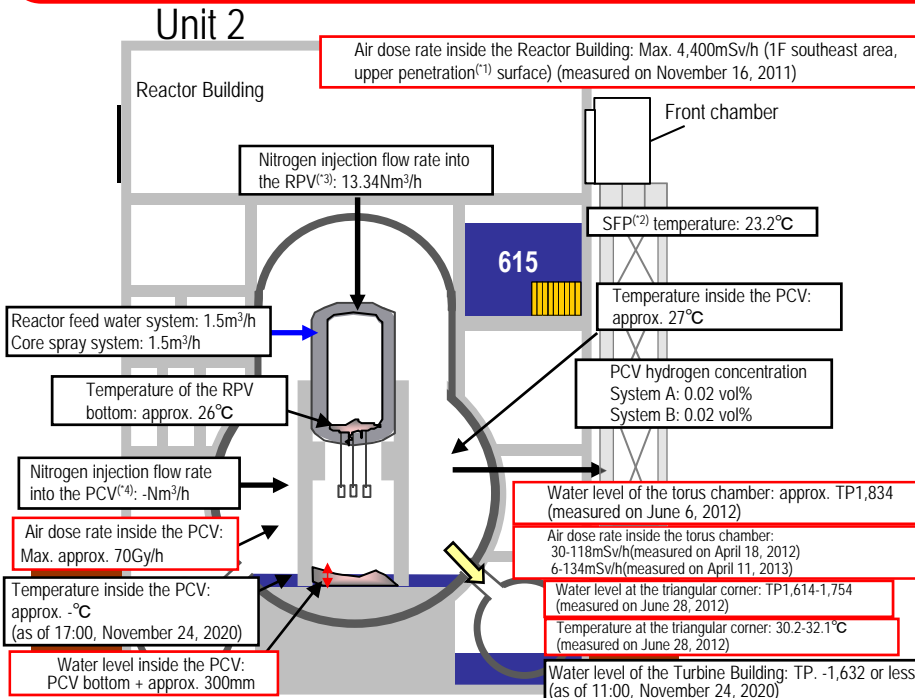
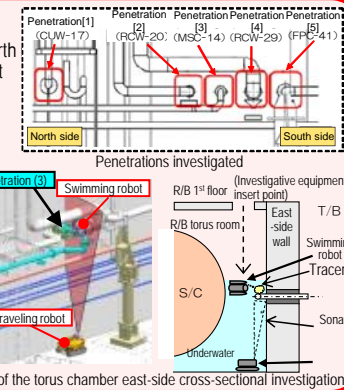
**Immediate target** Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

## Installation of an RPV thermometer and permanent PCV supervisory instrumentation

- Replacement of the RPV thermometer
  - As the thermometer installed at the Unit 2 RPV bottom after the earthquake had broken in February 2014, it was excluded from the monitoring thermometers.
  - In April 2014, removal of the broken thermometer failed and was suspended. Rust-stripping chemicals were injected and the broken thermometer was removed in January 2015. A new thermometer was reinstalled in March. The thermometer has been used as a part of permanent supervisory instrumentation since April.
- Reinstallation of the PCV thermometer and water-level gauge
  - Some of the permanent supervisory instrumentation for PCV could not be installed in the planned locations due to interference with existing grating (August 2013). The instrumentation was removed in May 2014 and new instruments were reinstalled in June 2014. The trend of added instrumentation will be monitored for approx. one month to evaluate its validity.
  - The measurement during the installation confirmed that the water level inside the PCV was approx. 300mm from the bottom.

## Investigative results on torus chamber walls

- July 2014, the torus chamber walls were investigated (on the north and the east-side walls) using equipment specially developed for that purpose (a swimming robot and a floor traveling robot).
- At the east-side wall pipe penetrations (five points), "the status" and "existence of flow" were checked.
- A demonstration using the above two types of underwater wall investigative equipment showed how the equipment could check the status of penetration.
- Regarding Penetrations 1 - 5, the results of checking the sprayed tracer <sup>(5)</sup> by camera showed no flow around the penetrations. (Investigation by the swimming robot)
- Regarding Penetration 3, a sonar check showed no flow around the penetrations. (Investigation by the floor traveling robot)



\* Indices related to plant are values as of 11:00, November 25, 2020

Investigations inside PCV	Period	Activities
Investigations inside PCV	1st (Jan 2012)	- Acquiring images - Measuring air temperature
	2nd (Mar 2012)	- Confirming water surface - Measuring water temperature - Measuring dose rate
	3rd (Feb 2013 - Jun 2014)	- Acquiring images - Sampling contaminated water - Measuring water level - Installing permanent monitoring instrumentation
	4th (Jan - Feb 2017)	- Acquiring images - Measuring dose rate - Measuring air temperature
	5th (Jan 2018)	- Acquiring images - Measuring dose rate - Measuring air temperature
	6th (Feb 2019)	- Acquiring images - Measuring dose rate - Measuring air temperature - Grasping characteristics of a portion of deposit
Leakage points from PCV	-	- No leakage from torus chamber rooftop - No leakage from all inside/outside surfaces of S/C

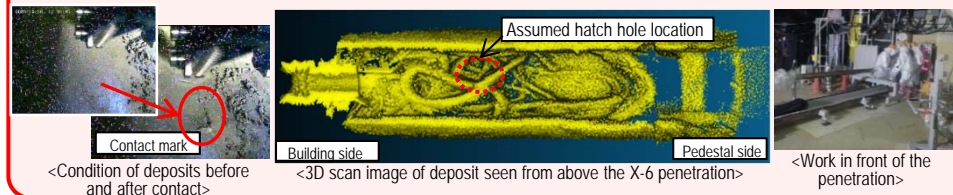
## Status of investigation inside the PCV

Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris. [Investigative outline]

- Investigative devices such as a robot will be injected from Unit 2 X-6 penetration<sup>(1)</sup> and access the inside of the pedestal using the CRD rail.

[Progress status]

- On January 26 and 30, 2017, a camera was inserted from the PCV penetration to inspect the status of the CRD replacement rail on which the robot will travel. On February 9, deposit on the access route of the self-propelled investigative device was removed and on February 16, the inside of the PCV was investigated using the device.
- The results of this series of investigations confirmed fallen and deformed gratings and a quantity of deposit inside the pedestal.
- On January 19, 2018, the status below the platform inside the pedestal was investigated using an investigative device with a hanging mechanism. From the analytical results of images obtained in the investigation, deposits probably including fuel debris were found at the bottom of the pedestal. In addition, multiple parts higher than the surrounding deposits were also detected. We presumed that there were multiple routes of fuel debris falling. Obtained data were processed in panoramic image visualization to acquire clearer images.
- On February 13, 2019, an investigation touching the deposits at the bottom of the pedestal and on the platform was conducted and confirmed that the pebble-shaped deposits, etc. could be moved and that hard rock-like deposits that could not be gripped may exist. In addition, images, etc. would help determine the contour and size of the deposits could be collected by moving the investigative unit closer to the deposits than the previous investigation.
- On October 28, 2020, as a preparatory stage of the PCV internal investigation and the trial retrieval, a contact investigation into deposits inside the penetration (X-6 penetration) was conducted. In this investigation, a guide pipe incorporating an investigative unit inserted into the penetration. By the contact, it was confirmed that deposits inside the penetration did not deform and unstuck.
- On October 30, 2020, a 3D scan investigation was conducted, measuring deposits by the 3D scan sensor mounted on the top of the investigative unit. Information obtained in the investigation will be utilized in the mockup test of the equipment to remove deposits inside the X-6 penetration.



## Capturing the location of fuel debris inside the reactor by measurement using muons

Period	Evaluation results
Mar - Jul 2016	Confirmed the existence of high-density materials, which was considered as fuel debris, at the bottom of RPV, and in the lower part and the outer periphery of the reactor core. It was assumed that a large part of fuel debris existed at the bottom of RPV.

<Glossary> <sup>(1)</sup> Penetration: Through-hole of the PCV <sup>(2)</sup> SFP (Spent Fuel Pool) <sup>(3)</sup> RPV (Reactor Pressure Vessel) <sup>(4)</sup> PCV (Primary Containment Vessel) <sup>(5)</sup> Tracer: Material used to trace the fluid flow. Clay particles

**Immediate target** Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

### Water flow was detected from the Main Steam Isolation Valve\* room

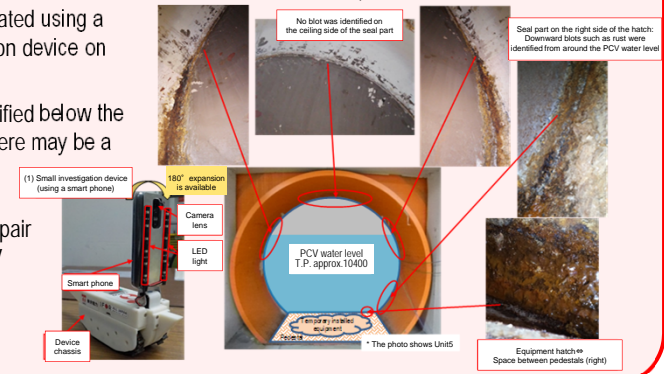
On January 18, 2014, a flow of water from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the underground part of the Reactor Building, there is no possibility of outflow from the building.

From April 23, 2014, image data has been acquired by camera and the radiation dose measured via pipes for measurement instrumentation, which connect the air-conditioning room on the Reactor Building 2nd floor with the Main Steam Isolation Valve Room on the 1st floor. On May 15, 2014, water flow from the expansion joint of one Main Steam Line was detected. This is the first leak from PCV detected in the Unit 3. Based on the images collected in this investigation, the leak volume will be estimated and the need for additional investigations will be examined. The investigative results will also be utilized to examine water stoppage and PCV repair methods.

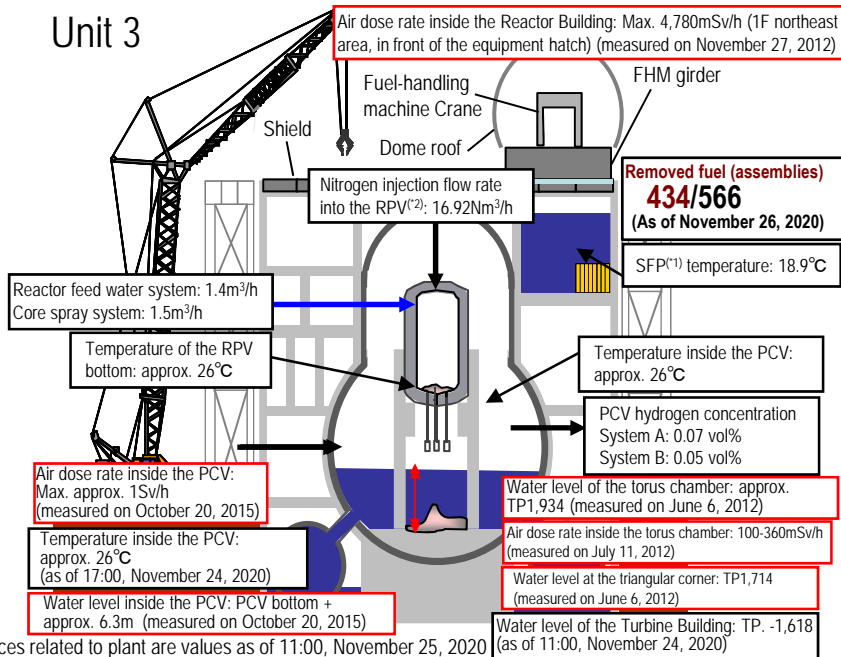
\* Main Steam Isolation Valve: A valve to shut off the steam generated from the Reactor in an emergency

### Investigative results into the Unit 3 PCV equipment hatch using a small investigation device

- As part of the investigation into the PCV to facilitate fuel debris retrieval, the status around the Unit 3 PCV equipment hatch was investigated using a small self-traveling investigation device on November 26, 2015.
- Given blots such as rust identified below the water level inside the PCV, there may be a leakage from the seal to the extent of bleeding. Methods to investigate and repair the parts, including other PCV penetrations with a similar structure, will be considered.



### Unit 3



\* Indices related to plant are values as of 11:00, November 25, 2020

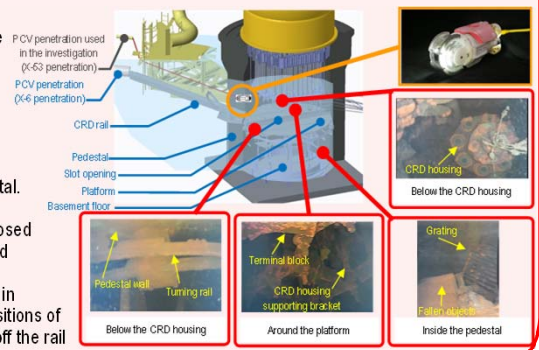
Investigations inside PCV	1st (Oct – Dec 2015)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling contaminated water - Installing permanent monitoring instrumentation (December 2015)
	2nd (Jul 2017)	- Acquiring images - Installing permanent monitoring instrumentation (August 2017)
Leakage points from PCV	- Main steam pipe bellows (identified in May 2014)	

### Investigation inside the PCV

Prior to fuel debris retrieval, the inside of the Primary Containment Vessel (PCV) was investigated to identify the status there including the location of the fuel debris.

[Investigative outline]

- The status of X-53 penetration<sup>(4)</sup>, which may be under the water and which is scheduled for use to investigate the inside of the PCV, was investigated using remote-controlled ultrasonic test equipment. The results showed that the penetration was not under the water (October 22-24, 2014).
- For the purpose of confirming the status inside the PCV, an investigation device was inserted into the PCV from X-53 penetration on October 20 and 22, 2015 to obtain images, data of dose and temperature and sample contaminated water. No damage was identified on the structure and walls inside the PCV and the water level was almost identical with the estimated value. In addition, the dose inside the PCV was confirmed to be lower than in other Units.
- In July 2017, the inside of the PCV was investigated using the underwater ROV (remotely operated underwater vehicle) to inspect the inside of the pedestal.
- Analysis of image data obtained in the investigation identified damage to multiple structures and the supposed core internals. Consideration about fuel removal based on the obtained information will continue.
- Videos obtained in the investigation were reproduced in 3D. Based on the reproduced images, the relative positions of the structures, such as the rotating platform slipping off the rail with a portion buried in deposits, were visually understood.



Status inside the pedestal

### Capturing the location of fuel debris inside the reactor by measurement using muons

Period	Evaluation results
May – Sep 2017	The evaluation confirmed that no large lump existed in the core area where fuel had been placed and that part of the fuel debris potentially existed at the bottom of the RPV.

<Glossary>  
 (1) SFP (Spent Fuel Pool) (2) RPV (Reactor Pressure Vessel) (3) PCV (Primary Containment Vessel) (4) Penetration: Through-hole of the PCV

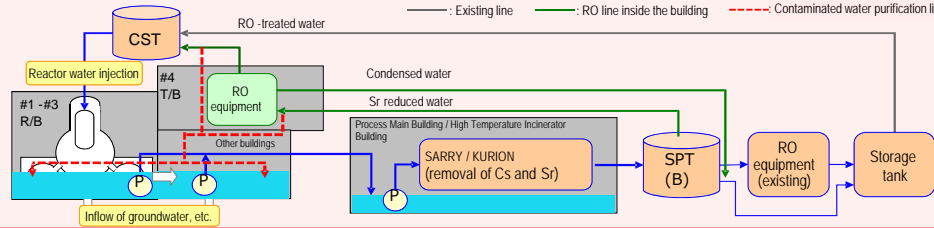


**Immediate target** Stably continue reactor cooling and contaminated water treatment, and improve reliability

Work to improve the reliability of the circulation water injection cooling system and pipes to transfer contaminated water.

- Operation of the reactor water injection system using Unit 3 Condensate Storage Tank (CST) as a water source commenced (from July 5, 2013). Compared to the previous systems, the reliability of the reactor water injection system was enhanced, e.g. by increasing the amount of water-source storage and enhancing durability.
- To reduce the risk of contaminated-water leakage, the circulation loop was shortened by installing a reverse osmosis (RO) device in the Unit 4 Turbine Building within the circulation loop, comprising the transfer of contaminated water, water treatment and injection into the reactors. Operation of the installed RO device started from October 7 and 24-hour operation started from October 20. Installation of the new RO device inside the building shortened the circulation loop from approx. 3 to 0.8 km.
- To accelerate efforts to reduce the radiation density in contaminated water inside the buildings, circulating purification of contaminated water inside the buildings started on the Unit 3 and 4 side on February 22 and on the Unit 1 and 2 side on April 11.
- For circulating purification, a new pipe (contaminated water purification line) divided from the water treatment equipment outlet line was installed to transfer water purified at the water treatment equipment to the Unit 1 Reactor Building and the Unit 2-4 Turbine Buildings.
- The risks of contaminated water inside the buildings will continue to be reduced in addition to reduction of its storage.

\* The entire length of contaminated water transfer pipes is approx. 2.1km, including the transfer line of surplus water to the upper heights (approx. 1.3km).



Progress status of dismantling of flange tanks

- To facilitate replacement of flanged tanks, dismantling of flanged tanks started in H1 east/H2 areas in May 2015. Dismantling of all flanged tanks was completed in H1 east area (12 tanks) in October 2015, in H2 area (28 tanks) in March 2016, in H4 area (56 tanks) in May 2017, in H3 B area (31 tanks) in September 2017, in H5 and H5 north areas (31 tanks) in June 2018, in G6 area (38 tanks) in July 2018, H6 and H6 north areas (24 tanks) in September 2018 and G4 south area (17 tanks) in March 2019.



Start of dismantling in H1 east area

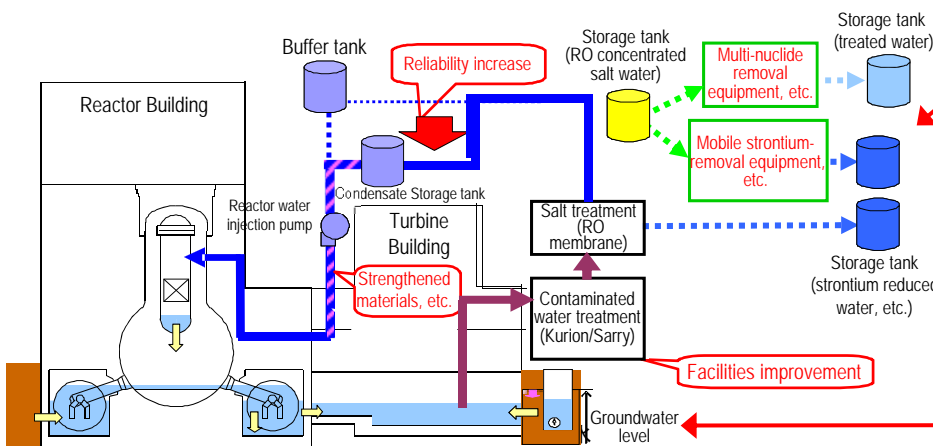


After dismantling in H1 east area

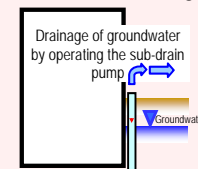
Completion of purification of contaminated water (RO concentrated salt water)

Contaminated water (RO concentrated salt water) is being treated using seven types of equipment including the multi-nuclide removal equipment (ALPS). Treatment of the RO concentrated salt water was completed on May 27, 2015, with the exception of the remaining water at the tank bottom. The remaining water will be treated sequentially toward dismantling the tanks.

The strontium reduced water from other facilities than the multi-nuclide removal equipment will be re-purified in the multi-nuclide removal equipment to further reduce risks.



Preventing groundwater from flowing into the Reactor Buildings



Reducing groundwater inflow by pumping sub-drain water

To reduce groundwater flowing into the buildings, pumping-up of groundwater from wells (subdrains) around the buildings started on September 3, 2015. Pumped-up groundwater was purified at dedicated facilities and released after TEPCO and a third-party organization confirmed that its quality met operational targets.

Via a groundwater bypass, reduce the groundwater level around the Building and groundwater inflow into the Building

Measures to pump up groundwater flowing from the mountain side upstream of the Building to reduce the groundwater inflow (groundwater bypass) have been implemented. The pumped up groundwater is temporarily stored in tanks and released after TEPCO and a third-party organization have confirmed that its quality meets operational targets. Through periodical monitoring, pumping of wells and tanks is operated appropriately. At the observation holes installed at a height equivalent to the buildings, the trend showing a decline in groundwater levels is checked.

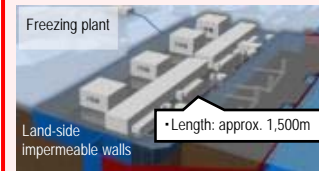
The analytical results on groundwater inflow into the buildings based on existing data showed a declining trend.

Installing land-side impermeable walls with frozen soil around Units 1-4 to prevent the inflow of groundwater into the building

To prevent the inflow of groundwater into the buildings, installation of impermeable walls on the land side is planned. Freezing started on the sea side and at a part of the mountain side from March 2016 and at 95% of the mountain side from June 2016. Freezing of the remaining unfrozen sections advanced with a phased approach and freezing of all sections started in August 2017.

In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas, while on the mountain side, the difference between the inside and outside increased to approx. 4-5 m. The 21st Committee on Countermeasures for Contaminated Water Treatment, held on March 7, 2018, evaluated that together with the function of sub-drains, etc., a water-level management system to stably control groundwater and isolate the buildings from it had been established and had allowed a significant reduction in the amount of contaminated water generated.

For the unfrozen depth, a supplementary method was implemented and it was confirmed that temperature of the part declined below 0°C by September 2018. From February 2019, maintenance operation started at all sections.



Freezing plant



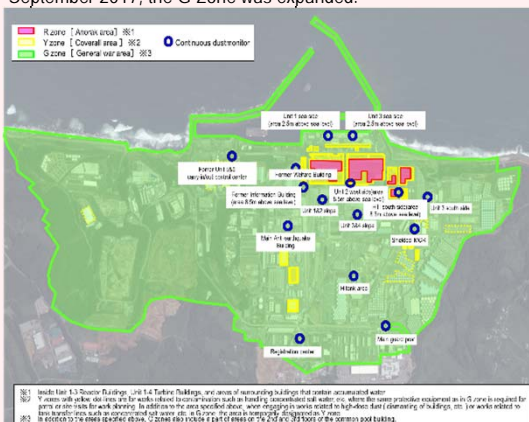
Land-side impermeable walls



## Progress toward decommissioning: Work to improve the environment within the site

### Immediate targets

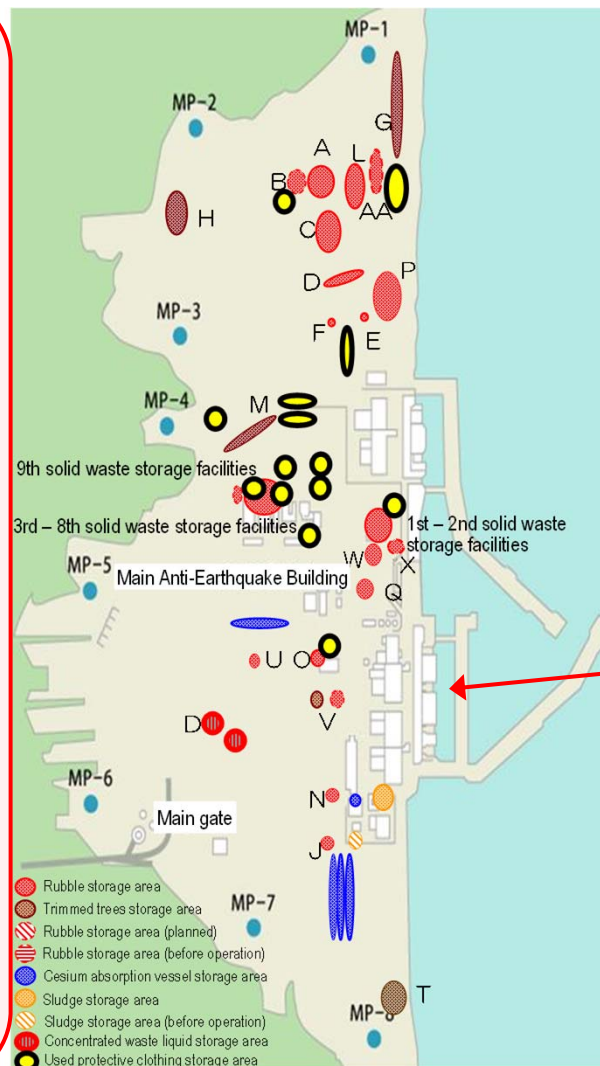
- Reduce the effect of additional release from the entire power station and radiation from radioactive waste (secondary water treatment waste, rubble, etc.) generated after the accident, to limit the effective radiation dose to below 1mSv/year at the site boundaries.
- Prevent contamination expansion in sea, decontamination within the site

**Optimization of radioactive protective equipment**  
Based on the progress of measures to reduce environmental dosage on site, the site is categorized into two zones: highly contaminated area around Unit 1-4 buildings, etc. and other areas to optimize protective equipment according to each category aiming at improving safety and productivity by reducing load during work.  
From March 2016, limited operation started. From March and September 2017, the G Zone was expanded.



R zone (Anorak area)	Y zone (Coverall area)	G zone (General wear)	
Full-face mask 	Full-face or half-face masks *1, *2  	Disposable disposable mask 	
Anorak on coverall Or double coveralls 	Coverall 	General*3 	Dedicated on-site wear 

\*1 For works in buildings including water-treatment facilities (multi-nuclide removal equipment, etc.) (excluding site visits), wear a full-face mask.  
\*2 For works in tank areas containing concentrated salt water or Sr-treated water (excluding works not handling concentrated salt water, etc., patrol, on-site investigation for work planning, and site visits) and works related to tank transfer lines, wear a full-face mask.  
\*3 Specified light works (patrol, monitoring, delivery of goods brought from outside, etc.)



### Installation of dose-rate monitors

To help workers in the Fukushima Daiichi Nuclear Power Station precisely understand the conditions of their workplaces, a total of 86 dose-rate monitors were installed by January 4, 2016.

These monitors allow workers to confirm real time on-site dose rates at their workplaces.

Workers are also able to check concentrated data through large-scale displays installed in the Main Anti-Earthquake Building and the access control facility.



Installation of Dose-rate monitor

### Installation of sea-side impermeable walls

To prevent the outflow of contaminated water into the sea, sea-side impermeable walls have been installed.

Following the completed installation of steel pipe sheet piles on September 22, 2015, connection of these piles was conducted and connection of sea-side impermeable walls was completed on October 26, 2015. Through these works, closure of sea-side impermeable walls was finished and the contaminated water countermeasures have been greatly advanced.



Installation of steel pipe sheet piles for sea-side impermeable wall

### Status of the large rest house

A large rest house for workers was established and its operation commenced on May 31, 2015.

Spaces in the large rest house are also installed for office work and collective worker safety checks as well as taking rest.

On March 1, 2016 a convenience store opened in the large rest house. On April 11, operation of the shower room started. Efforts will continue to improve convenience of workers.

